Cognitive Ability and Inconsistency in Reaction Time as Predictors of Everyday Problem Solving in Older Adults

by

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B.A., University of Saskatchewan, 2000
M.A., University of Victoria, 2002

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ABSTRACT

The purpose of the present investigation was to examine whether across-trials inconsistency in reaction time (RT), in addition to level of cognitive performance, is predictive of older adults' performance on a measure of everyday problem solving through a series of three investigations. A sample of community dwelling non-demented older adults, ranging in age from 62 to 92, completed the Everyday Problems Test (EPT), a measure of everyday problem solving that indexes instrumental activities of daily living (IADLs). Performance on the EPT varied according to age, cognitive status, and education, and was significantly predicted by measures of global cognitive status, cognitive decline, and various basic cognitive abilities (i.e., speed of processing, fluid abilities, episodic memory, crystallized abilities). Both inconsistency and mean latencies on measures of RT were found to be significantly associated with concurrent EPT performance, such that slower and more inconsistent RTs were associated with poorer everyday problem solving abilities. Finally, inconsistency in RT made a unique contribution in predicting performance on the EPT two years later, over and above age, education, and various basic cognitive abilities. Structural equation modeling analyses indicated that the relationship between inconsistency in RT and future EPT performance was mediated by fluid and crystallized abilities. Neither inconsistency nor cognitive functioning were significantly associated with changes in EPT performance across two years. Examination of the relationships between IADL functioning, as assessed through self- and informant-report, and inconsistency and basic cognitive abilities demonstrated that everyday problem solving and measures of IADLs tap into related but distinct constructs. The overall pattern of results obtained lends support to the idea that inconsistency in RT represents a behavioural marker of neurological dysfunction. In addition, the present investigation is the first to suggest a relationship between inconsistency in RT and real-world outcomes, such as everyday problem solving and IADL functioning.

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General Introduction

The study of everyday problem solving involves the investigation of individuals' performance on tasks designed to resemble the types of problems or situations they might actually encounter in daily life (Allaire & Marsiske, 1999; Willis, 1996b). Willis and Schaie (1993) described everyday problem solving as (1) the application of cognitive abilities and skills to (2) problems experienced in everyday environments that (3) are complex and multidimensional. This is in contrast to traditional psychometric or laboratory-type assessments of cognitive abilities, which tend to be relatively "acontextual," involving tasks that individuals rarely face in their daily lives (Artistico, Cervone, & Pezzuti, 2003).

Over the past couple of decades, there has been a growing interest in studying everyday problem solving in older adults, arising largely out of concerns regarding the external and ecological validity of traditional psychometric tests for use with older adults (Denney, 1989; Schaie, 1978). At issue is whether traditional measures of cognitive and intellectual abilities adequately reflect older adults' functioning in the real world (Allaire & Marsiske, 2002). For example, some authors have argued that because many psychometric measures of cognitive abilities and intelligence were designed to predict scholastic performance, their relevance to middle-aged and older adults, who are likely to be far removed from school-settings, is questionable (Cornelius & Caspi, 1987; Denney, 1989; Schaie, 1978). A second concern relates to observed discrepancies between declines on traditional psychometric measures of cognitive abilities with age and older adults' apparent ability to function successfully in everyday situations (Salthouse, 1990). Some researchers have suggested that traditional psychometric measures may underestimate older adults' performance in comparison to everyday contexts, where they can bring to use the experience and knowledge they have accumulated over the lifetime (Allaire & Marsiske, 2002; Denney, 1989). As such, many researchers have stressed the importance of using tasks that are more ecologically valid (i.e., representing problems taken from naturalistic or everyday environments) in order to more appropriately assess older adults' cognitive functioning (e.g., Allaire & Marsiske, 1999; Cornelius & Caspi, 1987; Willis, 1996a).

Emerging from these concerns, numerous investigations have examined the relationships between everyday problem solving ability and (a) age and (b) traditional psychometric measures of cognitive and intellectual abilities. The overall focus of the present discussion is to examine predictors of everyday problem solving in older adults, focusing on age and cognitive performance, both with respect to level of performance and inconsistency in performance. Initially, a brief overview of major conceptual issues pertaining to everyday problem solving in older adults will be presented, followed by a review of the literature examining the relationships between age and cognitive abilities and everyday problem solving. In the subsequent section, research pertaining to inconsistency in cognitive abilities will be reviewed and a rationale for examining everyday problem solving with respect to inconsistency will be presented.

Everyday Problem Solving: Conceptual Issues

Despite general agreement on the importance of evaluating older adults' performance on problems of everyday living, there is substantial variability in the definitions and approaches used to study everyday problem solving, with little consensus regarding defining features and the best methods of assessment (Allaire & Marsiske, 1999; Marsiske & Willis, 1995; Willis & Schaie, 1993). As Marsiske and Willis (1995) have pointed out, the diversity of terms used to describe performance on cognitive tasks of daily living (e.g., everyday problem solving, everyday cognition, practical problem solving, practical intelligence, etc.) reflects the diversity of approaches used in the literature to examine these constructs.

Two main approaches to studying everyday cognition and problem solving have been identified: problem solving on well-structured tasks versus ill-structured tasks (Allaire & Marsiske, 2002; Marsiske & Willis, 1995; Marsiske & Willis, 1998; Sinnott, 1989; Willis, 1996b). With respect to well-structured tasks, the problem, the desired goal, and potential ways of solving the problem are fairly easily identifiable; often there is a single correct answer for each problem and an optimal way in which to solve the problem (Marsiske & Willis, 1998; Sinnott, 1989; Willis, 1996b). In the case of ill-structured tasks, on the other hand, the problem, goal state, and/or strategies for solving the problem are not clearly specified, and often the problem can be solved with a variety of potential solutions (Allaire & Marsiske, 2002; Sinnott, 1989; Willis, 1996b). The use of ill-structured tasks to examine everyday problem solving is based on the assumption that many problems frequently encountered in daily life are ill-defined. In fact, some researchers suggest that most problems encountered in daily life are ill-structured (e.g., Sinnott, 1989) while others suggest that problem solving in daily life involves both well- and ill-structured tasks (Willis & Schaie, 1993).

Studies of everyday problem solving also differ with respect to the domain of everyday functioning that is investigated. One line of research has focused primarily upon tasks of everyday living that are critical to independent living, such as instrumental activities of daily living (IADLs) (e.g., Allaire & Marsiske, 1999; Allaire & Marsiske, 2002; Diehl, Willis, & Schaie, 1995; Willis, 1996a). Willis (1996b) argued that one of the major concerns for older adults is maintaining an independent lifestyle, of which an important determinant is the ability to perform instrumental activities of daily living (Fillenbaum, 1985). IADLs refer to those cognitively complex tasks essential for independent daily living, such as cooking, housework, managing finances, and taking medications, among others (Ward, Jagger, & Harper, 1998). Older adults face these types of tasks on a daily basis and limitations in these areas can compromise their ability to live independently. Willis (1996b) also suggested that because older adults spend more time on IADLs than any other type of activity, the majority of problem solving that older adults engage in should involve IADLs. Therefore, IADLs represent an important domain in which to investigate everyday problem solving.

Other researchers have also examined interpersonal/social problems encountered in everyday life and social-emotional contexts and influences on everyday problem solving (e.g., Berg, Meegan, & Deviney, 1998; Blanchard-Fields, Chen, & Norris, 1997; Blanchard-Fields, Jahnke, & Camp, 1995; Strough, Berg, & Sansone, 1996). These studies acknowledge the fact that many of the problems and challenges older adults face in daily life involve emotionally salient social situations.

Both domains (i.e., instrumental and interpersonal) are clearly important to understanding how older adults' deal with problems encountered in everyday life. However, Denney (1989) raised an issue that reinforces the importance of focusing specifically on IADLs when using everyday problem solving as an indicator of older adults' cognitive functioning. Specifically, Denney (1989) suggested that for many everyday problem solving tasks, some individuals are likely to have had more experience with the problem domain than others. If the intention is to measure ability, as is the case with traditional psychometric measures, as opposed to ability plus experience, then it is important to examine areas of everyday functioning in which all adults can be expected to have experience (Denney, 1989). IADLs represent one such domain.

Therefore, in this series of studies, the focus is on everyday problem solving in the domain of IADLs using a well-structured measure because (a) IADLs represent an important area of functioning for all older adults, and (b) previous research suggests that stronger associations are found between well-defined measures and basic cognitive abilities than with ill-defined measures (Allaire & Marsiske, 2002; Marsiske & Willis, 1995)

Age and Cognitive Abilities as Predictors of Everyday Problem Solving Ability

Several researchers have distinguished between two major theoretical perspectives, which yield different predictions regarding the relationships between age, basic cognitive abilities, and everyday problem solving ability (Allaire & Marsiske, 1999; Marsiske & Willis, 1998). The contextual/expertise-based perspective (Baltes, 1997; Berg & Sternberg, 1985; Denney & Pearce, 1989) suggests that domain-specific knowledge (both declarative and procedural) accumulates in areas in which individuals frequently participate; that this knowledge becomes decoupled from more basic cognitive abilities; and, that this knowledge is preserved with age, despite age-related losses in other basic mental abilities (Allaire & Marsiske, 1999; Marsiske & Willis, 1998). Thus, these theories predict that performance on everyday problems should be less vulnerable to the negative effects of aging that are observed with more basic cognitive abilities (Allaire & Marsiske, 1999).

An alternative theoretical perspective, which Willis and colleagues have referred to as the “hierarchical model,” argues that everyday problem solving and cognition is composed of a set of underlying basic abilities (Marsiske & Willis, 1998; Willis & Marsiske, 1991; Willis & Schaie, 1986, 1993). According to this model, everyday tasks are complex and therefore involve multiple abilities, with different tasks involving different constellations of abilities. A further assumption of the model is that although basic cognitive abilities are necessary for solving everyday problems, domain-specific knowledge is also likely to be required. This perspective predicts that age-trajectories of everyday problem solving are likely to reflect the age-trajectories of the cognitive abilities underlying each particular task (Marsiske & Willis, 1998; Willis & Marsiske, 1991; Willis & Schaie, 1986).

A number of studies have examined age differences in everyday problem solving and the relationship between everyday problem solving and basic cognitive abilities. With respect to the relationship with age, studies have reported discrepant results. For example, an early study conducted by Cornelius and Caspi (1987) provided participants, aged 20 to 78, with everyday problems from both the practical realm (e.g., managing a home) and the social realm (e.g., dealing with criticism). Each problem was presented with four possible solutions, varying in effectiveness, and participants were asked to rate the likelihood that they would select each of the possible solutions. Cornelius and Caspi (1987) reported that the older adults outperformed the younger adults. Similarly, Artistico et al. (2003) asked participants to generate as many solutions as possible to various everyday problems, and found that older adults (65-75 years of age) outperformed younger adults (20-29 years) on tasks that were specifically designed to be relevant to older adults. The younger adults, however, outperformed the older adults on the tasks specifically designed to be relevant to the younger adults. Denney and Pearce (1989) asked participants to verbally describe how they would solve ten practical problems, covering a range of everyday problem situations. The problems were specifically designed to give an advantage to older adults, but, in contrast to Cornelius and Caspi (1987) and Artistico et al. (2003), Denney and Pearce (1989) found that performance increased from the ages of 20 to 40, and decreased thereafter.

A couple of studies, focusing specifically on older adults and using more well-structured measures of everyday problem solving, have reported findings similar to those of Denney and Pearce (1989). Diehl et al. (1995) developed a performance-based measure in which participants had to actually perform tasks from three IADL domains in their homes. They found a significant negative relationship between age and performance ($ß = -.22$, $p < .05$). Using a measure of everyday problem solving in which the majority of questions represented tasks associated with IADLs, Willis, Jay, Diehl, and Marsiske (1992) reported that for a group of older adults, performance declined, on average, a magnitude of .30 *SD* over a 7 year period. However, they also found substantial interindividual variability in the patterns of change with many participants showing stability in performance. In a study using the Everyday Problems Test (EPT), a paper and pencil based task indexing IADLs developed by Willis and Marsiske (1993), age was found to be significantly correlated with everyday problem solving performance ($r = -.33$,

$p < .05$) in a sample of African American older adults (Whitfield, Allaire, & Wiggins, 2004).

Marsiske and Willis (1995) directly compared three measures of everyday problem solving in a group of older adults: Willis & Marsiske's (1993) EPT, Cornelius and Caspi's (1987) Everyday Problem Solving Inventory, and Denney and Pearce's (1989) Practical Problems Test. Age was negatively associated with the EPT, accounting for approximately 17 % of the variance in EPT scores, but was unrelated to either of the other two measures. Marsiske and Willis (1995) concluded that age differences in everyday problem solving appear to depend upon the particular measures used and the associated task demands and content covered. Consistent with this conclusion are findings from a study conducted by Camp, Doherty, Moody-Thomas, and Denney (1989). They found that age differences on problems from the Practical Problems Test (Denney & Pearce, 1989) and problems participants generated themselves, depended on who generated the problems and how they were scored.

A recent meta-analysis of everyday problem solving studies using either well- or ill-structured tasks reported a moderate effect size ($g = .54$) favouring problem solving in instrumental domains in young and middle-aged adults (18-59 years of age) over older adults (60+ years of age), but only a small effect size for problems within the interpersonal domain ($g = .21$) (Thornton & Dumke, 2005). Consistent with Camp et al. (1989), they also found that the age effects observed in studies depended upon who was rating (i.e., experimenter vs. participant) and how problems were rated (i.e., asking participants to predict which problem solving approach they would take vs. asking participants to rate how satisfied or confident they were in their performance).

Unfortunately, studies with samples restricted to older adults only (i.e., 60+) were not included in the meta-analysis due to lack of availability thereby limiting their ability to draw conclusions regarding age differences in everyday problem solving within the older adult age range.

Overall, the majority of studies seem to point towards a decline in everyday problem solving ability with age, but results are far from consistent. One illuminating study has provided a more detailed analysis of age-trajectories by examining age changes in everyday problem solving as a function of the specific cognitive abilities presumably underlying a particular task. Allaire and Marsiske (1999) developed a measure of everyday cognition, the Everyday Cognitive Battery, which contained four subtests, each designed to tap into a single cognitive ability (i.e., inductive reasoning, knowledge, declarative memory, working memory). Each subtest contained items drawn from three domains of daily living (i.e., medication use, financial planning, food preparation and nutrition). They found that everyday tasks involving fluid abilities and memory (both declarative and working memory) were negatively related to age (r = -.24 to -.45) whereas tasks involving more crystallized abilities (i.e., skills and knowledge acquired through exposure to one's culture, Horn & Noll, 1997) remained stable with age. These differential age trajectories paralleled the age-trajectories found for traditional psychometric measures of the same basic cognitive abilities. Thus, the relationship between everyday cognition and age was qualified by the particular cognitive demands of the task. This is consistent with Willis and colleagues' hierarchical model of everyday problem solving (Marsiske & Willis, 1998; Willis & Marsiske, 1991; Willis & Schaie, 1986) which would predict that age-associated declines in particular cognitive abilities would impact performance on everyday tasks that rely on those cognitive abilities. In contrast, tasks that rely more heavily on preserved cognitive abilities should not show the same age-related declines.

In fact, a number of studies have shown that various basic cognitive abilities are predictors of everyday problem solving. In a path analysis, Diehl et al. (1995) showed that measures of fluid ability (i.e., relatively culture-free cognitive operations and processes, Sattler, 2001), such as identifying patterns within sequences of figures and mental rotation tasks, and crystallized ability had a direct effect on older adults' performance on the Observed Tasks of Daily Living. Fluid abilities showed the strongest effect (fluid abilities: ß = .48, $p < .001$; crystallized abilities: ß = .22, $p < .05$). Measures of speed and memory were not directly related to performance, but exerted indirect effects through fluid and crystallized abilities. Similarly, Willis et al. (1992) reported that measures of fluid abilities significantly predicted everyday problem solving performance 7 years later, using the Test of Basic Skills, accounting for 52% of the variance. Measures of crystallized abilities, speed, and memory did not reach significance. Cornelius and Caspi (1987) described significant associations between the Everyday Problem Solving Inventory and both fluid ($r = .29$, $p < .01$) and crystallized abilities ($r = .27$, $p < .01$). Camp et al. (1989) found that nonverbal reasoning, a measure of fluid ability, predicted performance on everyday problems that were generated and scored by the experimenters. Problems that were generated by the experimenter but rated by the participants in terms of the efficacy of their solutions were related to measures of verbal knowledge and reasoning. In contrast, problems that were generated by the participants, regardless of how they were scored, were not significantly related to measures of either crystallized or fluid abilities. Kirasic, Allen, Dobson, and Binder (1996) found that measures of working memory predicted performance on a measure of everyday problems involving declarative learning (standardized path coefficient = .73). Allaire and Marsiske (1999; 2002) reported that measures of inductive reasoning, knowledge, and declarative memory were positively related to everyday cognition (r = .26 to .74), although the pattern of relationships varied depending on the particular type of everyday task.

As with the literature on age trajectories, findings across studies regarding the relationship between more basic cognitive abilities and everyday problem solving are not consistent. Marsiske and Willis (1995) suggested that inconsistent findings across studies "may have their roots in an unacknowledged multidimensionality" (p. 279). For example, consistent with Willis and colleagues' model (Marsiske & Willis, 1998; Willis & Marsiske, 1991; Willis & Schaie, 1986), the observed inconsistencies across studies may reflect, in part, different underlying cognitive demands of the various tasks used. Other dimensions along which studies have varied include age relevance, format, and problem domain. For example, Allaire and Marsiske (2002) noted differential relationships between basic cognitive abilities and everyday problem solving depending on whether well-structured or ill-structured tasks were used. Well-structured tasks were strongly related to measures of inductive reasoning, declarative memory, and verbal knowledge, whereas ill-defined tasks were not. In addition, Camp et al.'s study (1989) has clearly shown that conclusions regarding predictors of everyday problem solving depends upon the choice of stimuli and scoring schemes.

Overall, studies have shown that everyday problem solving is a complex activity, with links to age and basic cognitive abilities, depending on the particular type of task involved. It is important to note, however, that age and cognitive abilities are but a couple of the factors likely to influence older adults' performance on tasks of daily living. Willis and colleagues (Marsiske & Willis, 1995; Willis, 1996b; Willis & Schaie, 1993) have advocated a multidimensional view of everyday problem solving, suggesting that everyday problem solving is also influenced by social, emotional, and environmental factors, as well as personality, beliefs, and health. As such, Marsiske and Willis (1995) have argued that the field needs to move towards specifying precisely what aspects and dimensions of everyday cognition are being studied.

Inconsistency in Cognitive Performance

Consistent with most developmental and aging research, studies conducted to date examining predictors of everyday problem solving ability have focused exclusively on *level* of cognitive performance. However, *inconsistency* in cognitive performance has recently received increased attention in other areas of cognitive aging, with researchers arguing that performance inconsistency, or intraindividual variability, is an important phenomenon for study (e.g., Hultsch, MacDonald, Hunter, Levy-Bencheton, & Strauss, 2000; Martin & Hofer, 2004; Rabbitt, 2000; Stuss, Pogue, Buckle, & Bondar, 1994).

The study of variability has a long tradition in psychology, but the type of variability traditionally of interest has been *interindividual* variability. Sometimes referred to as *diversity*, this form of variability involves examining differences between individuals on a single task administered on a single occasion (Hultsch & MacDonald, 2004; Hultsch, MacDonald, & Dixon, 2002). In this type of research, individual differences in level of performance for a given behaviour or psychological ability is the primary focus and is based on the assumption that the behaviour of interest reflects a relatively stable characteristic of a person that is adequately captured by a single measurement.

In contrast to interindividual variability, *intraindividual* variability has received much less attention in the psychological literature until recently. This term, as used by Nesselroade (1991a; 1991b), refers to relatively short-term, reversible changes in a person's performance or functioning, such as with changes in mood or emotion. Nesselroade (1991a; 1991b) contrasts this form of within-person change with another, referred to as intraindividual change, which also has a long and rich tradition in life-span developmental psychology. Intraindividual change involves more or less enduring changes associated with, for example, development or learning. Nesselroade (1991a; 1991b) argues that both forms of within-person change are involved in determining a person's behaviour at a given instance of measurement and, therefore, intraindividual variability should also be considered in developmental research.

Hultsch and colleagues (Hultsch & MacDonald, 2004; Hultsch et al., 2002) have further clarified the concept of intraindividual variability by distinguishing between two forms: *dispersion* and *inconsistency*. Dispersion refers to variability in a single person's performance across different tasks administered on a single occasion. Inconsistency, on the other hand, refers to variability in a single person's performance within a single task over relatively short periods of time, such as across trials within the same testing session (i.e., moment to moment fluctuations) or across testing sessions separated by hours, days, or weeks. It is important to note that these concepts have been labelled and defined in many ways. For example, some researchers have differentiated within-person variability within a single occasion from within-person variability across occasions, referring to the former as dispersion and the latter as consistency (Shammi, Bosman, & Stuss, 1998; Stuss, Murphy, Binns, & Alexander, 2003; Wegesin & Stern, 2004; West, Murphy, Armilio, Craik, & Stuss, 2002). The focus of this discussion is on inconsistency as defined by Hultsch and colleagues (Hultsch & MacDonald, 2004; Hultsch et al., 2002).

Nesselroade and Salthouse (2004) suggest that, typically, a behavioural measurement is assumed to reflect a combination of: (a) the construct of interest; (b) other irrelevant constructs; (c) short-term fluctuations associated with, for example, shifts in arousal and motivation; and (d) measurement error. Variability in an individual's scores taken on different occasions is assumed to reflect the last two kinds of influences, and hence considered to be "noise" or "error." However, proponents of the study of intraindividual variability argue that such variability is not necessarily "noise" or "error", but is often a "signal" in its own right, deserving of measurement and explication (Nesselroade, 1991b; Nesselroade & Salthouse, 2004). For example, Nesselroade (1991a) describes intraindividual variability as "a coherent, interpretable steady-state 'hum' that describes the base condition of the individual" (p.94). In fact, research to date suggests that inconsistency in performance does not simply represent random errors, but rather appears to be a function of lawful, yet fluctuating, influences on behaviour (Hultsch et al., 2000; Nesselroade & Featherman, 1997; Slifkin & Newell, 1998).

Inconsistency refers to within-person variability that is independent of relatively durable and systematic changes, such as practice effects, fatigue, and learning to learn. Therefore, in order to examine inconsistency, it is important to dissociate systematic effects associated with repeated measurements from the more transient, yet lawful changes of interest (Hultsch et al., 2000). Hertzog, Dixon and Hultsch (1992) showed that inconsistency in cognitive performance could be reliably measured independent of systematic effects. They examined story memory in seven healthy older women, assessed weekly for up to 2 years. They found that participants demonstrated substantial inconsistency in performance across occasions, of which more than 20% was reliable variance that could not be accounted for by practice or material effects. A number of other studies have also demonstrated that inconsistency in performance can be reliably measured independent of systematic within-person variability (e.g., Hultsch et al., 2002; Hultsch et al., 2000; Li, Aggen, Nesselroade, & Baltes, 2001; Rabbitt, Osman, Moore, & Stollery, 2001).

Studies have also shown that inconsistency can be substantial in magnitude. For example, Nesselroade and Salthouse (2004) found that the magnitude of inconsistency on perceptual-motor tasks (both within-session and across-occasion inconsistency) ranged from 37% to 53% of the magnitude of between-persons variability in a sample of individuals ranging in age from 20 to 91. Similarly, in a study examining inconsistency in biweekly assessments of older adults' sensorimotor and memory functioning, Li et al. (2001) reported that the magnitude of inconsistency was approximately half the magnitude of individual differences. In a study examining across-occasion inconsistency on measures of reaction time, Salthouse and Berish (2005) reported that inconsistency was of approximately the same magnitude as the between-persons variability.

Inconsistency in performance also appears to be a relatively stable characteristic of an individual, such that some individuals tend to be more variable than others (Hultsch & MacDonald, 2004). A number of investigators have shown that individuals who are more inconsistent across trials within a testing session also tend to be more inconsistent across occasions (Hultsch et al., 2000; Nesselroade & Salthouse, 2004; Rabbitt, 2000; Rabbitt et al., 2001). Similarly, individuals who show more inconsistency on one task tend to show greater inconsistency on other tasks as well (Hultsch et al., 2002; Hultsch et al., 2000; Lecerf, Ghisletta, & Jouffray, 2004; Li et al., 2001). There is even evidence of across-domain relationships, such that greater inconsistency in one domain (e.g., cognitive) is related to greater inconsistency in another domain, such as physical functioning (Li et al., 2001; Strauss, MacDonald, Hunter, Moll, & Hultsch, 2002). For example, Li et al. (2001) found that inconsistency on walking tasks across biweekly sessions was positively correlated with inconsistency in text and spatial memory performance in older adults. Taken together, these findings indicate that relatively stable individual differences in inconsistency do exist (MacDonald, Hultsch, & Dixon, 2003).

Further data supporting the importance of inconsistency come from studies showing that inconsistency in performance predicts level of performance (Hultsch et al., 2002; Hultsch et al., 2000; Lecerf et al., 2004; Li et al., 2001; Nesselroade & Salthouse, 2004; Rabbitt, 2000; Rabbitt et al., 2001). In general, greater inconsistency in cognitive performance has been shown to be associated with poorer levels of cognitive performance (Hultsch et al., 2000; Nesselroade & Salthouse, 2004; Rabbitt et al., 2001). For example, individuals who are more inconsistent on measures of reaction time (RT) also tend to be slower and less accurate on these same measures (Hultsch et al., 2000). Rabbitt et al. (2000) showed that greater inconsistency in older adults' RT, both across trials and across sessions, was associated with lower levels of intelligence. Hultsch et al. (2002) reported that greater across-trials inconsistency on measures of RT was associated with poorer performance on measures of perceptual speed, working memory, episodic memory, and crystallized abilities. Although these studies examined the cross-sectional relationships between inconsistency and level of performance, a recent longitudinal study of older adults (MacDonald et al., 2003) showed that across-trials inconsistency in RT was predictive of changes in level of cognitive performance across a 6-year interval and that inconsistency and cognitive performance covaried across the 6 years.

Not only does inconsistency predict level of performance, but that it also appears to provide information that is distinct from level of performance (Hultsch & MacDonald, 2004). Several studies have shown that inconsistency in cognitive performance and level of performance are independent predictors of performance on other cognitive tasks (Hultsch et al., 2002; Hultsch et al., 2000; Jensen, 1982; Li et al., 2001; Rabbitt, 2000). For example, Hultsch et al. (2002) found that across-trials inconsistency on RT tasks accounted for a significant proportion of the variance (11-20%) on other cognitive measures independent of mean level of RT. Based on analyses of inconsistency across-trials on measures of RT, Jensen (1992) concluded that inconsistency and measures of central tendency (e.g., mean, median), although highly related, reflect independent sources of variance. Similarly, using various measures of visual working memory, Lecerf et al. (2004) demonstrated that level of performance and inconsistency indices shared considerable variance with one another within the same task, but that the inconsistency indices also shared specific variance.

In summary, the concept of inconsistency in cognitive performance has become a primary outcome of interest in psychological research, in addition to mean level of performance. Inconsistency in cognitive performance is no longer automatically considered to reflect measurement error. Rather, various studies have shown that inconsistency can be reliably measured, is substantial in magnitude (even after accounting for more systematic changes over time), and appears to represent a relatively stable characteristic of individuals. Furthermore, indices of inconsistency appear to provide valuable information that is independent of level of performance.

Inconsistency and Aging

The study of inconsistency in cognitive performance has most often been investigated from an aging perspective. That is, are there age-differences associated with inconsistency? The answer thus far appears to be yes, with most studies finding evidence of greater inconsistency for older adults in comparison to younger adults (Anstey, 1999; Anstey, Dear, Christensen, & Jorm, 2005; Fozard, Vercruyssen, Reynolds, & Hancock, 1994; Hultsch et al., 2002; Li et al., 2001; Nesselroade & Salthouse, 2004; Wegesin & Stern, 2004; West et al., 2002; Williams, Hultsch, Strauss, Hunter, & Tannock, 2005). The majority of studies have examined inconsistency using measures of RT, showing that inconsistency across trials increases with age (Anstey, 1999; Anstey et al., 2005; Fozard et al., 1994; Hultsch et al., 2002; Nesselroade & Salthouse, 2004; West et al., 2002; Williams et al., 2005). For example, Anstey (1999) examined the performance of 180 women, ranging in age from 60 to 90 on various RT tasks and found that inconsistency across trials increased with age. Some support for age-related increases in inconsistency has been found in longitudinal studies. Fozard (1994) demonstrated that inconsistency in RT increased with age over an 8-year period. MacDonald et al. (2003) found that inconsistency across a 6-year period increased for adults aged 75 to 89, but not for those aged 55 to 74.

Although most studies have used RT measures, a few studies have used other measures of cognitive performance and have found similar age-related increases in inconsistency. Li et al. (2001) examined inconsistency in a group of older adults aged 64 to 86 on sensorimotor measures, assessed across 13 biweekly sessions, and memory measures, assessed across 25 weekly sessions. They found that inconsistency on sensorimotor measures (i.e., walking tasks) and text memory were positively correlated with age, but that memory span and spatial memory were not. In a study examining the effects of estrogen use on inconsistency, Wegesin and Stern (2004) examined inconsistency on an item-source recognition memory task that was administered 16 times during the course of a single testing session in a group of younger women (ages 18-28) and older women (ages 60-80). They found that the younger women were less inconsistent than the older women. Nesselroade and Salthouse (2004) examined perceptual motor performance on 3 separate occasions within a 2-week period in a group of participants ranging in age from 20 to 91. They found that greater inconsistency, both within sessions and across the 3 sessions, was associated with increased age.

Some investigators have suggested that the observed age-related increases in inconsistency are attributable to corresponding increases in mean level of performance (Hale, Myerson, Smith, & Poon, 1988; Salthouse, 1993). Inconsistency is often indexed by the within-person *SD* (i.e., ISD) and the *SD* is known to increase as a statistical artefact of increases in mean RTs (Hale et al., 1988). So, older adults may show greater inconsistency in RT simply because their mean RTs are larger than younger adults. For example, Shammi et al. (1998) examined inconsistency across trials on two psychomotor tasks (choice-RT, finger tapping) and time estimation in a group of younger adults (20-35 years old) and older adults (60-75 years old). They found that the older adults demonstrated greater inconsistency on both of the psychomotor tasks but that controlling for mean level of performance eliminated the effect for choice-RT. Many studies reporting age-related increases in inconsistency have failed to control for group differences in mean level of performance (e.g., Anstey, 1999; Fozard et al., 1994; Nesselroade & Salthouse, 2004) but some have and have still found age-related increases in inconsistency (e.g., Anstey et al., 2005; Hultsch et al., 2002; Williams et al., 2005). Thus, increases in inconsistency with age do not necessarily reflect a statistical artefact of average differences in level of performance.

There is some evidence to suggest, however, that age differences in inconsistency may vary as a function of tasks demands. Hultsch and MacDonald (2004) have suggested that age differences may be particularly apparent on tasks that place greater demands on executive processes, but attenuated on tasks in which older adults' can use their relatively well-preserved verbal abilities as compensatory mechanisms. For example, West et al. (2002) examined inconsistency across 4 days of testing on four choice RT tasks, varying in the demands placed on executive control processes. They found that the group of older adults (aged 65 to 83) were more inconsistent, both within and across sessions, than the younger group (aged 19 to 29), but only for a task requiring higher levels of executive control. Group differences were not observed for tasks placing fewer demands on executive control processes. Other studies have also found evidence to suggest that inconsistency increases with greater complexity of the task, with the largest group differences appearing on more complex tasks (e.g., choice RT) compared to simpler tasks (e.g., simple RT) (Anstey et al., 2005; Bunce, MacDonald, & Hultsch, 2004; Hultsch et al., 2000).

In study that included both verbal and nonverbal RT tasks, Hultsch et al. (2002) found larger age group differences on nonverbal RT tasks (i.e., simple and choice visual RT) than for verbal RT tasks (i.e., lexical and semantic decisions tasks). They hypothesized that the greater verbal facility of older adults may have served as a compensatory mechanism resulting in a reduction in inconsistency on the verbal tasks. Interestingly, a later study conducted by the same group (MacDonald et al., 2003) showed that changes in inconsistency across a 6-year interval were actually greater for verbal than nonverbal tasks in the oldest group (aged 75-89). They suggested that the observed pattern might have reflected decreases in the ability of the oldest group to compensate on verbal tasks because of declines in their overall verbal abilities, which typically begin to show a decline around age 75.

Overall then, studies conducted to date suggest that inconsistency in cognitive performance increases with age. However, the pattern of age-related changes in inconsistency appears to vary depending on task demands and task complexity. In addition, some findings of age-related increases in inconsistency may simply reflect a concomitant increase with age in mean RTs, but not all, as a number of studies have controlled for level of performance and have continued to find age differences in inconsistency.

The Nature of Inconsistency

On a theoretical level, a number of hypotheses regarding the nature of inconsistency in cognitive performance have been put forth. Some investigators have attributed inconsistency to cognitive mechanisms (e.g., Bunce, Warr, & Cochrane, 1993; Stuss, Stethem, Hugenholtz, & Picton, 1989; West, 1999) whereas others have focused more on neurobiological mechanisms (e.g., Eysenck, 1982; Hendrickson, 1982; Jensen, 1992; Li & Lindenberger, 1999; Reed, 1998). At the cognitive level, inconsistency on RT tasks has primarily been attributed to attentional and executive control abilities. For example, Stuss and colleagues (Stuss & Alexander, 2000; Stuss et al., 1989) have proposed that increased inconsistency reflects an inability to sustain the "top-down" effort, or focused attention, required to maintain consistent performance. Similarly, Bunce et al. (1993) suggested that the intermittent occurrence of particularly slow responses on RT tasks represent occasional attentional lapses that arise as a result of brief interruptions to an individual's ability to inhibit irrelevant information. They also proposed that older adults have a less effective inhibitory mechanism, resulting in greater inconsistency. West's research (West, 1999; West et al., 2002) has lead him to speculate that inconsistency in cognitive performance is due to fluctuations in the efficiency of executive control processes. West et al. (2002) suggested that the efficiency of executive control processes fluctuates more in older adults than in younger adults, resulting from an age-related decline in the functional integrity of the prefrontal cortex.

A number of theorists have attributed increased inconsistency to neurobiological mechanisms based on observed links between inconsistency and neurological dysfunction (e.g., Eysenck, 1982; Hendrickson, 1982; Jensen, 1992; Li & Lindenberger, 1999; Reed, 1998). Specifically, past research has shown that individuals with various neurological conditions, such as dementia (Hultsch et al., 2000; Knotek, Bayles, & Kaszniak, 1990; Murtha, Cismaru, Waechter, & Chertkow, 2002), epilepsy (Bruhn & Parsons, 1977), traumatic brain injury (Bleiberg, Garmoe, Halpern, Reeves, & Nadler, 1997; Collins & Long, 1996; Stuss et al., 2003; Stuss et al., 1994), Parkinson's disease (Burton, Strauss, Hultsch, Moll, & Hunter, 2006), and Attention-Deficit/Hyperactivity Disorder (Leth-Steensen, Elbaz, & Douglas, 2000), demonstrate greater inconsistency than healthy controls on various cognitive measures, such as RT, finger tapping, and memory. These results have lead several researchers to suggest that inconsistency may be a behavioural marker of compromised neurobiological mechanisms associated with aging, disease, or injury (e.g., Bruhn & Parsons, 1977; Li & Lindenberger, 1999).

For instance, Eysenck (1982) and Hendrickson (1982) proposed that inconsistency in RT is attributable to random errors in the transmission of neural signals in the central nervous system. Li and Lindenberger (1999) further proposed that increased random inconsistency in the central nervous system is related to breakdowns in the modulation of neurotransmitter systems. According to Li and Lindenberger (1999), catecholamines (e.g., dopamine, epinephrine, norepinephrine) serve as neuromodulators of information processing by enhancing a neuron's responsiveness to incoming signals. Age-related decreases in the concentration of catecholamines leads to a "noisier (or with a higher level of random variability) information processing system" (p. 117).

Other models regarding the neural mechanisms underlying inconsistency have been proposed by Jensen (1992) and Reed (1998). Jensen's "neural oscillation model" (1992) posits that individual differences in the rates of oscillation in neurons' excitatory potential cause individual differences in variability in RT across trials. When incoming signals arrive at a neuron that is at a sub-threshold level of excitation, a response takes longer than when incoming signals arrive during a superthreshold phase. Therefore, individuals with slower rates of oscillation are hypothesized to produce some very fast RTs (when the stimulus coincides with a superthreshold phase) and some much longer RTs (when the stimulus coincides with the subthreshold phase). Jensen (1992) has also proposed that degree of myelination contributes to inconsistency. Incomplete myelination or demyelination, as may be observed with increasing age, causes "leakage" of action potentials between neurons, contributing to the amount of "noise" or interference in the neural transmission of information. Reed (1998), on the other hand, attributed inconsistency in RT to different neuronal pathways, of differing lengths, being taken on different individual trials.

In short, various explanations regarding the phenomenon of inconsistency in cognitive performance have been proposed. Findings of increased inconsistency in older adults and individuals with neurological conditions support the idea that increased inconsistency may be indicative of compromised neurobiological mechanisms, although the exact nature of the neurobiological and cognitive mechanisms involved is still up for debate. Inconsistency in performance is also likely to be a function of, at least partly, more exogenous factors that are more dependent on external environmental conditions (e.g., shifts in affect, perceived competence, stress, fatigue, pain). However, findings of increased inconsistency in physical functioning in older adults (Li et al., 2001) and in individuals with neurological disturbances (Burton, Hultsch, Strauss, & Hunter, 2002; Goldstein, Bartzokis, Hance, & Shapiro, 1998; Nakamura et al., 1997; Strauss et al., 2002) are consistent with the idea that inconsistency represents a behavioural marker of neurobiological functioning, as both cognitive and physical functioning are dependent upon the integrity of the central nervous system (Strauss et al., 2002). In addition, the relative consistency with which individual differences in inconsistency are observed is what one would expect to see if inconsistency is substantially influenced by relatively stable endogenous mechanisms, such as neurological disturbance, than by relatively labile exogenous influences, such as pain, fatigue, and stress (Hultsch et al., 2000; MacDonald et al., 2003).

Research Questions

As previously mentioned, research on everyday problem solving has thus far only examined whether mean level of performance on various cognitive abilities is predictive of everyday problem solving in older adults. However, given the previously observed links between (1) inconsistency and level of cognitive performance and (2) basic cognitive abilities and everyday problem solving abilities, a question arises as to whether or not inconsistency in cognitive performance may also be related to older adults' ability to solve cognitively complex everyday problems. One might expect inconsistency to be predictive of everyday problem solving because the ability to solve everyday problems is dependent upon various cognitive abilities, all of which are dependent upon the integrity of the central nervous system. Therefore, if increased inconsistency in cognitive functioning is a marker of neurological dysfunction, then compromise in the central nervous system should be manifested in decreased cognitive abilities, and in turn, in decreased everyday problem solving ability.

Thus, the main objective of the present investigation was to examine whether inconsistency in RT, in addition to level of cognitive performance, is predictive of older adults' performance on a measure of everyday problem solving. This question was addressed in a three-part study.

General Methodology

The data for this study originate from a four-year longitudinal study. The first two research questions were based upon data collected from the first year of the study. The third research question was based upon data collected from the first and third years of data collection.

Participants were recruited for the study through local media (newspaper and radio advertisements) requesting healthy community-dwelling volunteers who were concerned about their cognitive functioning. Potential participants were initially screened for exclusion criteria by a telephone interview. Exclusionary criteria included a diagnosis of dementia by their physician or a Mini Mental Status Examination (MMSE) (Folstein, Folstein, & McHugh, 1975) less than 24, a history of significant head injury (defined as loss of consciousness for more than five minutes), other neurological or major medical illnesses (e.g., heart disease, cancer, Parkinson's disease), severe sensory impairment, extensive drug or alcohol abuse, current psychiatric diagnoses, or psychotropic drug usage.

Individuals identified as potential participants then attended a group testing session to assess multiple aspects of cognitive functioning using five indicators: perceptual speed (WAIS-R Digit Symbol Substitution, Wechsler, 1981), inductive reasoning (Letter Series, Thurstone, 1962), episodic memory (Immediate Free Word Recall, Hultsch, Hertzog, & Dixon, 1990), verbal fluency (Controlled Associations, Ekstrom, French, Harman, & Dermen, 1976), and vocabulary (Extended Range Vocabulary, Ekstrom et al., 1976). Participants also provided information regarding demographic characteristics and self-ratings of health.

Following the group testing session, an individual intake interview was completed with each participant at which time participants provided information about medication use. They also completed a series of benchmark cognitive measures, including the MMSE, the Wechsler Adult Intelligence Scale-III (WAIS-III) Block Design and Vocabulary subtests (Psychological Corporation, 1997) and the North American Adult Reading Test (NAART, Blair & Spreen, 1989). Estimates of current general intellectual status (Full-Scale IQ or FSIQ) were computed based on the age-adjusted Block Design and Vocabulary subtest scaled-scores (Sattler & Ryan, 1999), and estimates of premorbid intellectual status were based on the NAART (Blair & Spreen, 1989). Participants were also asked to rate their level of difficulty with five basic activities of daily living (ADLs; walking across a room, bathing self, dressing self, getting up from a bed or chair, climbing stairs) and 4 IADLs (walking several blocks, managing finances, performing household activities, driving a car), on a scale of 0 to 2, ranging from no difficulty, to some difficulty, and finally to a lot of difficulty. A total score was obtained by summing participants' responses across the 9 activities, with higher scores indicating greater difficulties with ADLs/IADLs.

Following the intake interview, participants were assessed on five separate sessions by a team of research assistants who were trained to administer the battery of tests. Participants were tested approximately bi-weekly (although time intervals between testing sessions ranged anywhere from 3 days to 4 weeks because of scheduling conflicts, holidays and illnesses) in their homes. During each session, they completed a battery of cognitive tasks (e.g., RT, episodic memory) and state-like indicators of physical functioning (e.g., gait, blood pressure, respiratory functioning) and emotional functioning (e.g., beliefs, affect). Participants completed a measure of everyday problem solving (EPT, Willis & Marsiske, 1993) during the 4th or 5th session or occasionally during a separate session between sessions 4 and 5 when it was anticipated that a participant might require additional time in order to complete it.

For each of the following waves of testing (i.e., years 2 to 4), the structure of the sessions remained the same. In the initial session, participants provided information regarding any changes in their health, medication use, and educational attainment in the past year, and the benchmark cognitive measures were re-administered. In contrast to the first year, only four sessions of testing (instead of five) were completed starting in year 2. Participants were again tested approximately biweekly on the same battery of cognitive tasks and indicators of physical and emotional functioning. In year 3, self- and informant-reported versions of an IADL scale (Lawton & Brody, 1969) were introduced and thus participants and designated informants also completed measures of IADL functioning.

Research Question 1: Cognitive Functioning and Everyday Problem Solving in Older Adults

Introduction

The objective of Research Question 1 was two-fold. The first aim was to characterize the everyday problem solving performance of a group of non-demented older adults, ranging in functioning from cognitively-intact to mildly impaired but not yet demented. In particular, performance on the EPT was examined as a function of age, gender, cognitive status, and education. Given the strong links between everyday problem solving and cognition, it was expected that EPT performance would vary as a function of cognitive status. The effects of demographic variables were less certain given the contradictory findings in the existing literature.

The second aim was to investigate the relationship between cognitive functioning and everyday problem solving. Measures of global cognitive functioning (e.g., MMSE) have sometimes been used as predictors of functional abilities and everyday problem solving in past research (e.g., Bertrand, Willis, & Sayer, 2001; Njegovan, Man-Son-Hing, Mitchell, & Molnar, 2001; Willis et al., 1998) and, therefore, the association of everyday problem solving with the MMSE was investigated. However, a number of other specific cognitive abilities have also been shown to be important predictors. Therefore, the association of everyday problem solving with measures of memory, speed of processing, crystallized ability, and fluid ability, was examined to determine whether measures of specific cognitive abilities *are even more useful* in predicting problem solving abilities than measures of global cognitive functioning. In addition, an estimate of cognitive decline was included in order to assess whether the extent of decline from presumed premorbid levels would relate to everyday problem solving competence.

Methods

Participants

Data from a total of 291 older adults (204 women and 87 men), ranging in age from 64 to 91 ($M = 73.94$, $SD = 5.84$) were analyzed for the first study. Participants were categorized into two age groups: young-old ($n = 163$, $M = 69.67$ years, $SD = 2.72$, range 64-74) and old-old ($n = 128$, $M = 79.38$ years, $SD = 3.92$, range 75-91). Participants were predominantly Caucasian (99.3%).

Participants were also categorized on the basis of cognitive status, which ranged from cognitively intact to mildly impaired but not yet demented. Although researchers agree that there are important intermediate states along a continuum of cognitive functioning between normal, healthy cognition and dementia, there is no consensus with respect to the criteria used to define these states or the terms used to denote them (Palmer, Fratiglioni, & Winblad, 2003; Tuokko & Frerichs, 2000). Some of the most commonly used terms have included Age-Associated Cognitive Decline (Levy, 1994), Mild Cognitive Impairment (Petersen et al., 2001), and Mild Neurocognitive Disorder (American Psychiatric Association, 1994), all of which are associated with varying inclusion and exclusion criteria (Collie & Maruff, 2002). For example, definitions differ in terms of the requirement for a memory deficit (e.g., Petersen et al., 2001) versus the presence of impairment in other cognitive domains (Levy, 1994). Requirements for self-reported cognitive impairment and impairments in activities of daily living also differ amongst the various labels, with impaired daily living required for a diagnosis of Mild

Neurocognitive Disorder, but not for Mild Cognitive Impairment. In light of this lack of consensus, we have chosen to use the term Cognitively Impaired, No Dementia (CIND), which is a more general, inclusive term that encompasses many of these various definitions (Tuokko & Frerichs, 2000).

Classifying the participants on the basis of cognitive status is ideally done using norms from a set of reference cognitive tasks obtained from a separate sample. Normative data were available on five cognitive measures (perceptual speed – WAIS-R Digit Symbol Substitution, Wechsler, 1981; inductive reasoning - Letter Series, Thurstone, 1962; episodic memory – immediate free word recall, Hultsch, Hertzog, & Dixon, 1990; verbal fluency - Controlled Associations, Ekstrom, French, Harman, & Dermen, 1976; and vocabulary - Extended Range Vocabulary, Ekstrom et al., 1976) from an independent sample of 445 adults aged 65 to 94 years recruited from the same population[1]. Although published norms are available for most of these measures, they derive from a variety of different samples with varying demographic characteristics. The use of local norms derived for all tasks on the same population is preferred given the close demographic match to the current sample and the ability to make more accurate comparisons across tasks.

The normative sample was partitioned into four age by education groups (age = 65-74 years and 75+ years; education = 0-12 years and 13+ years). Means and standard deviations were computed for these groups for the five measures and these normative values were used to classify participants from the present sample on the basis of cognitive

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[1] Data on all 445 participants were available for the measures of perceptual speed, reasoning, verbal fluency, and vocabulary, but, due to implementation of a counterbalancing procedure, information on the episodic memory task was only available for 194 of the 445 participants of the normative sample.

status. We used a relatively liberal definition of CIND based on criteria adapted from Levy (1994); specifically, participants were classified as possible CIND if they obtained scores more than 1.0 *SD* below the mean of their age- and education-matched peers from the normative sample on the cognitive reference tasks. Using this basic definition, three cognitive status groups were identified. Participants were classified as CIND-Single (CIND-S, $n = 77$) if they scored more than 1.0 *SD* below their normative peers on one of the five cognitive reference tasks. Participants were classified as CIND-Multiple (CIND-M, $n = 52$) if they scored more than 1.0 *SD* below their normative peers on two or three of the five cognitive reference tasks. The remaining participants (N = 162) were classified as not cognitively impaired (NCI).

Table 1 shows the age, education, self-reported health, and benchmark cognitive status of the participants as a function of age and cognitive status. To examine group differences in age a one-way ANOVA was conducted. In addition, 2 (young-old, old-old) by 3 (NCI, CIND-S, CIND-M) between-subjects ANOVAs were conducted for each of the other descriptive variables. Significant Cognitive Status main effects were observed for Education: $F\ (2,285) = 7.35$, $p = .001$; Number of Chronic Illnesses: $F\ (2, 285) = 3.16$, $p = .04$; Self-Reported ADLs: $F\ (2,285) = 4.26$, $p = .015$; WAIS-III Block Design: $F\ (2,285) = 19.81$, $p < .001$; WAIS-III Vocabulary: $F\ (2,285) = 22.52$, $p < .001$; WAIS-III Estimated Full-Scale IQ: $F\ (2,285) = 34.70$, $p < .001$; and NAART Estimated IQ: $F\ (2,285) = 31.25$, $p < .001$. Significant Age Group main effects emerged for Education: $F\ (1,285) = 7.73$, $p = .006$; Number of Chronic Illnesses: $F\ (1,285) = 13.87$, $p < .001$; Self-Reported ADLs: $F\ (1,285) = 28.35$; $p < .001$; and NAART Estimated IQ: $F\ (1,285) =$

4.10, p =.044. A Significant Age Group x Cognitive Status interaction was observed for NAART Estimated IQ: F (2,285) = 3.07, p = .048.

Table 1

Descriptive Statistics for Demographic and Cognitive Benchmark Variables Across Age and Cognitive Status Groups

	NCI		CIND-S		CIND-M	
	Young-Old (n = 92)	Old-Old (n = 70)	Young-Old (n = 44)	Old-Old (n = 33)	Young-Old (n = 27)	Old-Old (n =25)
Age						
M	69.38	78.49	69.98	80.64	70.15	80.20
SD	2.86	3.29	2.50	4.42	2.57	4.35
Education (years)						
M	16.34	14.69	15.14	14.82	14.33	13.00
SD	2.88	3.20	3.05	3.30	2.82	2.68
Chronic Illness [a]						
M	2.35	3.11	2.45	3.94	3.15	3.60
SD	1.72	1.99	1.63	1.85	2.03	1.96
Self-report ADLs [b]						
M	0.70	1.94	0.89	2.30	1.37	3.32
SD	1.49	2.49	1.65	2.46	2.47	3.42
Block Design [c]						
M	13.07	13.07	12.25	11.03	10.52	10.64
SD	2.68	3.09	2.72	2.08	1.70	2.61
Vocabulary [c]						
M	15.42	15.39	14.50	14.52	13.52	12.12
SD	2.01	2.29	2.65	3.05	2.90	2.32
WAIS-III Est. FSIQ						
M	124.52	124.43	119.50	115.91	111.67	107.96
SD	10.77	12.23	11.22	11.85	11.33	10.66
Est. NAART IQ						
M	119.34	117.92	115.67	116.67	113.27	108.92
SD	4.63	4.54	6.81	7.39	7.55	8.22

Note . [a]Chronic Illness consists of self-reported presence of 16 chronic conditions during the past year.

[b] Self-report ADLs consists of self-reported ability to perform 9 ADL/IADL tasks, higher scores indicate poorer performance.

[c]WAIS-III Scaled Score.

Posthoc contrasts using Tukey's HSD ($p < .05$) for unequal N's and one-way ANOVAs indicated that the NCI and CIND-S groups were more highly educated than the CIND-M group. The NCI group reported better IADL functioning than the CIND-M group. For WAIS-III Block Design and WAIS-III Estimated Full-Scale IQ, all three groups differed significantly from one another with the NCI group obtaining the highest scores and the CIND-M group obtaining the lowest scores. On WAIS-III Vocabulary, both the NCI and CIND-S groups scored higher than the CIND-M group. Despite a significant *F*-test for group differences in cognitive status for the number of chronic illnesses, posthoc contrasts failed to reach significance ($p < .05$). The Young-Old group were more highly educated and reported fewer chronic illnesses and better IADL functioning than the Old-Old group. With respect to the NAART Estimated IQ, the NCI group performed better than the CIND-M group for both Young-Old and Old-Old participants. In addition, the NCI group outperformed the Young-Old CIND-S participants but not the Old-Old CIND-S participants.

Measures

Global clinical assessment. The Mini Mental Status Examination (MMSE; Folstein et al., 1975) is a brief screening measure for cognitive impairment that assesses orientation, attention, immediate and delayed memory, language, and constructional praxis. Scores range from 0 to 30 with higher scores indicating better cognitive functioning.

IQ discrepancy. For each participant, an estimate of cognitive decline was computed by subtracting the estimate of current intellectual functioning (i.e., WAIS-III Estimated IQ) from the estimate of premorbid intellectual functioning (i.e., Estimated NAART IQ).

Speed of processing. Trail Making Test Part A (Reitan & Wolfson, 1985) is a timed test of psychomotor speed and visual scanning in which participants are asked to connect randomly arranged numbers in ascending order as quickly as possible. Scores are based on the time to complete the task with higher scores reflecting poorer performance. The Wechsler Adult Intelligence Scale-Revised (WAIS-R) Digit Symbol Substitution subtest (Wechsler, 1981) is a measure of processing speed that requires participants to draw the correct symbols beneath a series of digits according to a key displaying pairs of digits and symbols. Participants have a maximum of 90 seconds to complete as many symbols as possible. Scores are based on the number of correctly copied symbols, with possible scores ranging from 0 to 93.

Fluid ability. Trail Making Test Part B (Reitan & Wolfson, 1985) is a timed performance-based test of cognitive flexibility. Participants are asked to connect randomly arranged numbers and letters alternately, in ascending order, as quickly as possible. Scores are based on the time to complete the task with longer completion time reflecting poorer performance. For the Letter Series task (Thurstone, 1962), participants are asked to complete series of letters (e.g., a b c a b d a b e a b), by selecting the letter that comes next in the series, from a choice of 5 letters. After completing 4 sample items, participants were given 6 minutes to complete 20 letter series, ranging in length from 6 to

15 letters. One point was awarded for each correct item for a maximum possible score of 20.

Episodic memory. For the Word Recall task (Hultsch et al., 1990), participants were instructed to study a list of 30 English nouns for 2 minutes. The list contained six words from each of five taxonomic categories presented in unblocked order. Immediately following study, the list was removed and participants were asked to write down as many words as they could recall within 5 minutes. One point was awarded for each correct word. Duplicates and incorrect words were scored as zero. The maximum possible score was 30, with higher scores indicating better performance. Story Recognition was based on four narrative stories selected from a set of 25 structurally equivalent texts developed by Dixon, Hultsch, and Hertzog (1989). Each story was approximately 300 words and 160 propositions long and related events in the life (lives) of older adults. The stories were recorded on audiotape by a male professional actor. Immediately following presentation of the story, 24 statements about the story were presented one at a time on the computer screen. Participants were asked to press one of two keys to indicate whether each statement represented an idea that was contained in the story (statements presenting a correct idea from the story), or an idea that was not contained in the story (statements presenting an incorrect idea from the story, and ideas consistent with the theme of the story that were not mentioned). There were eight statements of each type. The measure used consisted of the number of items correctly completed.

Crystallized ability. For the Controlled Associations task (Ekstrom et al., 1976), participants were provided with a sample word (i.e., “weak”) and were asked to write down as many words as they could with the same or similar meaning. They were then provided with four words (“clear”, “dark”, “strong”, and “wild”), and asked to write down as many words as they could with the same or similar meaning in 6 minutes. The total score was based on the total number of acceptable words provided. Participants also completed a 36 item multiple-choice Vocabulary survey (Ekstrom, 1976). For each item, participants had to select, from 5 options, one word with the same or nearly the same meaning. They were provided with a maximum of 10 minutes to complete the test and the maximum possible score was 36.

Everyday problem solving. The Everyday Problems Test (EPT, Willis & Marsiske, 1993) is a paper and pencil measure of everyday cognitive competence that requires participants to solve problems associated with daily living. Participants are provided with 21 printed stimulus materials (e.g., medication label, pay phone information) and asked to solve two problems pertaining to each stimulus. All stimuli are reproductions of real-life materials with four to six items representing one of the following IADL domains: medication use, meal preparation, telephone use, shopping, financial management, household management, and transportation. For example, with respect to meal preparation, participants are provided with a nutritional information chart for cereal and are asked to determine how many calories are in a serving of cereal if whole milk is used instead of skim milk. For a question in the transportation domain, participants are provided with a chart of taxi rates and are asked to determine how much they would have to pay if they travelled 1 mile in a suburban area. The original EPT consists of 42 items; however, for the purposes of the present study, items 10 (Medicare Benefits Payment Schedule) and 12 (Stain Removal Directions) were omitted because a significant minority of participants disputed interpretation of elements of the problems.

Consequently, possible scores ranged from 0 to 40, with higher scores indicating better performance.

Willis and Marsiske (1993) reported a one-year test-retest reliability of .93. The internal consistency (Cronbach's alpha) for the EPT for the current study was .88. With respect to validity, the EPT has been found to significantly correlate with direct observation of older adults' performance of everyday tasks involving medications, meal preparation, and phone usage (r = .67), with older adults' self-reports of IADL functioning (r = .23), and with dementia patients' self-reports of IADL functioning (r = .36) (Willis and Marsiske, 1993; Willis et al., 1998).

Statistical Analyses

Group differences in EPT performance was examined using a 2 (young-old, old-old) x 2 (male, female) x 2 (high school, more than high school) x 3 (NCI, CIND-S, CIND-M) between-subjects ANOVA. Posthoc analyses were conducted using one-way ANOVAs with Tukey's HSD for unequal N's. Pearson correlation coefficients were used to examine the bivariate relationships between the EPT and the various cognitive tasks. According to Cohen (1977), correlations of .30 to .50 are considered moderate in size and those above .50 are viewed as large. In the current study, all correlations below $p < .05$ are highlighted; however given the large number of correlations and in order to protect against Type 1 error, only those above .30 were considered noteworthy. The relationships between EPT scores and cognitive performance were also examined using hierarchical regression analyses. However, given the observed multicollinearity among the cognitive measures and the large number of measures, we employed a theoretically driven data reduction procedure to create composite scores, with each composite representing a basic cognitive ability (i.e., speed of processing, fluid ability, episodic memory, crystallized ability). All raw scores were converted to z-scores, which were then used to calculate the composite scores using the measures hypothesized to represent the cognitive abilities under investigation (Lezak, 1995; Spreen & Strauss, 1998). The "speed of processing" composite was derived by averaging the z-scores from the Trail Making Test Part A and Digit Symbol tasks. The z-scores from the Trail Making Test Part B and the Letter Series tasks were averaged to form a "fluid ability" composite. Similarly, the Word Recall and Story Recognition tasks were used to form the "episodic memory" composite, while the "crystallized ability" composite was derived from the Vocabulary and Controlled Associations tasks.

Results

Group Differences on EPT Scores

The mean score across all participants for the EPT was 31.13 (SD = 6.19, range = 6 to 40). An age x gender x education x cognitive status group between-subjects ANOVA on the EPT scores revealed significant main effects for age (F (1,267) = 43.37, p < .001; η^2 = .14), education (F (1,267) = 42.35, p < .001; η^2 = .14), and cognitive status (F (2,267) = 28.35, p < .001; η^2 = .18). Significantly higher scores were associated with younger age (young-old: M = 33.11, SD = 4.80; old-old: M = 28.33, SD = 6.72), higher level of education (high school education: M = 26.92, SD = 6.69; more than high school education: M = 32.28, SD = 5.44) and more intact cognitive status (NCI: M = 32.98, SD = 4.33; CIND: M = 30.36; SD = 5.72, CIND-M: M = 25.83, SD = 8.34). In addition, a significant Age x Cognitive status interaction (F (2,267) = 3.94, p = .021; η^2 = .03) was found and is shown in Figure 1. Posthoc analyses indicated that for the young-old participants, the NCI group performed significantly better on the EPT than the other two groups (i.e., CIND-S and CIND-M), which did not differ (F (2,160) = 8.81, p < .001; η^2 = .10). For the old-old participants, both the NCI and CIND-S groups obtained better scores than the CIND-M group (F (2,125) = 34.04, p < .001; η^2 = .35).

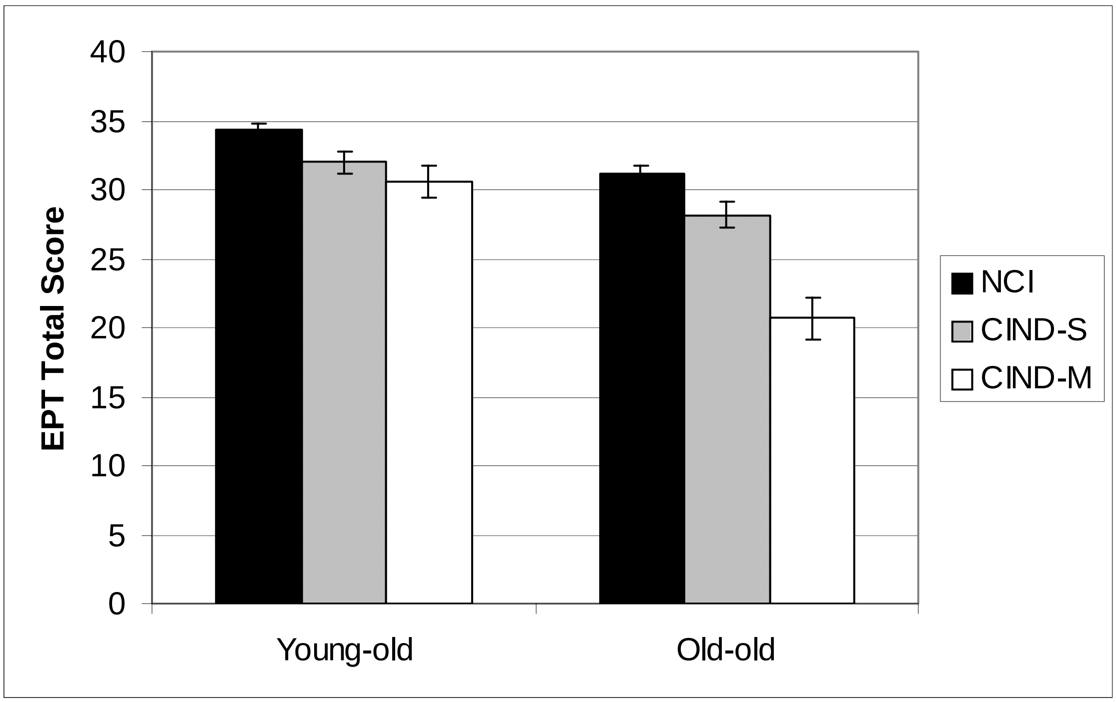

Figure 1. Performance on the EPT as a function of age group and cognitive status

Relationship of EPT to Cognitive Variables

The bivariate associations between EPT performance and the cognitive tasks are shown in Table 2. Significant associations were found between the EPT and all of the cognitive measures. In all cases, the correlations were moderate to large in size and better performance on the EPT was associated with better cognitive performance and less cognitive decline.

Table 2

Intercorrelations Between EPT Performance and the Cognitive Tasks

Variable	1	2	3	4	5	6	7	8	9	10	11
1. EPT	--										
2. MMSE	**.32****	--									
3. IQ Discrepancy	**-.30****	-.19**	--								
4. Digit Symbol	**.36****	.24**	-.22**	--							
5. Trails A[a]	**-.31****	-.25**	.24**	**-.47****	--						
6. Trails B[a]	**-.42****	-.25**	.23**	**-.51****	**.60****	--					
7. Letter Series	**.59****	**.35****	**-.33****	**.49****	**-.38****	**-.52****	--				
8. Word Recall	**.42****	.29**	-.23**	**.37****	**-.33****	**-.32****	**.47****	--			
9. Story Recognition	**.37****	.24**	-.13*	.15**	-.25**	**-.36****	**.32****	.28**	--		
10. Ekstrom's Vocabulary	**.49****	.19**	-.27**	.13*	-.05	-.16**	**.34****	.28**	.16**	--	
11. Controlled Associations	**.37****	.17**	-.29**	.28**	-.20**	-.27**	**.42****	**.44****	.22**	**.47****	--

[a] Lower values indicate better performance

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

A hierarchical regression model predicting EPT total scores was formed by entering demographic variables previously found to be significant predictors of IADLs in the first step (i.e., age group, education group, gender, number of chronic illnesses) (e.g., Bertrand et al., 2001; Carlson et al., 1999; Diehl et al., 1995; Grigbsy et al., 1998; Moore & Lichtenberg, 1996). Following the demographic variables, the MMSE and the IQ Discrepancy scores (NAART minus WAIS-III estimated IQ) were entered in the subsequent two steps to account for overall level of cognitive functioning and extent of cognitive decline. The order of entry for the remaining composite variables was determined using a theoretically based rationale (Hultsch et al., 1992) in which variables were entered along a process to product continuum: speed of processing, fluid ability, episodic memory, and crystallized ability.

As shown in Table 3, the demographic variables were found to account for the largest proportion of the variance in the EPT total scores, accounting for 25.4% of the variance. The MMSE, entered on step 2, emerged as a significant predictor of EPT scores, but only accounted for 3.0% of unique variance, above and beyond that accounted for by demographic variables. The IQ discrepancy score accounted for a further 5.6% of unique variance in EPT scores. Each of the cognitive composite variables (i.e., speed of processing, fluid ability, episodic memory, crystallized ability) significantly increased the amount of variance explained in EPT total scores, accounting for 1.1%, 7.9%, 2.6%, and 3.4% of the unique variance respectively.

Table 3

Summary of Hierarchical Regression Analysis for Demographic and Cognitive Variables Predicting EPT Performance: Model 1

Variable	*B*	*SE B*	β	*R*	R^2	Adjusted R^2	ΔR^2
Step 1							
Age Group	-2.125**	.625	-.171				
Education Group	1.751*	.703	.121				
Gender	-.209	.591	-.015				
Chronic Illness	.017	.145	.005				
				.504	.254	.244	.254***
Step 2							
MMSE	.276	.247	.053	.533	.284	.272	.030**
Step 3							
IQ Discrepancy	-.052	.028	-.087	.583	.340	.326	.056***
Step 4							
Speed of Processing	-.357	.432	-.049	.592	.351	.334	.011*
Step 5							
Fluid Ability	2.036***	.471	.287	.655	.429	.413	.079***
Step 6							
Episodic Memory	1.198**	.413	.155	.675	.456	.438	.026***
Step 7							
Crystallized Ability	1.633***	.377	.226	.700	.490	.472	.034***

* $p < .05$. ** $p < .01$. *** $p < .001$.

In order to more fully examine the relative contribution of the variables representing more specific cognitive domains in comparison to the variables representing more global estimates of cognitive functioning (i.e., MMSE and IQ Discrepancy scores) in predicting EPT total scores, the hierarchical regression analysis was re-run by entering the cognitive composite scores following the demographic variables, and entering the MMSE and IQ Discrepancy scores last. As shown in Table 4, after accounting for the variance associated with the cognitive composite variables, the MMSE and the IQ Discrepancy score were no longer significant predictors of EPT total scores. Following the demographic variables, the fluid ability composite accounted for the largest proportion of unique variance in EPT total scores, accounting for 11.4% of the variance.

Table 4

Summary of Hierarchical Regression Analysis for Demographic and Cognitive Variables Predicting EPT Performance: Model 2

Variable	*B*	*SE B*	β	*R*	R^2	Adjusted R^2	ΔR^2
Step 1							
Age Group	-2.125**	.625	-.171				
Education Group	1.751**	.703	.121				
Gender	-.209	.591	-.015				
Chronic Illness	.017	.145	.005				
				.504	.254	.244	.254***
Step 2							
Speed of Processing	-.357	.432	-.049	.537	.288	.276	.034***
Step 3							
Fluid Ability	2.036***	.471	.287	.634	.402	.390	.114***
Step 4							
Episodic Memory	1.198**	.413	.155	.660	.436	.422	.033***
Step 5							
Crystallized Ability	1.633***	.377	.226	.693	.481	.466	.045***
Step 6							
MMSE	.276	.247	.053	.695	.484	.467	.003
Step 7							
IQ Discrepancy	-.052	.028	-.087	.700	.490	.472	.006

* $p < .05$. ** $p < .01$. *** $p < .001$.

Discussion

The purpose of this investigation was to examine a sample of community dwelling non-demented older adults on a measure of problem solving thought to index cognitively demanding IADLs, the EPT, and to explore associations between EPT performance and cognitive test performance. This study adds to the existing literature by providing an independent replication of the association between cognition and everyday problem solving. Further, a broader selection of cognitive measures was included than is typical of existing studies. Third, this investigation included a sample of older adults at risk for cognitive decline.

Everyday problem solving, as measured by the EPT, appears to be sensitive to differences in age, cognitive status, and education, even in older adults who have only mild cognitive impairment. Older adults with more than 12 years of education performed better on the EPT than those with 12 or less years of education. An age by level of cognitive functioning interaction revealed that for older adults aged 64 to 74, those who showed no signs of cognitive impairment (i.e., NCI group) performed significantly better on the EPT than those showing mild signs of cognitive impairment (i.e., CIND-S, CIND-M). However, for adults 75 years or older, both the NCI and CIND-S groups performed significantly better on the EPT than the group with the lowest level of cognitive functioning (i.e., CIND-M). Of interest for future research will be determining the extent to which group differences in EPT performance, associated with age, education, or cognitive status, translate into clinically or functionally significant changes.

Consistent with the negative association found between age and other measures of everyday problem solving ability in past studies (Allaire & Marsiske, 1999; Denney &

Pearce, 1989; Diehl et al., 1995), the present study found that the performance of old-old participants on the EPT was inferior to that of young-old participants. With respect to the EPT, Willis (1996a) reported declines in EPT performance with age in a sample of healthy community dwelling older adults, with rates of decline increasing from the 60s through the 70s and 80s. Similarly, Marsiske and Willis (1995) found a negative relationship between age and EPT performance in a sample of older adults, with age accounting for 17% of the variance in EPT scores. However, Marsiske and Willis (1995) also failed to find an association between age and two other measures of everyday problem solving, while Cornelius and Caspi (1987) reported that older adults outperformed younger adults on one of the same measures used by Marsiske and Willis (1995).

Thus it appears as though a negative relationship is consistently found between age and everyday problem solving when measured by the EPT, but that the relationship is less clear when other measures of everyday problem solving ability are used. As Marsiske and Willis (1995) and Allaire and Marsiske (1999) have suggested, the relationship between everyday problem solving and age is likely to depend on the measures used, the specific content areas of the task, as well as the particular cognitive demands of the task. Additionally, large individual differences observed in the rates of decline in everyday problem solving associated with aging (Willis et al., 1992) may also serve to obscure results across studies. Therefore, it is important to bear in mind that the present results are based on cross-sectional analyses only and that longitudinal analyses are needed to more fully elucidate the relationship between age and everyday problem solving.

Using bivariate correlations, the EPT was significantly associated with measures of global cognitive status, cognitive decline, speed of processing, fluid ability, episodic memory, and crystallized ability. Findings from hierarchical regression analyses indicated that approximately 25% of the variance in the EPT was accounted for by demographic variables, of which age group and education group made significant unique contributions. All of the cognitive measures together accounted for 23.6 % of the variance, above and beyond that contributed by demographic variables.

Of particular interest to the present study was the relative contribution of more general indices of cognitive functioning and measures of specific cognitive abilities in predicting performance on the EPT. After adjusting for demographic and health variables, the MMSE, a measure of global cognitive functioning, accounted for 3% of the variance in the EPT. These findings are inconsistent with previous reports suggesting that the MMSE accounts for a relatively large proportion of the variance in IADL functioning. For example, Hill et al. (1995) and Tekin et al. (2001) reported that the MMSE explained 21% and 15% of the variance, respectively, in IADL functioning. However, in contrast to the present study, both of these studies involved participants with dementia and assessed IADL functioning using informant-based measures. Therefore, in addition to differences in the method of assessment (i.e., informant-report versus paper and pencil measure of everyday problem solving), differences in the range of cognitive impairment exhibited by participants are likely to account for differences in observed relationships with the MMSE. For example, Willis et al. (1998) found that measures of global cognitive ability accounted for almost 60% of the variance in the EPCCE, a modified version of the EPT, in a sample of participants with Alzheimer’s disease. In the present study, the range of

MMSE scores was restricted due to the inclusion of only non-demented participants, possibly accounting for the relatively small proportion of variance predicted by the MMSE in comparison to previous reports. In short, the present findings suggest that the MMSE may not be particularly useful for predicting the ability of non-demented older adults to solve cognitively demanding problems associated with IADLs.

A measure of cognitive decline, as assessed by the discrepancy between estimates of current (WAIS-III) and premorbid (NAART) intellectual functioning, was found to be a significant predictor of EPT performance independent of overall level of cognitive functioning (MMSE), and demographic and health-related variables. Estimates of the magnitude of cognitive decline have not yet been examined in the literature investigating predictors of everyday problem solving. It will be of interest to see whether future studies replicate this finding using other estimates of premorbid functioning.

Of the variables measuring specific cognitive abilities, speed of processing made the smallest contribution in predicting EPT performance, accounting for approximately 1% of the variance after accounting for demographic variables, overall level of cognitive functioning, and cognitive decline. This finding is perhaps not surprising given the untimed nature of the EPT; the task was designed to assess tasks of daily living that are not usually performed under time constraints (Willis & Marsiske, 1993). Consequently, these findings may be representative of low demands for speed of processing when tasks of daily living are carried out in real life. Few studies have examined the relationship between speed of processing and everyday problem solving. Willis et al. (1992) failed to find a significant relationship between speed and everyday problem solving performance measured 7 years later. Using a performance-based measure of IADLs, Diehl et al. (1995)

reported that speed of processing did not exert a direct effect on everyday functioning, but rather exerted indirect effects through crystallized and fluid intelligence. It is unclear the extent to which differences in samples and assessment methods may be contributing to the contradictory results reported in the literature to date.

Consistent with much of the literature investigating the relationship between specific cognitive abilities and everyday problem solving, fluid abilities were found to be a significant predictor of the EPT (Allaire & Marsiske, 1999; Cornelius & Caspi, 1987; Diehl et al., 1995; Willis et al., 1992). Next to the demographic variables, fluid abilities accounted for the largest proportion of variance in EPT scores (i.e., 7.9%), even after accounting for general cognitive status and decline. These findings suggest that measures of fluid abilities contribute useful information in predicting everyday problem solving abilities above and beyond that provided by more global measures of cognitive functioning.

Measures of episodic and crystallized ability were found to make relatively small, but significant, contributions in predicting everyday problem solving. Past research has provided conflicting results regarding the relationship between memory and IADL functioning with some studies providing support (Allaire & Marsiske, 1999) and others failing to (Diehl et al., 1995; Willis et al., 1992). Hill et al. (1995) suggested that because measures of episodic memory are highly associated with the MMSE, controlling for the MMSE may result in little remaining variance for the measures of episodic memory. Consequently, results may differ between studies depending on whether the MMSE is controlled for or the order of entry used in a regression model.

Various studies have explored the relationship between everyday problem solving and measures of verbal or crystallized abilities, with most reporting significant associations (Allaire & Marsiske, 1999; Camp et al., 1989; Cornelius & Caspi, 1987; Diehl et al., 1995). Given that the format of the EPT is a pencil and paper task with stimuli presented in a written format, it is likely that verbal abilities are particularly important in completing a language-based measure of everyday problem solving.

In summary, global measures of cognitive functioning and decline, as well as measures of specific cognitive abilities, were found to be important predictors of older adults' ability to solve problems of everyday living. Along with demographic and health-related variables, these variables accounted for 49% of the variance in EPT scores. Increasing our understanding of the factors influencing the ability of older adults to remain independent in IADLs is instrumental in designing interventions to delay or prevent institutionalization as well as to increase the safety and quality of life of older adults. In particular, understanding which specific cognitive abilities are most likely to impact functional abilities may be used to inform selection of cognitive interventions and development of compensatory strategies. For example, based on past research examining the relationship between cognitive functioning and functional abilities, Ball et al. (2002) have begun to address the issue of whether cognitive training interventions improve the mental abilities and daily functioning of older adults.

Research Question 2: The Relationship between Everyday Problem Solving and Inconsistency in Reaction Time in Older Adults

Introduction

The primary purpose of Research Question 2 was to investigate the association between everyday problem solving abilities and inconsistency in RT. As previously mentioned, past studies, including part one of this study, have shown that various basic cognitive abilities predict older adults' performance on everyday problem solving measures. However, the issue of whether inconsistency in cognitive performance predicts everyday problem solving abilities has not yet been addressed. Therefore, the relationship between everyday problem solving and inconsistency across trials on RT tasks was examined to determine whether inconsistency in cognitive performance makes a unique contribution, over and above level of performance, in predicting everyday problem solving in the area of IADLs.

A secondary purpose was to examine whether potential relationships between measures of inconsistency and everyday problem solving would be maintained across time by examining measures of inconsistency obtained from two separate occasions. It is possible that any relationships found between inconsistency and everyday problem solving may be a function of task novelty. Therefore, examining two separate occasions demonstrates whether the patterns obtained are maintained across time.

Methods

Participants

Data from a total of 304 older adults (208 women and 96 men), ranging in age from 64 to 92 (*M* = 74.02, *SD* = 5.95), were examined in part two of the study. Although parts one and two of the study were based upon the same sample of participants, the overall sample size differs between the two because of the decision to include individuals who scored greater than 1.0 *SD* below their age-group mean in two or more (up to five) areas of cognitive functioning in the CIND-M group for the second part of the study. In the first part, this group only included participants with deficits in only two or three areas. Participants were again categorized into two age groups: young-old (n = 170, M = 69.67 years, SD = 2.74, range 64-74) and old-old (n = 134, M = 79.54 years, SD = 4.02, range 75-92).

Measures

Everyday problem solving. The EPT was used as the measure of everyday problem solving (refer to Study 1 for description).

Measures of inconsistency. Inconsistency in RT was measured on four tasks: finger tapping, simple RT, choice RT, and one-back RT. All of the tasks were administered on a laptop computer. The instructions emphasized speed of performance. Tasks were administered in a constant order across the five sessions. Hultsch et al. (2000) reported that latency was a more sensitive indicator of intraindividual variability than accuracy; therefore, for the purpose of the present study, only measures of latency (including correct and incorrect trials) were analyzed.

For Finger Tapping (tap dominant, tap nondominant), participants were instructed to press the “Left” key with their left hands as quickly as possible. With each tap, a letter “L” appeared on the screen and participants were asked to continue tapping until they completed a practice row of L’s (24 taps) followed by the test trial with two rows of Ls (i.e., 48 taps). They were then asked to repeat the same procedure using their right hands with the “Right” key. For each hand, the measures used were the latencies between the taps.

On the Simple RT (SRT) task, participants were presented with a warning stimulus (cross) followed by a signal stimulus (box) in the middle of the screen. Participants were instructed to press a key with the index finger of their dominant hand as quickly as possible when the signal stimulus appeared. A total of 5 practice trials followed by 50 test trials were administered. Ten randomly arranged trials were presented at each of five intervals separating the warning and signal stimuli *(*500, 625, 750, 875, and 1000 ms*)*. The measures used were the latencies of the 50 test trials.

For Choice RT (CRT), participants received a warning signal consisting of four crosses positioned horizontally (+ + + +) on the screen. After a delay of 250 ms, one of the crosses changed into a square. The location of the square was randomly equalized across trials. Participants were instructed to press a key on a response keyboard corresponding to the location of the square as quickly as possible, using separate fingers (i.e., two fingers from left hand and two fingers from right hand) for each button. A total of 10 practice trials followed by 60 test trials were administered. The measures used were the latencies for the 60 test trials.

The One-Back RT (BRT) task was similar to CRT except that participants were instructed to press the key on the response keyboard that matched the position of the box on the previous trial. A total of 10 practice trials followed by 60 test trials were administered. The measures used were the latencies for the 60 test trials.

Data Preparation and Statistical Analyses

Prior to conducting statistical analyses, the first step in creating an index of inconsistency is to remove outliers at the level of individual trials for each participant in order to minimize error variance (Hultsch et al., 2000). For example, extremely fast or slow responses might reflect errors associated with accidental key presses or distraction of the participant. Lower limits were set as follows: SRT – 150 ms, CRT – 150 ms, BRT – 150ms. A lower limit was not set for the finger tapping task. Upper limits were established by computing the mean and standard deviation separately for each of the three groups for each occasion and dropping any trials exceeding the mean by three or more *SDs*. The number of missing trials for the entire Persons x Trials x Occasions data matrix was small and relatively uniform across tasks (Finger tapping = 1.02%, SRT = 1.55%, CRT = .84%, BRT = 2.96%). To avoid statistical problems associated with missing data, values were imputed for the missing trials for all three groups together using a regression procedure in which missing value estimates are based on the correlations among responses across trials and occasions. Missing values were imputed by using data from all available individuals, trials, and occasions. Dropping outlier scores and imputing corresponding missing values helps to reduce error from our measure of variability and thereby increases the reliability of the variability estimate. This procedure reduces variability and therefore represents a conservative approach to examining the phenomenon.

Of the many indices that may be computed to examine inconsistency in RT (Slifkin & Newell, 1998), perhaps the simplest is the intraindividual standard deviation (ISD). Given that group differences in response speed and systematic changes across time (e.g., practice effects) represent potential confounds for the analysis of inconsistency, calculating ISDs based on raw scores is potentially problematic. Therefore, effects associated with age group, cognitive status group, trial and their interactions were statistically removed, or partialled, from the raw data prior to computing ISDs by regressing each dependent measure on these variables. The resulting residual scores were then converted to T-scores to permit comparison of the tasks in the same metric.

For the purposes of the present study, ISDs were created from all trials (i.e., both correct and incorrect trials). Past research has shown that the same pattern of results is obtained whether ISDs are created from all trials or restricted to trials from correct responses (Burton et al., 2006). Relatively few errors were made by participants on the CRT and BRT tasks (accuracy data are not obtained for finger tapping or SRT). The mean percentage of correct responses for CRT for the NCI, CIND-S, and CIND-M groups were 98.4%, 98.3%, and 97.0% (Occasion 1), respectively, and 98.5%, 99.3%, and 98.5% (Occasion 5), respectively. For BRT, the mean percentage of correct responses were 89.4%, 86.9%, and 77.9% (Occasion 1), and 94.6%, 92.0%, and 86.8%, respectively for the NCI, CIND-S, and CIND-M groups. In addition, only ISDs from the first and fifth testing sessions are analyzed for the purposes of the present study. Comparing the pattern of results obtained from the first session to those of the fifth session allows for an examination of the generalizability of the relationship between inconsistency and EPT performance across time. We analyzed the two sessions that were farthest apart to maximize generalizability.

The issues of whether level of performance and inconsistency in performance on measures of RT differ as a function of age and cognitive status are addressed in a separate paper (Dixon et al., 2005). Briefly, these analyses have shown that older age and poorer cognitive status are associated with slower and more inconsistent RTs. Thus the present analysis will examine inconsistency in RT for the sample as a whole.

Pearson correlation coefficients were used to examine the relationships between the EPT and RT tasks. The relative contributions of inconsistency and mean level of performance to the prediction of EPT scores was investigated using two sets of hierarchical regression analyses.

Results

Relationship of EPT to Demographic Variables and RT Tasks

Table 5 shows the mean latencies and ISDs for the RT tasks for occasions 1 and 5. Bivariate associations between the EPT and (1) mean latencies and (2) ISDs for the RT tasks for occasions 1 and 5 are shown in Table 6. Significant negative associations were found between the EPT and all of the RT latencies and ISDs, indicating that better EPT performance was associated with faster latencies and more consistent performance. Most of the correlations between the EPT and the finger tapping tasks and SRT were small, whereas those for the more complex CRT and BRT tasks were all moderate in size.

Table 5

Descriptive Statistics for Reaction Time Mean Latency and ISD Scores for Occasions 1 and 5

	Latencies		ISDs	
Variable	Occasion 1	Occasion 5	Occasion 1	Occasion 5
Tap dominant				
M	203.30	199.32	5.14	4.73
SD	42.02	41.03	3.30	3.01
Tap nondominant				
M	233.92	222.98	6.24	6.56
SD	55.58	46.60	3.62	3.48
SRT				
M	377.23	370.34	7.49	6.84
SD	85.25	85.60	4.24	2.32
CRT				
M	633.41	581.91	8.02	7.69
SD	120.39	100.87	2.14	2.08
BRT				
M	1740.39	1032.34	7.63	7.45
SD	719.83	456.21	3.58	3.24

Note. Mean latency scores are measured in milliseconds.

Table 6

Correlations between EPT Performance and Reaction Time Mean Latency and ISD Scores

	Latency		ISDs	
	Occasion 1	Occasion 5	Occasion 1	Occasion 5
Tap dominant	-.22***	-.27***	-.22***	-.15*
Tap nondominant	-.24***	-.25***	-.17**	-.15**
SRT	-.26***	-.29***	-.40***	-.20**
CRT	-.35***	-.37***	-.34***	-.35***
BRT	-.45***	-.46***	-.48***	-.47***

* $p < .05$.** $p < .01$.*** $p < .001$.

Hierarchical Regression Analyses

In the first analysis, demographic variables previously found to be significant predictors of IADLs in the first study were entered in the first block (i.e., age group, education group). The mean latencies for all five RT tasks were entered in the second block, followed by the ISDs for all 5 tasks in the last block. The demographic variables were also entered first in the second model, but the order of entry of the blocks of mean latencies and ISDs was reversed. As shown in Table 5 for Occasion 1 of the first model, the demographic variables accounted for the largest proportion of the variance (22.8%), with both age (*B* = -2.032; ß = -.158) and education (*B* = 3.789; ß = .250) making significant contributions in predicting the EPT. The mean latencies accounted for 10.2% of unique variance, above and beyond that accounted for by demographic variables. None of the latency measures made significant unique contributions. The ISDs accounted for a further 8.7% of unique variance. With the exception of the nondominant finger tapping task, all of the other ISD measures made unique contributions, relative to the total set of variables, in predicting EPT performance (dominant finger tapping: *B* = -.201; ß = -.104; SRT: *B* = -.290; ß = -.192; CRT: *B* = -.364; ß = -.122; BRT: *B* = -.442; ß = -.248). For occasion 5, the mean latencies and ISD scores accounted for 10.9% and 4.8% of unique variance respectively, after having accounted for demographic variables. Again, none of the unique contributions made by the latency measures were significant. For the ISD measures, the dominant finger tapping and SRT tasks no longer made significant unique contributions, while CRT and BRT continued to predict performance (CRT: *B* = -.392; ß = -.127; BRT: *B* = -.468; ß = -.237).

Table 7

Summary of Hierarchical Regression Analyses Demonstrating the Increment in Prediction of EPT Performance for ISD Scores over and above Mean Latency Scores

Variable	*B*	*SE B*	β	*R*	R^2	Adjusted R^2	ΔR^2
			Occasion 1				
Step 1							
Age Group	-2.032**	.655	-.158				
Education Group	3.789***	.696	.250				
				.478	.228	.223	.228***
Step 2							
FT dom. Latency	-.002	.012	-.010				
FT nondom. Latency	-.004	.009	-.036				
SRT Latency	-.001	.004	-.009				
CRT Latency	.001	.003	.027				
RT Latency	.000	.001	-.011				
				.574	.330	.314	.102***
Step 3							
Tap dom. ISD	-.201*	.099	-.104				
Tap nondom. ISD	-.032	.096	-.018				
SRT ISD	-.290***	.078	-.192				
CRT ISD	-.364*	.169	-.122				
BRT ISD	-.442**	.129	-.248				
				.646	.417	.393	.087***
			Occasion 5				
Step 1							
Age Group	-2.007**	.676	-.156				
Education Group	3.559***	.713	.235				
				.478	.228	.223	.228***
Step 2							
FT dom. Latency	-.020	.013	-.131				
Tap nondom. Latency	.007	.011	.051				
SRT Latency	-.003	.004	-.035				
CRT Latency	-.002	.004	-.024				
BRT Latency	-.001	.001	-.067				
				.581	.337	.322	.109***
Step 3							
Tap dom. ISD	.025	.108	.012				
Tap Nondom. ISD	-.123	.099	-.067				
SRT ISD	-.149	.137	-.054				
CRT ISD	-.392*	.165	-.127				
BRT ISD	-.468**	.143	-.237				
				.621	.386	.360	.048**

*$p < .05$. **$p < .01$. ***$p < .001$.

When reversing the order of entry for the mean latencies and ISDs (see Table 8), the ISD scores continued to account for a significant proportion of the variance (Occasion 1:18.7%; Occasion 5: 14.2%), but the mean latencies were no longer significant for either occasion. Thus, inconsistency in RT accounted for a significant proportion of the variance in EPT scores, above and beyond mean level of performance, whereas mean latencies failed to account for a significant proportion of the variance, above and beyond inconsistency.

Table 8
Summary of Hierarchical Regression Analyses Demonstrating the Increment in Prediction of EPT Performance for Mean Latency Scores over and above ISD Scores

Variable	*B*	*SE B*	β	*R*	R^2	Adjusted R^2	ΔR^2
				Occasion 1			
Step 1							
Age Group	-2.032**	.655	-.158				
Education Group	3.789***	.696	.250				
				.478	.228	.223	.228***
Step 2							
Tap dom. ISD	-.201*	.099	-.104				
Tap nondom. ISD	-.032	.096	-.018				
SRT ISD	-.290***	.078	-.192				
CRT ISD	-.364*	.169	-.122				
BRT ISD	-.442**	.129	-.248				
				.645	.416	.402	.187***
Step 3							
Tap dom. Latency	-.002	.012	-.010				
Tap nondom. Latency	-.004	.009	-.036				
SRT Latency	-.001	.004	-.009				
CRT Latency	.001	.003	.027				
BRT Latency	.000	.001	-.011				
				.646	.417	.393	.002
				Occasion 5			
Step 1							
Age Group	-2.007**	.676	-.156				
Education Group	3.559***	.713	.235				
				.478	.228	.223	.228***
Step 2							
Tap dom. ISD	.025	.108	.012				
Tap nondom. ISD	-.123	.099	-.067				
SRT ISD	-.149	.137	-.054				
CRT ISD	-.392*	.165	-.127				
BRT ISD	-.468**	.143	-.237				
				.609	.371	.356	.142***
Step 3							
Tap dom. latency	-.020	.013	-.131				
Tap nondom. Latency	.007	.011	.051				
SRT Latency	-.003	.004	-.035				
CRT Latency	-.002	.004	-.024				
BRT Latency	-.001	.001	-.067				
				.621	.386	.360	.015

*$p < .05$. **$p < .01$. ***$p < .001$.

Discussion

The purpose of the second research question was to explore associations between EPT performance and inconsistency in RT. Both mean level of performance in RT and inconsistency across trials in RT were found to be significantly associated with EPT performance. Bivariate correlations indicated that slower RTs and greater variability were related to poorer performance on the EPT. However, given previously found relationships between inconsistency and level of performance on various cognitive tasks (Hultsch et al., 2000; Li et al., 2001; Rabbitt et al., 2001), the possibility arises that the relationship between inconsistency and everyday problem solving is mediated by level of performance. In other words, was a relationship found between inconsistency and everyday problem solving because both are related to mean latency in RT? To investigate this possibility, the mean latencies for all of the RT tasks were entered together as a block in a hierarchical regression analysis, followed by the ISD scores together in a block. After controlling for age and education, which accounted for approximately 23% of the variance, the mean latencies for all of the RT tasks together accounted for approximately 10% of the variance for both Occasions 1 and 5. None of the individual latency measures made a significant unique contribution to prediction relative to the total set of latency measures. The measures of inconsistency continued to account for a significant proportion of the variance in the EPT, even after accounting for age, education, and mean level of performance. The measures of inconsistency obtained from Occasion 1 accounted for almost 9% of the variance, with all of the inconsistency measures, except for nondominant finger tapping, uniquely contributing to the prediction of EPT performance. For the ISDs from Occasion 5, the measures of inconsistency still accounted for almost 5% of unique variance in EPT scores, with CRT and BRT making significant unique contributions.

Thus, inconsistency in RT contributes useful information in predicting everyday problem solving in the domain of IADLs above and beyond that provided by mean level of performance. Additionally, it is important to note that although the proportion of variance accounted for by inconsistency in RT is somewhat attenuated in the final occasion in comparison to the first occasion, significant effects were still obtained even after previous exposure to the tasks. Thus, the relationship between inconsistency and everyday problem solving appears to generalize across time and is not simply a function of task novelty.

Whether mean latencies would predict EPT performance over and above inconsistency was also examined. In these analyses, inconsistency accounted for 18.7% and 14.2% for occasions 1 and 5, respectively, of the variance in EPT scores, but the mean latencies failed to make a significant contribution. Thus, it appears that inconsistency in RT has unique predictive power whereas mean latencies do not.

Rabbitt et al. (2001) has examined the relationship between inconsistency and a more traditional laboratory measure of intelligence, the Culture Fair intelligence test. They showed that inconsistency on choice RT tasks was significantly and negatively correlated with older adults' performance on the Culture Fair intelligence test, such that greater inconsistency was associated with lower intelligence scores. Thus, it appears as though inconsistency in cognitive functioning may be related to both traditional measures of intelligence and more ecologically valid measures of problem solving on everyday activities. However, Rabbit et al. (2001) did not examine whether inconsistency predicted intelligence scores over and above mean level of performance. Hultsch et al. (2002) did examine the unique contributions of both inconsistency and mean latencies in RT in predicting performance on measures of perceptual speed, working memory, episodic memory, and crystallized abilities. They found that inconsistency on measures of RT uniquely accounted for 11% to 20% of the variance in cognitive performance over and above mean-level influences.

The observed link between inconsistency and older adults' ability to solve cognitively complex everyday problems raises the question of practical implications. Although possible clinical implications of inconsistency in cognitive performance are evident, it is not yet clear whether inconsistency is of any functional importance. For example, from a clinical perspective, fluctuations in cognitive performance may be sufficiently large that a person might be diagnosed as impaired one day, but within the normal range of cognitive functioning on another day (Hultsch et al., 2000). It remains to be seen, however, whether inconsistency in cognitive performance directly affects an older adult's ability to function in everyday life. The findings from this study address this second question and tentatively suggest that inconsistency in cognitive functioning may in fact be of functional relevance. The observed link between inconsistency in RT and everyday problem solving in this cross-sectional sample also raises the question of whether inconsistency predicts declines in everyday problem solving or instrumental activities of daily living.

In summary, the present findings suggest both level of performance and across-trial inconsistency on RT tasks are important predictors of older adults' ability to solve cognitive complex tasks indexing IADLs. Particularly noteworthy was the fact that even after accounting for level of performance, inconsistency continued to make a significant and unique contribution in predicting everyday problem solving.

Research Question 3: Predictors of Change in Everyday Problem Solving in Older Adults

Introduction

The first two parts of the study demonstrated that both cognitive abilities and inconsistency were predictive of everyday problem solving in a cross-sectional sample of community dwelling older adults. The purpose of Research Question 3 was to expand upon the previous studies and examine the relationship between everyday problem solving, inconsistency, and cognitive abilities from a longitudinal perspective; that is, do inconsistency and cognitive performance predict *changes* in everyday problem solving? Findings reported by MacDonald et al. (2003) indicate that inconsistency in RT predicts changes in cognitive abilities over a 6-year interval. Therefore, given the relationship between basic cognitive abilities and everyday problem solving, inconsistency in RT should also predict changes in everyday problem solving. In particular, higher inconsistency at year 1 is expected to be associated with decreases in EPT performance over the two-year interval, whereas lower inconsistency is expected to be associated with relative stability or even gains in EPT performance.

In part two of the study, where the relative contributions of inconsistency and mean level of performance were examined, the indices for mean level of performance were derived from reaction time measures. Part three examined whether inconsistency makes a unique contribution to predicting everyday problem solving over and above other cognitive abilities previously found to be important correlates of everyday problem solving (e.g., speed of processing, fluid ability, episodic memory, crystallized ability). Although not included in part one of the study, a measure of visual-spatial ability (i.e., Block Design) was included in part three because this particular cognitive domain has not yet been investigated as a predictor of everyday problem solving. Thus, Research Question 3 examined the relative contributions of (a) inconsistency in RT and (b) mean level of performance in various specific cognitive abilities in predicting changes on the EPT over a 2-year period. These findings are relevant in evaluating the extent to which inconsistency contributes useful information in predicting everyday problem solving abilities in older adults.

The EPT was specifically designed to tap into everyday problems that older adults might experience within the domain of IADLs. Currently there is no gold standard for assessing older adults' performance in the area of IADLs, with various methods being used including self-report, proxy-report, and performance-based measures. Although the EPT is not a direct measure of functional capacity, as defined by these 3 categories, it likely provides a rough estimate of an older adult's actual performance in the natural environment. This raises the question as to whether the EPT and other measures of IADL status, such as self-reports and informant-reports, demonstrate similar relationships with inconsistency. To the extent that the EPT and self-/informant-reported IADLs tap into the same construct, inconsistency should also be predictive of self- and informant-reported IADL status.

There has not been a great deal of research examining the congruence between measures of everyday problem solving within the domain of IADLs and other measures of IADLs. Willis and Marsiske (1993) reported a significant but small correlation ($r = -.23$, $p < .05$) between the EPT and Lawton and Brody's self-report measure of IADLs. In contrast, Allaire and Marsiske (1999) examined the relationship between a factor derived from two self-report measures of IADLs (Lawton & Brody, 1969; Pfeffer, 1982) and a factor based on another well-defined measure of everyday problem solving, the Everyday Cognition Battery. They reported a large correlation between the two (r = -.69), with higher levels of IADL dependence associated with poorer everyday problem solving.

With respect to informant-reported IADL functioning, Willis and colleagues reported a significant relationship between spousal IADL ratings and everyday problem solving performance (r = -.24, p < .05) in a sample of older adults (Willis, 1996a) but the correlation failed to reach significance for caregiver IADL ratings (r = .24, p > .05, reverse-coded) in a sample of participants with Alzheimer's disease (Willis et al., 1998). Bertrand and Willis (1999) reported a significant association between caregiver IADL ratings and everyday problem solving for individuals with Alzheimer's disease (r = .25, p < .05). All of these studies reported correlations of similar magnitude, thus, the discrepancy in results is likely attributable to differences in power.

The present study provided an opportunity to investigate the congruence between the EPT and self- and informant-report measures of IADLs (i.e., Lawton & Brody, 1969) as well as to examine the relative contributions of inconsistency in RT and specific cognitive abilities in predicting IADL functioning 2 years later. The Lawton and Brody (1969) instrument was added to the battery of measures after the first year, so, unfortunately, change in self-report could not be examined.

The third aim was to examine the hypothesis that inconsistency represents a basic central nervous system phenomenon, as has been suggested by numerous investigators (e.g., Eysenck, 1982; Hendrickson, 1982; Hultsch et al., 2000; Jensen, 1992; Li & Lindenberger, 1999). If inconsistency is an indicator of neurological integrity, then age-associated declines in the fidelity of the central nervous system should result in decrements in basic cognitive abilities, which would in turn cause declines in everyday problem solving. Thus, a mediational model was examined in which basic cognitive abilities are hypothesized to mediate the relationship between inconsistency, as indexed by RT measures, and change in everyday problem solving, as indexed by the EPT.

Methods

Participants

Of the original 304 participants who completed the first year of the study, 255 individuals (176 females, 79 males) completed the third year of testing. At year one of the study, these participants ranged in age from 64 to 90 years old (*M* = 73.63, *SD* = 5.70) and had completed a mean of 15.20 years of education (range: 7 to 24, *SD* = 3.10). At the time the study was initiated, all participants resided in the community and ranged in functioning from cognitively intact to mildly impaired but not yet demented.

Measures

Cognitive Measures. In addition to the eight basic cognitive ability measures used in part one of the study, the following four tests were analyzed in part three.

In the WAIS-R Digit Symbol Recall subtest (Wechsler, 1981), participants are asked to draw as many of the nine symbols they can recall from the Digit Symbol Substitution subtest after it is administered.

The WAIS-III Block Design (Psychological Corporation, 1997) is a timed measure in which participants arrange red and white blocks to match a design in a specific time period, ranging from 30 to 120 seconds. The patterns increase in difficulty as the task proceeds and the task is discontinued if the individual fails three consecutive items. The maximum score possible is 68 with higher scores indicating better performance.

The WAIS-III Vocabulary test (Psychological Corporation, 1997) is a 33-item measure of vocabulary for which participants provide oral definitions to words. The words progressively increase in difficulty and the test is discontinued after the individual fails six consecutive items. Each item is given a score ranging from 0 (incorrect definition) to 2 (correct definition), for a total possible score of 66.

The NAART (Blair & Spreen, 1989) consists of 61 irregularly spelled words, which participants are asked to read aloud. The total number of incorrectly pronounced words comprises the total score.

Measures of inconsistency. The same measures of inconsistency that were examined in part two of the study were also used in part three (i.e., finger tapping, simple RT, choice RT, and one-back RT).

Everyday problem solving. The EPT was used as the measure of everyday problem solving.

Self-reported IADLs. The Lawton and Brody (1969) IADL scale is a self-report measure indexing 8 IADL domains: telephone use, food preparation, housekeeping, laundry, transportation, shopping, financial management, and medication use. Participants rated their level of independence in each of the eight IADL domains according to Likert scales ranging from 0 to 2-4. The items were summed to provide a total score (total possible score = 23), with lower scores indicating higher levels of functional independence.

Informant-reported IADLs. The Lawton and Brody IADL scale was also administered to individuals identified by each participant as a significant other. Informants willing to complete the measures were available for 230 of the participants and included spouses (43.9%), friends (23.1%), adult children (18.8%), siblings (.8%), and other relationships (3.5%), such as in-laws, a partner who lives separately, and a personal trainer. The informants ranged in age from 29 to 90 (M = 66.71, SD = 13.11) and had an average of 15.34 years of education (SD = 3.13, range 7 to 27). Most of the informants had known their participant for more than 20 years (68.2%) while 7.8% had known them for 10 to 20 years, 7.8% for 5 to 10 years, 4.7% for 3 to 5 years, and 1.6% for 2 years or less. The frequency of contact varied: 45.5% daily and living in same household, 14.9% daily or almost daily but living in separate households, 21.2% one to two times a week, and 6.7% one to two times a month (2.0% unknown frequency of contact).

Statistical Analyses

Change in EPT scores from year 1 to year 3 was measured using simple difference scores, in which EPT total scores from year 3 were subtracted from the EPT total scores obtained from year 1, for each participant. Although the use of simple difference scores has traditionally been met with much controversy, largely due to their supposed unreliability (e.g., Cronbach & Furby, 1970), it is now recognized that (1) most of this supposed unreliability is due to reduced variability (relative to the scores used to create differences) rather than measurement error, and (2) that it is possible for a simple difference score to have a low reliability and yet be a highly precise measure of change (Collins, 1996a, 1996b; Rogosa & Willett, 1983; Williams & Zimmerman, 1996).

Therefore, along with its face validity and ease of interpretation, the simple difference score was selected as the measure of change in EPT scores.

A series of Pearson product-moment correlation coefficients were calculated to examine the relationships between the measures of inconsistency at year 1 (i.e., ISDs for finger tapping, SRT, CRT, and BRT), the basic cognitive ability measures, EPT change scores, and the year 3 self- and informant-reported IADL scores.

In order to examine the relative contributions of inconsistency and the basic cognitive abilities in predicting EPT change scores, hierarchical regression analyses were conducted. Age and education were entered in the first block. The ISDs for all five of the inconsistency tasks were entered in the second block, followed by the total scores for the basic cognitive ability measures. In this model, it was expected that each step would be significant. A second model was run with the demographic variables entered first, but reversed with respect to the order of the second and third blocks (i.e., the basic cognitive ability measures and then the ISDs). These analyses demonstrated the relative contributions of basic cognitive abilities and inconsistency as predictors of 2-year change in EPT scores. In addition, the second model evaluated whether the mediational model has merit. Specifically, if inconsistency does not have any direct effects on EPT performance, then when ISDs are entered *after* the basic cognitive abilities, this third step (which evaluates the direct effect of ISDs on EPT) should not be significant. These two models were also run with year 3 Self- and Informant-reported IADLs as the criterion.

Structural Equation Modeling (SEM) was used to evaluate the proposed mediational model in which basic cognitive abilities were hypothesized to mediate the relationship between year 1 inconsistency in RT and EPT change scores. It was hypothesized that if inconsistency in RT represents a behavioural marker of neurological integrity, then all 5 of the inconsistency indices (i.e., ISDs) should form a single factor.

Based on a hierarchical model of everyday problem solving (e.g., Marsiske & Willis, 1998; Willis & Marsiske, 1991; Willis & Schaie, 1986, 1993), in which problem solving on everyday tasks is believed to be composed of a set of underlying basic abilities, one might expect that all of the basic cognitive abilities mediate the relationship between inconsistency and EPT performance. As such, direct paths would be expected between inconsistency and all five of the basic cognitive abilities, followed by direct paths from all of the basic cognitive abilities to change in EPT performance. Similar models substituting self- and informant-reported IADL status at year 3 for change in EPT scores allowed for an examination of the extent to which self-reported IADLs and everyday problem solving represent the same construct.

In contrast to the hierarchical model, Salthouse (e.g., 1985; 1996; 2000b) has proposed that processing efficiency is a major factor contributing to age-related differences observed with other cognitive abilities (e.g., memory, reasoning, spatial ability). He further proposed: “it is conceivable that various age-related biological changes directly affect the time and accuracy in simple behavioural tasks (i.e., processing efficiency)” (Salthouse, 2000b, p. 43). He, therefore, considered slower speed of processing to be a manifestation of more basic alterations in processing efficiency that are directly due to age-related biological changes. Examples of possible biological changes cited include decreases in the number of neurons, dendritic branching, myelination, or the quantity of particular neurotransmitters. Therefore, according to Salthouse’s perspective, one could hypothesize that both inconsistency and speed of processing (serving as an indicator of processing efficiency) are indicators of neurological integrity and should directly predict the remaining 4 basic cognitive abilities (i.e., fluid ability, episodic memory, visual-spatial ability, crystallized ability).

AMOS 5.0 was used to evaluate the hypothesized models. Maximum likelihood estimation was employed to estimate all models. Model fit was evaluated using the chi-square statistic (χ^2) which compares the sample variance-covariance matrix to the reproduced implied covariance matrix (Schumacker & Lomax, 2004). A nonsignificant χ^2 is desirable, indicating that the model fits the data (Tabachnick & Fidell, 2001). However, the chi-square statistic is sensitive to sample size and trivial differences are often significant with large sample sizes (Tabachnick & Fidell, 2001). Therefore, a number of other model fit indices were used as well. The Goodness-of-Fit Index (GFI) is an absolute fit index which assesses how well the hypothesized model reproduces the sample data (Hu & Bentler, 1999). The Normed Fit Index (NFI) is an incremental fit index which compares the hypothesized model with the independence model (Tabachnick & Fidell, 2001). For both the GFI and NFI, values greater than .90 represent good model fit (Tabachnick & Fidell, 2001). The Comparative Fit Index (CFI) also compares the estimated model to the independence model (Schumacker & Lomax, 2004), with values greater than .95 considered to be a good fit (Hu & Bentler, 1999). The root mean square error of approximation (RMSEA) compares the estimated model to the saturated model (Tabachnick & Fidell, 2001), such that values of .06 or less are indicative of a good fit (Hu & Bentler, 1999). The Akaike Information Criterion (AIC) is a measure of model parsimony used to compare competing models; smaller values indicate a good-fitting, parsimonious model (Tabachnick & Fidell, 2001).

Results

Performance on the EPT and IADL Measures

Table 9 shows participants' mean performance on the EPT (years 1 and 3) and the Lawton and Brody IADL scale (self- and informant-report) along with change in EPT performance from year 1 to year 3. Negative values on EPT Change indicate declines in performance from years 1 to 3, whereas positive values indicate improvement. Table 9 shows that, on average, participants' performance on the EPT declined across the 2 years. However, the average amount of decline was small (-.47 points), with 66.67% of the sample demonstrating changes (increases or decreases) of 3 or less points across the 2 year-interval. With respect to the IADL scales, both participants and informants reported, on average, relatively high levels of IADL functioning.[2]

Table 9
Descriptive Statistics for the EPT and IADL Measures

	n	*M*	*SD*	Minimum	Maximum
EPT Year 1	255	31.47	5.68	10.5	40
EPT Year 3	252	31.13	5.84	12	40
EPT Change	252	-0.47	3.70	-11.5	14.5
SR-IADL	253	0.54	1.55	0	12
IR-IADL	230	0.59	1.83	0	17

Note. SR-IADL = Self-Reported IADLs; IR-IADL = Informant-IADLs.

[2] The discrepancy between Self- and Informant-Reported IADL scores was also examined (i.e., Self-Reported IADL score minus Informant-Reported IADL score) but the range of scores was very restricted (M = -0.01, SD = 1.36), with 75.2% of the dyads reporting identical levels of IADL functioning. In addition, the discrepancy score failed to show significant bivariate relationships with any of the ISD scores, the cognitive variables, or the EPT variables and therefore results pertaining to the discrepancy score are not presented.

Correlational Analyses

The intercorrelations between the various EPT and IADL measures are presented in Table 10. Small (i.e., $r < .30$, Cohen, 1977) but significant negative associations were obtained between the EPT and the Self- and Informant-Reported IADL measures, indicating that better performance on the EPT at years 1 and 3 was related to fewer reported difficulties with IADL functioning. EPT Change was not significantly related to the IADL measures.

Table 10
Intercorrelations between the EPT and IADL Measures

	1	2	3	4	5
1. EPT Year 1	--				
2. EPT Year 3	.79***	--			
3. EPT Change	-.26***	.39***	--		
4. SR-IADL	-.21**	-.23***	-.05	--	
5. IR-IADL	-.17**	-.19**	-.03	.69***	--

Note. SR-IADL = Self-Reported IADLs; IR-IADL = Informant-Reported IADLs.
*p < .05. **p < .01. ***p < .001.

Intercorrelations between the ISD scores for the various RT tasks are show in Table 11, demonstrating, that in general, increased inconsistency on one RT task was associated with increased inconsistency on the other RT tasks as well. The intercorrelations between the cognitive tasks used in the study are shown in Table 12.

Table 11
Intercorrelations between the ISD Scores

	1	2	3	4	5
1. FT Left ISD	--				
2. FT Right ISD	.41***	--			
3. SRT ISD	.11	.28***	--		
4. CFT ISD	.16**	.30***	.23***	--	
5. BRT ISD	.13*	.36***	.46***	.37***	--

*p < .05. **p < .01. ***p < .001.

Table 12

Intercorrelations between the Cognitive Tasks

	1	2	3	4	5	6	7	8	9	10	11	12
1.Digit Symbol	--											
2. Trails A	-.48***	--										
3. Letter Series	.47***	-.37***	--									
4. Trails B	-.48***	.58***	-.48***	--								
5. Block Design	.41***	-.31***	.51***	-.37***	--							
6. WAIS-III Vocabulary	.23***	-.10	.41***	-.18**	.31***	--						
7. Ekstrom Vocabulary	.16*	-.01	.36***	-.17**	.26***	.72***	--					
8. NAART Errors	-.14*	-.01	-.41***	.20**	-.30***	-.59***	-.70***	--				
9. Controlled Associations	.29***	-.18**	.39***	-.25***	.32***	.42***	.46***	-.39***	--			
10. Word Recall	.33***	-.26***	.45***	-.28***	.28***	.36***	.29***	-.29***	.42***	--		
11. Story Recall	.26***	-.22***	.37***	-.22***	.25***	.34***	.23***	-.18***	.29***	.32***	--	
12. Digit Symbol Recall	.38***	-.32***	.29***	-.27***	.23***	.12	.10	-.10	.18**	.31***	.22***	--

*$p < .05$. **$p < .01$. ***$p < .001$.

The bivariate associations between the RT task ISDs, the basic cognitive ability measures, the EPT, and IADL measures are shown in Table 13. Significant negative associations were found between the EPT at years 1 and 3 and all of the ISDs, indicating that better EPT performance was associated with more consistent performance. EPT Change was not, however, significantly associated with inconsistency in RT with the exception of a small but significant correlation between EPT Change and the ISD for BRT. Self- and Informant-Reported IADL functioning were both significantly related to inconsistency on finger tapping and the BRT, indicating that greater difficulty with IADLs was associated with greater inconsistency in RT performance.

Table 13

Intercorrelations for the EPT and IADL variables with the ISD Scores and Cognitive Tasks

	EPT Year 1	EPT Year 3	EPT Change	SR-IADL	IR-IADL
FT Left ISD	-.18**	-.20**	-.03	.11	.05
FT Right ISD	-.36***	-.34***	.00	.20**	.20**
SRT ISD	-.38***	-.38***	-.06	.12	.08
CFT ISD	-.33***	-.36***	-.09	.02	.01
BRT ISD	-.43***	-.52***	-.15*	.33**	.32**
Digit Symbol	.31***	.32***	.06	-.21**	-.20**
Trails A	-.24***	-.27***	-.07	.24***	.26***
Letter Series	.57***	.59***	.08	-.21**	-.18**
Trails B	-.32***	-.40***	-.20**	.22***	.20**
Block Design	.44***	.42***	.02	-.10	-.10
WAIS-III Vocabulary	.53***	.56***	.09	-.08	-.02
Ekstrom Vocabulary	.52***	.52***	.06	-.05	-.03
NAART Errors	-.59***	-.50***	.07	.01	-.04
Controlled Associations	.33***	.35***	.06	-.09	-.14*
Word Recall	.41***	.39***	.04	-.32***	-.27***
Story Recall	.41***	.42***	.05	-.23***	-.19**
Digit Symbol Recall	.12	.17**	.07	-.25***	-.19**

Note. SR-IADL = Self-Reported IADLs; IR-IADL = Informant-Reported IADLs.
$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 13 also shows that better performance on the EPT was associated with better performance on all of the measures of basic cognitive ability except for Digit Symbol Recall at year 1. In contrast, EPT Change was unrelated to any of the cognitive measures except for Trails B; longer time to complete Trails B was associated with declines in performance on the EPT from year 1 to year 3. Both Self- and Informant-Reported IADLs were associated with better cognitive performance on the memory measures (i.e., Word Recall, Story Recall, Digit Symbol Recall) as well as most of the speed and fluid ability measures (i.e., Digit Symbol, Trails A, Letter Series, Trails B). Neither of the IADL measures was significantly related to Block Design or the measures of crystallized ability.

With respect to the correlations between inconsistency and the cognitive ability measures, Table 14 shows that poorer cognitive performance was associated with increased inconsistency in RT on the Right Finger Tapping, SRT, CRT, and BRT tasks. Some of the correlations between inconsistency on the Left Finger Tapping task and the cognitive ability measures were significant (e.g., Letter Series, Trails B, WAIS-III Vocabulary, Story Recall), but they were relatively small in magnitude.

Table 14
Intercorrelations between the ISD Scores and the Cognitive Tasks

	FT Left ISD	FT Right ISD	SRT ISD	CRT ISD	BRT ISD
Digit Symbol	-.12	-.26***	-.35***	-.42***	-.49***
Trails A	.05	.15*	.24***	.26***	.37***
Letter Series	-.14*	-.36***	-.41***	-.39***	-.58***
Trails B	.14*	.25***	.26***	.33***	.41***
Block Design	-.07	-.20**	-.25***	-.29***	-.38***
WAIS-III Vocabulary	-.16*	-.20**	-.31***	-.23***	-.33***
Ekstrom Vocabulary	-.10	-.21**	-.23***	-.16*	-.29***
NAART Errors	.10	.18**	.23***	.17**	.23***
Controlled Associations	-.09	-.12*	-.25***	-.17**	-.28***
Word Recall	-.05	-.23***	-.24***	-.19**	-.30***
Story Recall	-.14*	-.24***	-.29***	-.28***	-.29***
Digit Symbol Recall	-.03	-.15*	-.21**	-.17**	-.26***

*$p < .05$. **$p < .01$. ***$p < .001$.

In general, the pattern of relationships obtained between the ISDs, measures of cognitive ability, and the EPT and IADL measures was as expected: better performance on the EPT and fewer difficulties with IADLs were associated with less inconsistency in RT and better cognitive performance.

Hierarchical Linear Regression Analyses

A series of hierarchical regression analyses were conducted in order to examine the relative contributions of inconsistency and the cognitive ability measures in predicting the indices of everyday functioning. In Research Question 1, composite scores of various basic cognitive abilities (i.e., speed of processing, fluid ability, episodic memory, crystallized ability) were created by averaging the standardized scores of measures hypothesized to represent these cognitive abilities. For Research Question 3, a single indicator was selected to represent each of the cognitive abilities of interest because exploratory analyses conducted for part one of the study indicated that the cognitive measures did not form factors with simple structure. The measures were selected on the basis of being commonly used, and therefore easily interpretable, markers of a variety of basic cognitive abilities. The following tasks were selected: Digit Symbol (speed of processing), Letter Series (fluid ability), Word Recall (episodic memory), Ekstrom's Vocabulary (crystallized ability), and WAIS-III Block Design raw score (visual-spatial ability).

In the first series of analyses, age and education were entered in the first block, followed by the ISDs for the RT tasks in the second block. Finally, the total scores for the basic cognitive ability measures (i.e., Digit Symbol, Letter Series, Block Design, Word Recall, Ekstrom's Vocabulary) were entered in the third block.

As shown in Table 15, age and education accounted for a significant proportion of the variance in scores ($p < .05$) for all of the indices. The demographic variables accounted for 27.5% and 22.0% of the variance in EPT Year 1 and EPT Year 3, respectively. In contrast, age and education accounted for a much smaller proportion of the variance in EPT Change (3.5%), Self-Reported IADLs (5.2%) and Informant-Reported IADLs (4.8%). After accounting for the demographic variables, the ISDs made significant contributions in predicting everyday functioning for all of the measures except EPT Change. The ISDs accounted for a significant proportion of the variance in EPT performance at year 1 (12.3%) and year 3 (16.8%) and both Self-Reported IADLs (9.2%) and Informant-Reported IADLs (9.6%). The cognitive ability measures also accounted for a significant proportion of the variance in everyday functioning, above and beyond that accounted for by demographic variables and ISDs, for EPT Year 1 (14.7%), EPT

Year 3 (16.3%), Self-Reported IADLs (6.9%), and Informant-Reported IADLs (4.7%), but not for EPT Change.

Table 15
Summary of Hierarchical Regression Analyses Demonstrating the Increment in Prediction for the Cognitive Tasks over and above the ISD Scores in Predicting the EPT and IADL Measures

Criterion	Predictor	*B*	*SE B*	β	*R*	R^2	Adjusted R^2	ΔR^2
EPT Year 1								
	Step 1							
	Age	-.140*	.055	-.140				
	Education	.342***	.091	.186				
					.525	.275	.270	.275***
	Step 2							
	FT Right ISD	-.149	.092	-.085				
	FT Left ISD	-.083	.080	-.050				
	SRT ISD	-.126	.066	-.098				
	CRT ISD	-.209	.127	-.084				
	BRT ISD	-.021	.102	-.012				
					.631	.399	.382	.123***
	Step 3							
	Digit Symbol	-.065*	.031	-.118				
	Letter Series	.188*	.078	.156				
	Word Recall	.135	.071	.096				
	Block Design	.083**	.030	.146				
	Vocabulary	.365***	.064	.284				
					.739	.546	.523	.147***
EPT Year 3								
	Step 1							
	Age	-.151**	.056	-.147				
	Education	.077	.094	.041				
					.469	.220	.214	.220***
	Step 2							
	FT Right ISD	-.039	.094	-.021				
	FT Left ISD	-.148	.083	-.085				
	SRT ISD	-.090	.068	-.068				
	CRT ISD	-.241	.131	-.094				
	BRT ISD	-.210*	.105	-.123				
					.623	.388	.370	.168***
	Step 3							
	Digit Symbol	-.058	.032	-.101				
	Letter Series	.244**	.081	.197				
	Word Recall	.155*	.073	.106				
	Block Design	.057	.030	.098				
	Vocabulary	.420***	.066	.317				
					.742	.551	.529	.163***

Table 15 cont.

Criterion	Predictor	*B*	*SE B*	β	*R*	R^2	Adjusted R^2	ΔR^2
EPT Change								
	Step 1							
	Age	-.020	.051	-.030				
	Education	-.289**	.085	-.241				
					.186	.035	.027	.035*
	Step 2							
	FT Right ISD	.128	.086	.110				
	FT Left ISD	-.048	.075	-.043				
	SRT ISD	.011	.062	.012				
	CRT ISD	-.046	.119	-.028				
	BRT ISD	-.169	.096	-.155				
					.259	.067	.040	.032
	Step 3							
	Digit Symbol	.006	.029	.017				
	Letter Series	.054	.073	.068				
	Word Recall	.032	.066	.035				
	Block Design	-.022	.027	-.060				
	Vocabulary	.075	.060	.089				
					.281	.079	.033	.012
SR-IADL								
	Step 1							
	Age	.023	.020	.087				
	Education	.011	.033	.022				
					.228	.052	.045	.052**
	Step 2							
	FT Right ISD	.039	.033	.078				
	FT Left ISD	.040	.029	.086				
	SRT ISD	-.032	.024	-.090				
	CRT ISD	-.109*	.046	-.160				
	BRT ISD	.138***	.037	.300				
					.380	.144	.120	.092***
	Step 3							
	Digit Symbol	-.007	.011	-.049				
	Letter Series	.005	.028	.016				
	Word Recall	-.109***	.025	-.283				
	Block Design	.010	.011	.064				
	Vocabulary	.026	.023	.073				
					.462	.214	.174	.069**

Table 15 cont.

Criterion	Predictor	*B*	*SE B*	β	*R*	R^2	Adjusted R^2	ΔR^2
IR-IADL								
	Step 1							
	Age	.026	.025	.080				
	Education	-.005	.041	-.009				
					.220	.048	.040	.048**
	Step 2							
	FT Right ISD	.068	.042	.117				
	FT Left ISD	.011	.037	.019				
	SRT ISD	-.053	.029	-.132				
	CRT ISD	-.110	.057	-.136				
	BRT ISD	.175***	.046	.330				
					.380	.145	.118	.096***
	Step 3							
	Digit Symbol	-.009	.014	-.052				
	Letter Series	.020	.036	.053				
	Word Recall	-.104**	.033	-.224				
	Block Design	.006	.013	.035				
	Vocabulary	.040	.029	.098				
					.437	.191	.147	.047*

Note. R^2 and R^2 change values are reported for each step in the analyis, but Betas are reported only for the final step. SR-IADL = Self-Reported IADLs; IR-IADL = Informant-Reported IADLs.
**p* < .05. ***p* < .01. ****p* < .001.

For the second series of analyses, age and education were entered first, but the order of entry was reversed for the blocks of ISDs and cognitive measures (see Table 16). Given that EPT Change did not demonstrate statistically significant relationships with any of the predictor groups in the bivariate correlations or the first series of hierarchical regression analyses, it was not included in the second series of analyses. After accounting for age and education, the cognitive measures accounted for a large proportion of the variance in EPT Year 1 (24.2%) and EPT Year 3 (29.7%) and smaller but still significant proportions of the variance in Self-Reported IADLs (8.1%) and Informant-Reported IADLs (5.9%). Following the demographic variables and cognitive measures, the ISDs continued to make significant unique contributions in predicting functional abilities, accounting for 2.9% (EPT Year 1), 3.4% (EPT Year 3), 8.0% (Self-Reported IADLs), and 8.4% (Informant-Reported IADLs) of unique variance.

Table 16

Summary of Hierarchical Regression Analyses Demonstrating the Increment in Prediction for the ISD Scores over and above the Cognitive Tasks in Predicting the EPT and IADL Measures

Criterion	Predictor	*B*	*SE B*	β	*R*	R^2	Adjusted R^2	ΔR^2
EPT Year 1								
	Step 1							
	Age	-.140*	.055	-.140				
	Education	.342***	.091	.186				
					.525	.275	.270	.275***
	Step 2							
	Digit Symbol	-.065*	.031	-.118				
	Letter Series	.188*	.078	.156				
	Word Recall	.135	.071	.096				
	Block Design	.083**	.030	.146				
	Vocabulary	.365***	.064	.284				
					.719	.517	.503	.242***
	Step 3							
	FT Left ISD	-.083	.080	-.050				
	FT Right ISD	-.149	.092	-.085				
	SRT ISD	-.126	.066	-.098				
	CRT ISD	-.209	.127	-.084				
	BRT ISD	.021	.102	-.012				
					.739	.546	.523	.029*
EPT Year 3								
	Step 1							
	Age	-.151**	.056	-.147				
	Education	.077	.094	.041				
					.469	.220	.214	.220***
	Step 2							
	Digit Symbol	-.058	.032	-.101				
	Letter Series	.244**	.081	.197				
	Word Recall	.155*	.073	.106				
	Block Design	.057	.030	.098				
	Vocabulary	.420***	.066	.317				
					.719	.518	.504	.297***
	Step 3							
	FT Left ISD	-.148	.083	-.085				
	FT Right ISD	-.039	.094	-.021				
	SRT ISD	-.090	.068	-.068				
	CRT ISD	-.241	.131	-.094				
	BRT ISD	-.210*	.105	-.123				
					.742	.551	.529	.034**

Table 16 cont.

Criterion	Predictor	*B*	*SE B*	β	*R*	R^2	Adjusted R^2	ΔR^2
SR-IADL								
	Step 1							
	Age	.023	.020	.087				
	Education	.011	.033	.022				
					.228	.052	.045	.052**
	Step 2							
	Digit Symbol	-.007	.011	-.049				
	Letter Series	.005	.028	.016				
	Word Recall	-.109***	.025	-.283				
	Block Design	.010	.011	.064				
	Vocabulary	.026	.023	.073				
					.366	.134	.109	.081***
	Step 3							
	FT Left ISD	.040	.029	.086				
	FT Right ISD	.039	.033	.078				
	SRT ISD	-.032	.024	-.090				
	CRT ISD	-.109*	.046	-.160				
	BRT ISD	.138***	.037	.300				
					.462	.214	.174	.080***
IR-IADL								
	Step 1							
	Age	.026	.025	.080				
	Education	-.005	.041	-.009				
					.220	.048	.040	.048**
	Step 2							
	Digit Symbol	-.009	.014	-.052				
	Letter Series	.020	.036	.053				
	Word Recall	-.104**	.033	-.224				
	Block Design	.006	.013	.035				
	Vocabulary	.040	.029	.098				
					.327	.107	.079	.059*
	Step 3							
	FT Left ISD	.011	.037	.019				
	FT Right ISD	.068	.042	.117				
	SRT ISD	-.053	.029	-.132				
	CRT ISD	-.110	.057	-.136				
	BRT ISD	.175***	.046	.330				
					.437	.191	.147	. 084**

Note. R^2 and R^2 change values are reported for each step in the analyis, but Betas are reported only for the final step. SR-IADL = Self-Reported IADLs; IR-IADL = Informant-Reported IADLs.
**p* < .05. ***p* < .01. ****p* < .001.

In summary, the results of the hierarchical regression analyses indicated that basic cognitive abilities accounted for a significant proportion of the variance, above and beyond inconsistency in RT, in EPT scores at years 1 and 3, Self-Reported IADLs, and Informant-Reported IADLs. In addition, inconsistency in RT accounted for a significant proportion of the variance, above and beyond the basic cognitive abilities, in these same criterion variables. Neither inconsistency nor the basic cognitive abilities were significant predictors of change in EPT performance across the 2-year interval. These findings suggest that inconsistency makes a unique contribution to predicting EPT performance (concurrent or future) and IADL functioning 2 years later over and above other cognitive abilities previously found to be important predictors of everyday problem solving.

Mediational Model

The above hierarchical regression analyses were not only informative in terms of elucidating the relative contributions of inconsistency in RT and basic cognitive abilities in predicting everyday problem solving and IADL functioning 2 years later, but they are also informative in terms of whether the proposed mediational model was of any merit. It was hypothesized that the relationship between inconsistency and everyday problem solving is mediated by basic cognitive abilities. If inconsistency does not have a direct effect on everyday problem solving, then when entered after the block of basic cognitive abilities, the block of ISDs should not be significant. This, however, was not the case: the ISDs remained significant even after accounting for the basic cognitive abilities. Nevertheless, the proportion of variance accounted for by the ISDs was reduced after accounting for basic cognitive abilities (i.e., entered in the 3rd step), compared to when the ISDs were entered in the second step. In the first set of analyses, the ISDs accounted for 12.3% and 16.8% of the variance in EPT at Years 1 and 3, respectively, but only 2.9% and 3.4% in the second set of analyses. These findings are consistent with a partial mediational model, whereby inconsistency appears to have both direct and indirect effects on everyday problem solving.

The IADL scores demonstrated a similar pattern. The proportion of variance accounted for in IADL functioning decreased after accounting for the basic cognitive abilities but not as substantially as with the EPT scores. The proportion of variance accounted for decreased from 9.2% to 8.0% for the Self-Reported IADLs and from 9.6% to 8.4% for the Informant-Reported IADLs. These findings also suggest that the relationship between inconsistency and IADLs is based on both direct and indirect effects.

Originally, it was proposed that the mediational model would be examined using *change* in everyday problem solving from years 1 to 3. However, since EPT Change was found to be unrelated to either inconsistency or the basic cognitive abilities, EPT performance at year 3 was used instead.

SEM Analyses: EPT

Missing data were imputed using Maximum Likelihood Estimation (EM) for the three dependent variables with missing data: Year 3 EPT (1.17%), Self-Reported IADLs (.78%) and Informant-Reported IADLs (9.80%).

In accordance with a two-step approach to SEM (Schumacker & Lomax, 2004), the first step in the analysis was to evaluate the measurement portion of the model; that is, to verify that the latent variable “Inconsistency” was adequately defined by the five measures of RT inconsistency selected. The fit of the hypothesized measurement model was poor (χ^2 (5) = 34.59, p < .001; NFI = .82, GFI = .95, CFI = .84; RMSEA = .15; AIC = 64.59). Post hoc model modifications were performed in an attempt to develop a better fitting model. Examination of the standardized residual covariances revealed a large residual between the Right and Left Finger Tapping ISDs (3.47). Therefore, a covariance was added between these measures, resulting in a better fitting model (χ^2 (4) = 4.26, p = .372; NFI = .98, GFI = .99, CFI = .999; RMSEA = .02; AIC = 36.26). A chi-square difference test indicated that the model was significantly improved by the addition of this path (χ^2_{diff} (1) = 30.33, p < .001). See Figure 2.

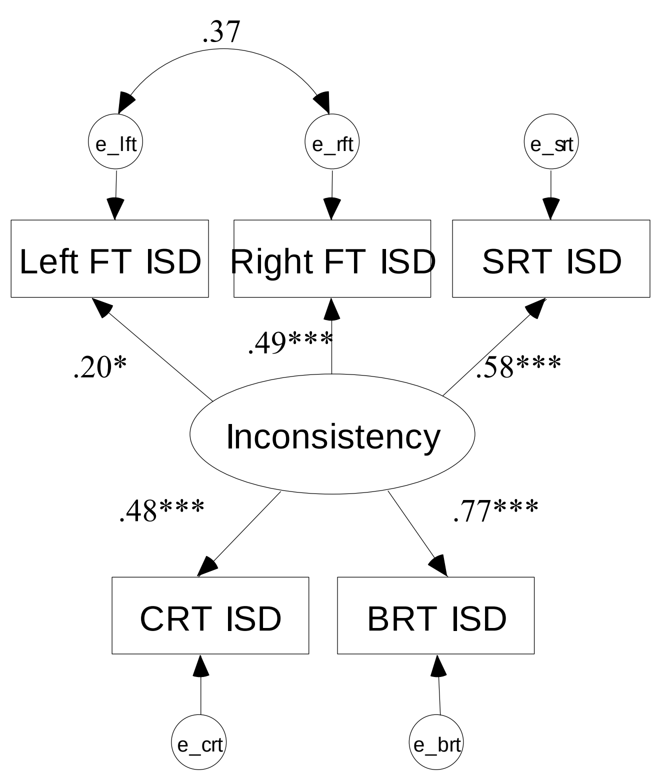

Figure 2. Measurement model for the Inconsistency latent variable

After obtaining an adequate fit for the measurement portion of the model, the next step was to evaluate the hypothesis that basic cognitive abilities mediate the relationship between inconsistency and everyday problem solving. Holmbeck (2003) outlined a series of steps to test whether a variable can be considered a mediator using SEM. The first step is to assess the fit of the direct effect of ISDs on EPT performance. If there is an adequate fit, the fit of the overall model is then tested (ISDs → cognitive abilities → EPT). Providing an adequate fit, the path coefficients from the ISDs to the cognitive abilities and from the cognitive abilities to the EPT are examined to verify that they are significant and in the predicted direction. The final step is to compare the fit of the model under two conditions: (a) when the ISDs → EPT path is constrained to zero, and (b) when the ISDs → EPT path is not constrained. According to Holmbeck (2003), the addition of the ISDs → EPT path to the constrained model should not result in an improvement in fit if there is a mediational effect present.

Holmbeck's steps were followed in evaluating the mediational model for EPT Year 3. In the first step, a model specifying a direct path from the Inconsistency latent variable to EPT Year 3 fit well (χ^2 (8) = 6.52, p = .59; NFI = .98, GFI = .99, CFI = 1.00; RMSEA = .00), with a standardized regression weight of -.69 ($p < .001$) for the path from Inconsistency to EPT Year 3, indicating that increased inconsistency was related to poorer performance on the EPT at Year 3.

The fit of the overall model (i.e., ISDs → cognitive abilities → EPT) was then assessed, resulting in an adequate fit (χ^2 (39) = 74.68, p = .001; NFI = .91, GFI = .95, CFI = .96; RMSEA = .06, AIC = 128.68). As shown in Figure 3, all of the path coefficients from Inconsistency to the cognitive ability measures were significant and in the expected direction (i.e., negative), such that increased inconsistency was predictive of poorer performance on the cognitive measures. With respect to the paths from the cognitive ability measures to EPT Year 3, only those from Letter Series, Block Design, and Vocabulary were significant. These paths were also in the expected direction, with better cognitive functioning predictive of higher EPT Year 3 scores.

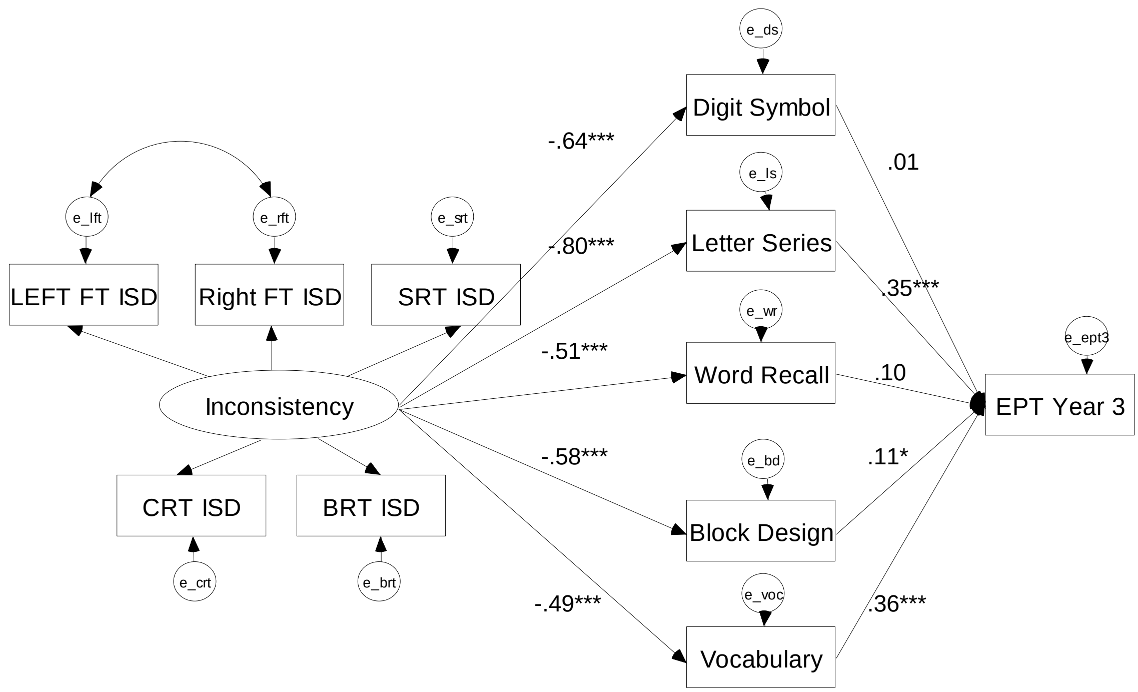

Figure 3. Mediational model of the relationship between Inconsistency and EPT performance at year 3 using five observed cognitive variables as mediators.

The fit of the model was also compared when the Inconsistency to EPT path was and was not constrained to zero (Figure 4). The addition of the direct path from Inconsistency to EPT resulted in a significant improvement in model fit (χ^2 (38) = 52.36, p = .061; NFI = .94, GFI = .97, CFI = .98; RMSEA = .04, AIC = 108.34; $\chi^2_{\text{diff}}(1)$ = 22.32, p < .001). The regression weight from Vocabulary to EPT Year 3 remained significant and positive with the addition of this path but the paths from Letter Series, Block Design, and Word Recall failed to reach significance. In addition, the path from Digit Symbol became significant and negative, suggesting that faster speed of processing was associated with poorer performance on the EPT at year 3. For both the constrained and unconstrained models, the pattern of results obtained for the regression weights from the cognitive ability measures to EPT Year 3 were unexpected. Although all of the cognitive ability measures demonstrated significant, positive zero-order relationships with the EPT at Year 3, not all of them were significant predictors in the constrained model, suggesting that there may have been substantial shared variance between the cognitive variables, resulting in little unique predictive variance remaining for Digit Symbol and Word Recall. This may have also contributed to the unexpected finding of a significant negative relationship between Digit Symbol and EPT Year 3 in the unconstrained model. Thus, although the fit of the model was adequate, the pattern of results obtained for the path coefficients suggested that the relationships among the variables were not well represented by the model.

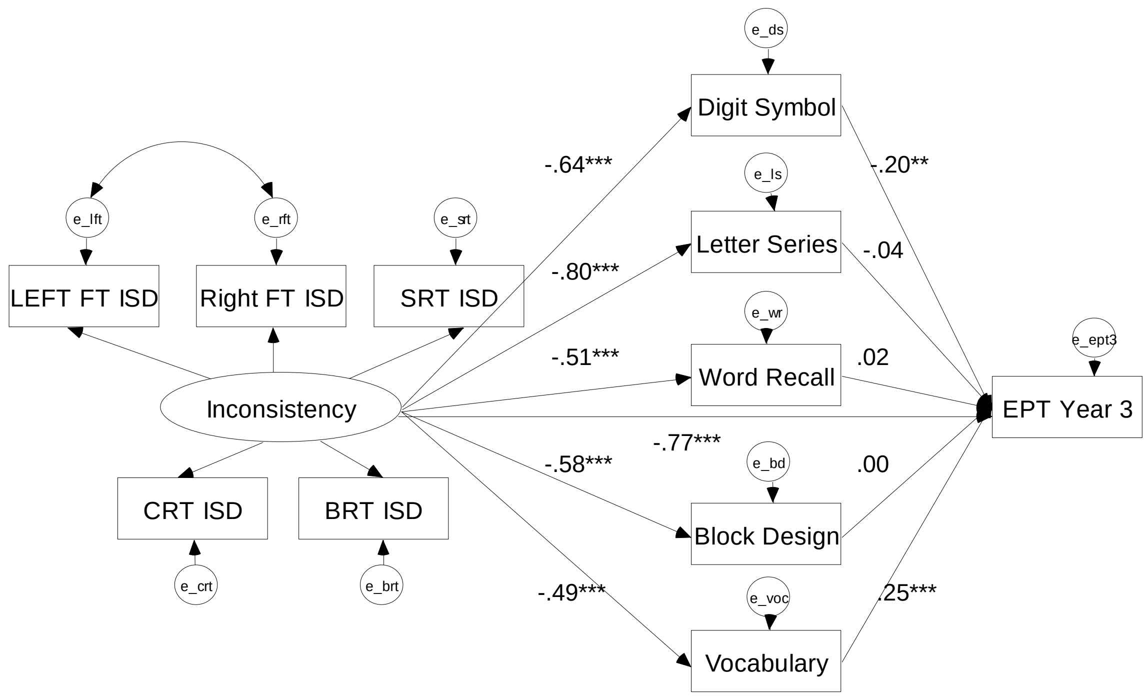

Figure 4. Model testing the direct effect of Inconsistency on EPT performance at year 3, with five observed cognitive variables.

In order to further explore the relationships between inconsistency in RT, speed of processing, and EPT performance, another series of hierarchical regression analyses was conducted (see Table 17). In the first model, the ISDs for the RT measures were entered in the first block followed by Digit Symbol in the second block. The ISDs accounted for 33.7% ($p < .001$) of the variance in EPT Year 3 scores but Digit Symbol failed to make a significant contribution in predicting EPT performance after accounting for the ISDs. In the second model, the order of entry was reversed. When entered first, Digit Symbol accounted for 10.0% ($p < .001$) of the variance in EPT scores, and ISDs accounted for a further 23.6% ($p < .001$) of the variance. This pattern of results is more consistent with the idea that inconsistency mediates the relationship between speed and everyday problem solving than vice versa, as originally hypothesized. As shown in Table 17, even when controlling for age and education, the same pattern of results is obtained. The analyses were also re-run using Digit Symbol and Trails A, which were both used as the indicators of speed in part one of the study, and the same overall pattern of results was obtained.

Table 17
Summary of Hierarchical Regression Analyses Demonstrating the Increment in Prediction for the ISD Scores and Speed of Processing in Predicting EPT Performance at Year 3

Criterion	Predictor	*B*	*SE B*	β	*R*	R^2	Adjusted R^2	ΔR^2
EPT Year 3								
	Step 1							
	FT Right ISD	-.176	.112	-.096				
	FT Left ISD	-.123	.098	-.070				
	SRT ISD	-.198*	.080	-.148				
	CRT ISD	-.405**	.152	-.157				
	BRT ISD	-.588***	.115	-.343				
					.580	.337	.323	.337***
	Step 2							
	Digit Symbol	.002	.036	.003				
					.580	.337	.320	.000
EPT Year 3								
	Step 1							
	Digit Symbol	.002	.036	.003				
					.317	.100	.097	.100***
	Step 2							
	FT Right ISD	-.176	.112	-.096				
	FT Left ISD	-.123	.098	-.070				
	SRT ISD	-.198*	.080	-.148				
	CRT ISD	-.405**	.152	-.157				
	BRT ISD	-.588***	.115	-.343				
					.580	.337	.320	.236***

Table 17 cont.

Criterion	Predictor	*B*	*SE B*	β	*R*	R^2	Adjusted R^2	ΔR^2
EPT Year 3								
	Step 1							
	Age	-0.121	.064	-.119				
	Education	.399***	.099	.211				
					.469	.220	.214	.220***
	Step 2							
	FT Right ISD	-.162	.108	-.089				
	FT Left ISD	-.136	.095	-.078				
	SRT ISD	-.169*	.078	-.127				
	CRT ISD	-.411**	.148	-.160				
	BRT ISD	-.490***	.115	-.286				
					.623	.388	.370	.168***
	Step 3							
	Digit Symbol	-.039	.036	-.068				
					.625	.391	.371	.003
EPT Year 3								
	Step 1							
	Age	-0.121	.064	-.119				
	Education	.399***	.099	.211				
					.469	.220	.214	.220***
	Step 2							
	Digit Symbol	-.039	.036	-.068				
					.482	.233	.223	.012*
	Step 3							
	FT Right ISD	-.162	.108	-.089				
	FT Left ISD	-.136	.095	-.078				
	SRT ISD	-.169*	.078	-.127				
	CRT ISD	-.411**	.148	-.160				
	BRT ISD	-.490***	.115	-.286				
					.625	.391	.371	.158***

Table 17 cont.

Criterion	Predictor	*B*	*SE B*	β	*R*	R^2	Adjusted R^2	ΔR^2
EPT Year 3								
	Step 1							
	FT Right ISD	-.183	.112	-.100				
	FT Left ISD	-.128	.098	-.073				
	SRT ISD	-.194*	.080	-.145				
	CRT ISD	-.398**	.152	-.155				
	BRT ISD	-.565***	.116	-.330				
					.580	.337	.323	.337***
	Step 2							
	Digit Symbol	-.012	.038	-.022				
	Trails A	-.030	.027	-.068				
					.583	.340	.321	.003
EPT Year 3								
	Step 1							
	Digit Symbol	-.012	.038	-.022				
	Trails A	-.030	.027	-.068				
					.344	.119	.111	.119***
	Step 2							
	FT Right ISD	-.183	.112	-.100				
	FT Left ISD	-.128	.098	-.073				
	SRT ISD	-.194*	.080	-.145				
	CRT ISD	-.398**	.152	-.155				
	BRT ISD	-.565***	.116	-.330				
					.583	.340	.321	.221***

Table 17 cont.

Criterion	Predictor	*B*	*SE B*	β	*R*	R^2	Adjusted R^2	ΔR^2
EPT Year 3								
	Step 1							
	Age	-.110	.065	-.108				
	Education	.401***	.100	.212				
					.469	.220	.214	.220***
	Step 2							
	FT Right ISD	-.168	.108	-.092				
	FT Left ISD	-.137	.095	-.079				
	SRT ISD	-.169*	.078	-.127				
	CRT ISD	-.411**	.149	-.160				
	BRT ISD	-.480***	.116	-.280				
					.623	.388	.370	.168***
	Step 3							
	Digit Symbol	-.047	.037	-.082				
	Trails A	-.020	.027	-.044				
					.626	.392	.369	.004
EPT Year 3								
	Step 1							
	Age	-.110	.065	-.108				
	Education	.401***	.100	.212				
					.469	.220	.214	.220***
	Step 2							
	Digit Symbol	-.047	.037	-.082				
	Trails A	-.020	.027	-.044				
					.485	.236	.223	.015
	Step 3							
	FT Right ISD	-.168	.108	-.092				
	FT Left ISD	-.137	.095	-.079				
	SRT ISD	-.169*	.078	-.127				
	CRT ISD	-.411**	.149	-.160				
	BRT ISD	-.480***	.116	-.280				
					.626	.392	.369	.156***

Note. R^2 and R^2 change values are reported for each step in the analyis, but Betas are reported only for the final step.
$*p < .05$. $**p < .01$. $***p < .001$.

A structural equation model was conducted exploring the hypothesis that inconsistency mediates the relationship between speed and EPT performance. Both Trails A and Digit Symbol were used as indicators for the latent variable 'Speed.' Shown in Figure 5, the constrained model (Speed → Inconsistency → EPT Year 3) provided an adequate fit (χ^2 (18) = 21.24, p = .267; NFI = .96, GFI = .98, CFI = .99; RMSEA = .03, AIC = 57.24). The addition of a direct path from Speed to EPT Year 3 significantly improved the fit of the model (χ^2 (17) = 16.16, p = .513; NFI = .97, GFI = .98, CFI = 1.00; RMSEA = .00, AIC = 54.16, χ^2_{diff} (1) = 5.08, p < .025); however, the regression weight from Speed to EPT was not significant (p > .05). These results suggest that the relationship between Speed and EPT is mostly mediated by inconsistency in RT.

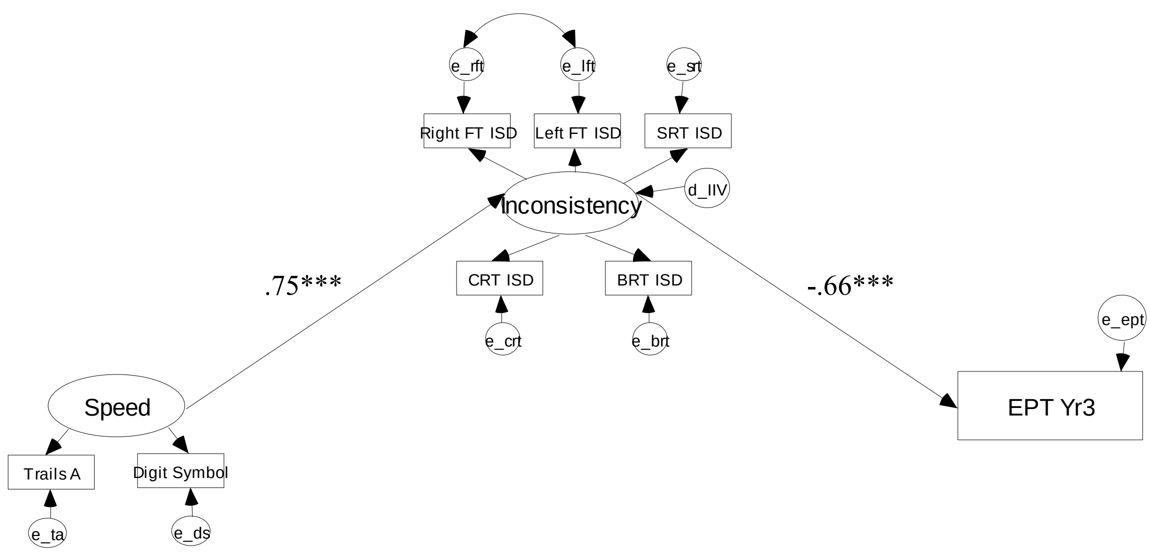

Figure 5. Test of the mediational effect of Inconsistency on the relationship between speed of processing and EPT performance at year 3.

Due to the suspected multicollinearity among the remaining cognitive variables, a Principle Components Analysis (PCA) was conducted in order to explore the shared variance among the cognitive variables. Because exploratory analyses indicated that the original eight cognitive measures used in part one of the study did not form factors with simple structure, all available measures from the study assessing cognitive ability were used (except for Digit Symbol and Trails A, which demonstrated a different mediational relationship with inconsistency and EPT performance than the other cognitive variables). Therefore, in addition to the original six variables used in the first part of the study as indicators of crystallized ability (Ekstrom's Vocabulary, Controlled Associations), fluid ability (Trails B, Letter Series), and episodic memory (Word Recall, Story Recall), WAIS-III Block Design, WAIS-III Vocabulary, the NAART, and WAIS-R Digit Symbol Recall were entered in a PCA to identify the number of reliable and interpretable components.

Principle components extraction was used to estimate the number of components from the eigenvalues. Two components with eigenvalues greater than 1.0 were extracted, accounting for a total of 54.71% of the variance. However, examination of the scree plot (Figure 6) suggested the presence of a third component (63.55% of the variance): the slope of a line drawn through the eigenvalue points, starting with the first eigenvalue, noticeably changes slope between the third and fourth eigenvalues (Tabachnick & Fidell, 2001).

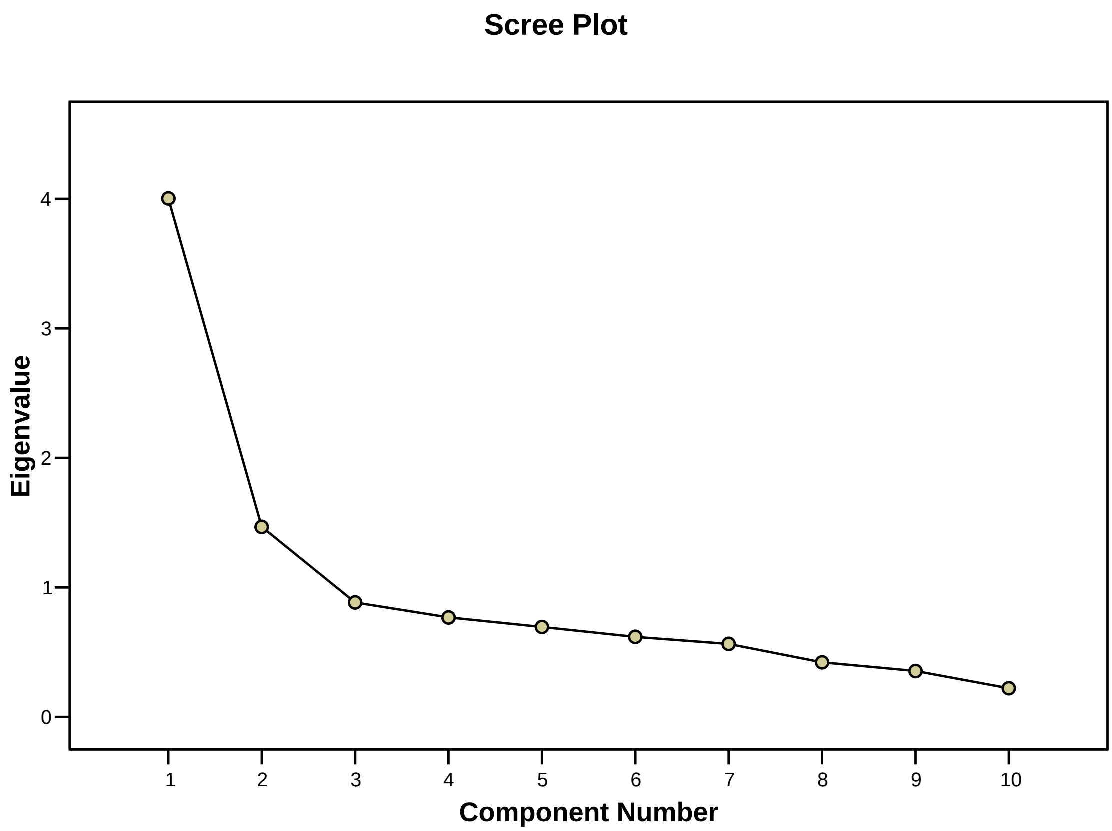

Figure 6. Scree plot for the principal components analysis of the ten observed cognitive variables.

A principle components extraction with varimax rotation was then requested specifying 3 components. A criterion of .45 was selected for inclusion of a variable in the interpretation of a component (i.e., 20% overlapping variance) and using this criterion only one variable loaded on more than one component (i.e., Controlled Associations). An oblique rotation was also requested in order to examine the correlations among the components. The correlation between the second and third component was moderate in size (r = -.42), with more modest correlations between the other components (first & second component: r = .29; first & third component: r = -.30). In addition, interpretation of the components improved with an oblique rotation as none of the variables loaded on more than one component. Therefore, the results from the oblique rotation were used for interpretation. The first component consisted of the NAART, WAIS-III Vocabulary, Ekstrom's Vocabulary, and Controlled Associations (the "Crystallized" component). The second component consisted of Block Design, Letter Series, and Trails B (the "Fluid" component). The third component included Digit Symbol Recall, Word Recall, and Story Recall (the "Episodic Memory" component). The Pattern Matrix for the oblique rotation is shown in Table 18.

Table 18
Principle Component Analysis of the Cognitive Tasks: Pattern Matrix

	Component		
	Crystallized Ability	Episodic Memory	Fluid Ability
Block Design	0.120	-0.074	**-0.781**
Letter Series	0.204	0.201	**-0.625**
Trails B	0.124	-0.018	**0.837**
NAART	**-0.857**	0.112	0.107
WAIS-III Vocabulary	**0.814**	0.124	-0.001
Ekstrom Vocabulary	**0.909**	-0.022	-0.005
Controlled Associations	**0.460**	0.368	-0.055
Digit Symbol Recall	-0.233	**0.692**	-0.135
Word Recall	0.174	**0.667**	-0.043
Story Recall	0.104	**0.702**	0.067

The component structure of the cognitive variables was confirmed in a confirmatory factor analysis using SEM (see Figure 7). The fit of the initial model was adequate (χ^2 (32) = 69.84, p < .001; NFI = .92, GFI = .95, CFI = .95; RMSEA = .07).

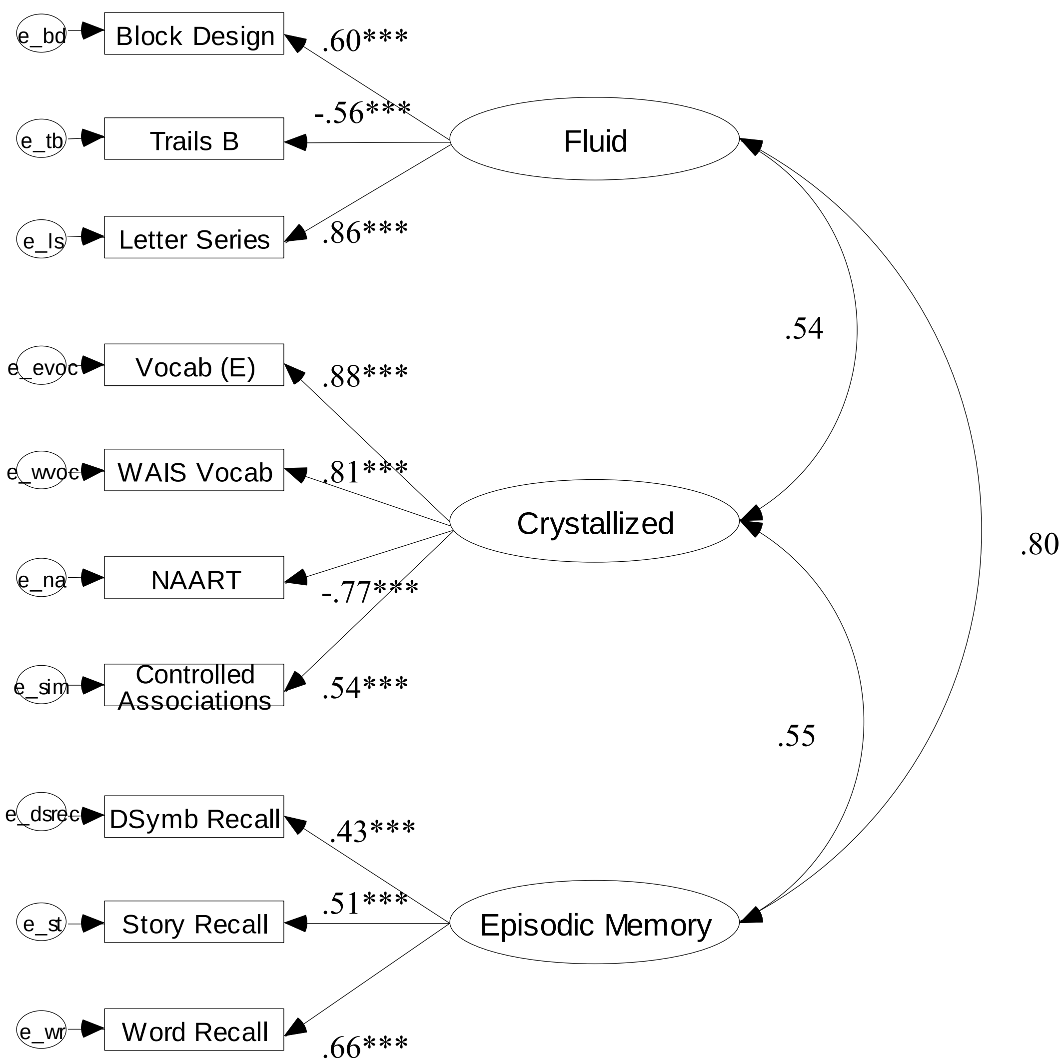

Figure 7. Confirmatory factor analysis of the three latent cognitive variables

Based on the results from the mediational model for Speed and the confirmatory factor analysis for the remaining cognitive variables, a single structural model was developed and tested, as shown in Figure 8. The fit of the initial model was marginal (χ^2 (128) = 254.43, $p < .001$; NFI = .86, GFI = .90, CFI = .92; RMSEA = .06, AIC = 340.43). Based on a large standardized residual covariance between Trails A and Trails B (4.23), along with a Modification Index of 39.50 for the covariance between the errors for Trails A and B, a covariance was added between the Trails A and B errors, resulting in a significant improvement in fit (χ^2 (127) = 211.38, $p < .001$; NFI = .88, GFI = .92, CFI = .95; RMSEA = .05, AIC = 299.38; χ^2_{diff} (1) = 43.05, $p < .001$). With the exception of the regression weight from Episodic Memory to EPT Year 3, all of the regression weights were significant and in the expected direction. Slower speed of processing was predictive of greater inconsistency in RT. Increased inconsistency was associated with poorer fluid, crystallized, and episodic memory abilities. Poorer fluid and crystallized abilities were predictive of poorer performance on the EPT at year 3.

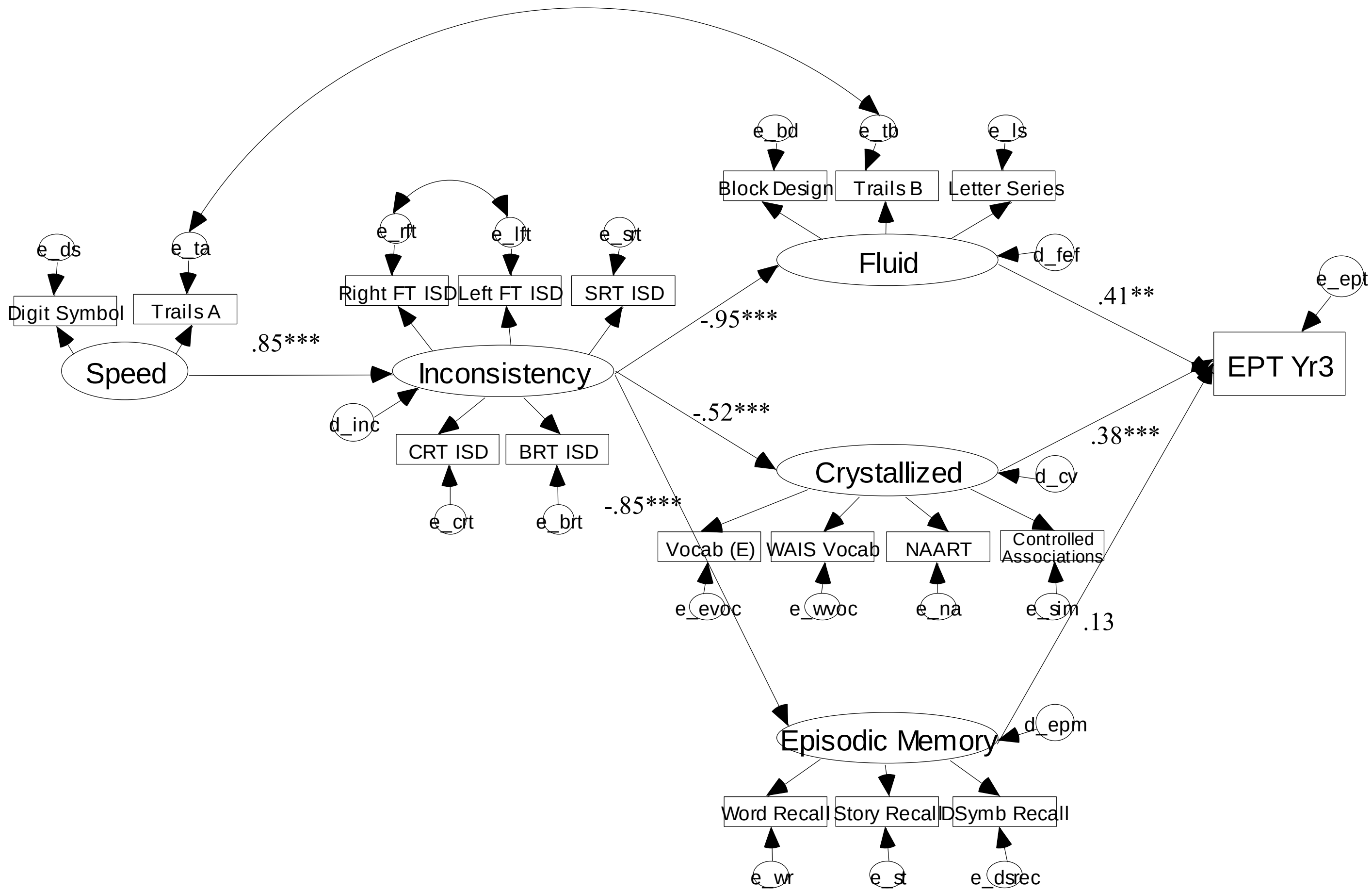

Figure 8. Mediational model of the relationship between Inconsistency and EPT performance at year 3 using the three latent cognitive variables as mediators.

Since the path from Episodic Memory to EPT Year 3 was not significant, likely due to overlapping variance with the Fluid ability latent variable, the model was re-run without Episodic Memory, as shown in Figure 9. The fit of the model was good (χ^2 (84) = 126.49, p = .002; NFI = .92, GFI = .94, CFI = .97; RMSEA = .05, AIC = 198.49) and all regression weights were significant and in the expected direction. The addition of a direct path from the Inconsistency latent variable to Year 3 EPT did not significantly improve the fit of the model (χ^2 (83) = 126.46, p = .002; NFI = .92, GFI = .94, CFI = .97; RMSEA = .05, AIC = 200.46; $\chi^2_{diff}(1) = .03$, $p > .05$) nor was the path from Inconsistency to Year 3 EPT significant ($p > .05$), supporting a mediational relationship between Inconsistency and Year 3 EPT.

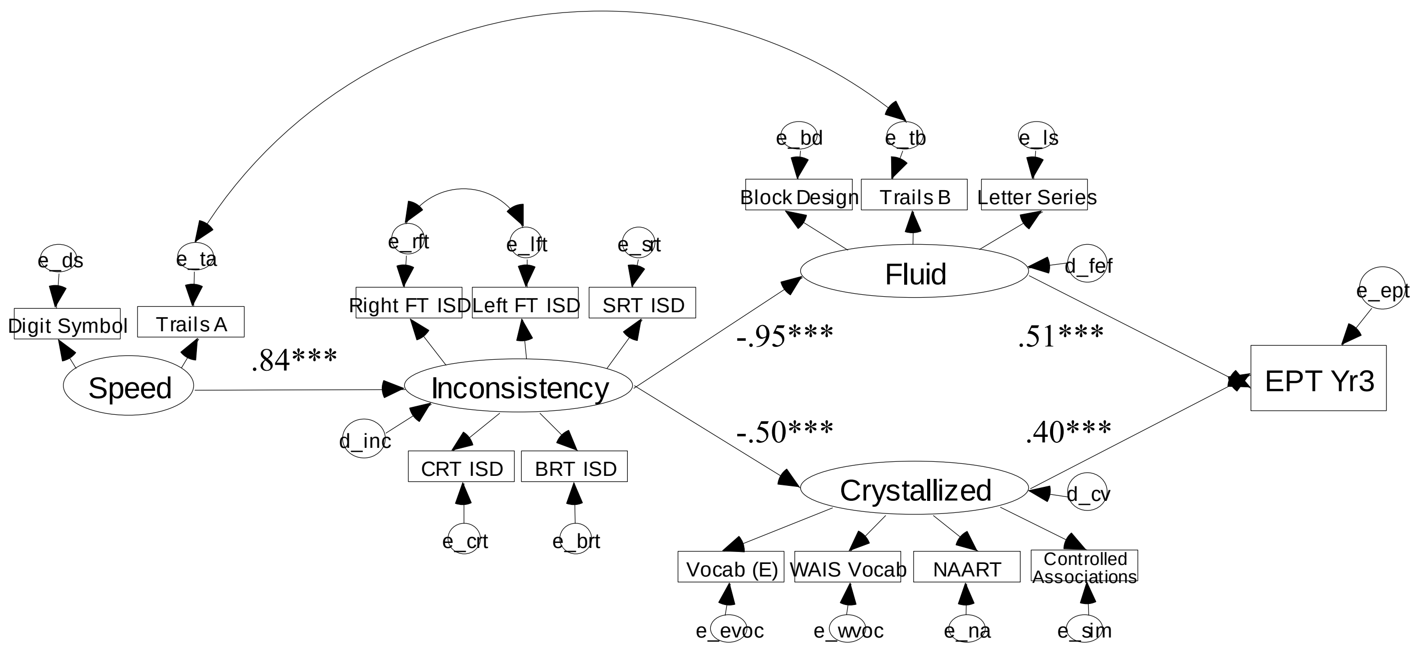

Figure 9. Final mediational model of the relationship between Inconsistency and EPT performance at year 3.

In Research Question 2, the relative contributions of inconsistency and mean level of performance in RT was examined. Therefore, the final two models (i.e., Figures 8 and 9) were re-run using the means for the RT measures as indicators of speed of processing instead of Digit Symbol and Trails A to examine whether the results could be replicated using completely different indices of speed. The same pattern of results was obtained.

SEM Analyses: Self- and Informant-Reported IADLs

To examine whether Self-Reported and Informant-Reported IADLs demonstrated similar relationships to inconsistency and the cognitive measures, another series of structural equations models were run. Inspection of the raw data revealed a substantial degree of skewness and kurtosis for the IADL variables (Self-Reported IADLs: skewness = 4.45, kurtosis = 25.38; Informant-Reported IADLs: skewness = 5.10, kurtosis = 34.20), thus violating the assumption of normality for SEM. Given that the ability to perform various IADLs is not expected to be normally distributed in a sample of healthy, community dwelling older adults (as most older adults would have few difficulties), it was decided to dichotomize these variables, rather than perform a data transformation technique. Participants who obtained scores of less than 1.0 on the IADL scales were classified as "Not Impaired" (n = 208) and those who obtained scores equal to or greater than 1.0 were classified as "Impaired" (n = 47).

Initially, the direct relationship between inconsistency and the two dichotomous IADL variables was analyzed. Both models provided an acceptable fit (Self-Reported IADLS: χ^2 (8) = 5.14, p = .742; NFI = .98, GFI = .99, CFI = 1.00; RMSEA = .00; Informant-Reported IADLs: χ^2 (8) = 7.56, p = .477; NFI = .97, GFI = .99, CFI = 1.00;

RMSEA = .00), with standardized regression weights of .25 (p = .001) and .30 (p < .001) for Self- and Informant-Reported IADLs, respectively. In contrast to the EPT, where higher values indicate better performance, a positive relationship between inconsistency and the IADL variables indicates that increased inconsistency is predictive of impairment in IADL functioning.

As shown in Figure 10, the first model that was evaluated for Self-Reported IADLs, whereby Inconsistency predicts the Fluid, Episodic Memory, and Crystallized latent variables, demonstrated an adequate fit (χ^2 (127) = 187.22, p < .001; NFI = .88, GFI = .93, CFI = .96; RMSEA = .04). The regression coefficients for the paths from Speed to Inconsistency, from Inconsistency to the 3 other cognitive latent variables, and from Episodic Memory to Self-Reported IADLs, were all significant and in the predicted direction. However, the path from the Fluid variable to Self-Reported IADLs was not significant, likely due to shared variance with the Episodic Memory latent variable. The nonsignificant path from Crystallized ability to Self-Reported IADLs was not unexpected, given the nonsignificant zero-order correlations between these variables. The same pattern of results was observed for Informant-Reported IADLs, as shown in Figure 11 (χ^2 (127) = 188.22, p < .001; NFI = .88, GFI = .92, CFI = .96; RMSEA = .04).

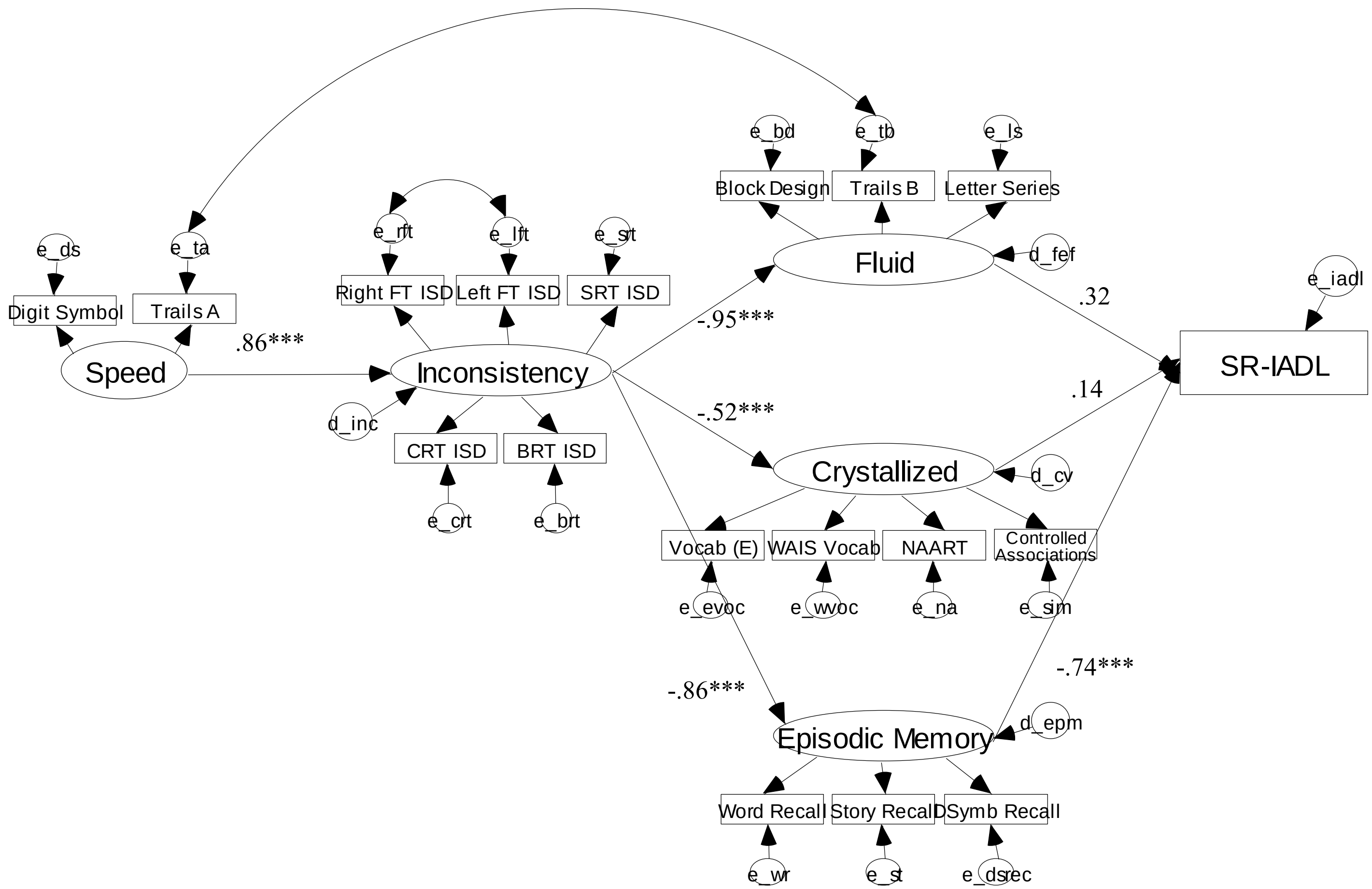

Figure 10. Mediational model of the relationship between Inconsistency and Self-Reported IADLs using the three latent cognitive variables as mediators.

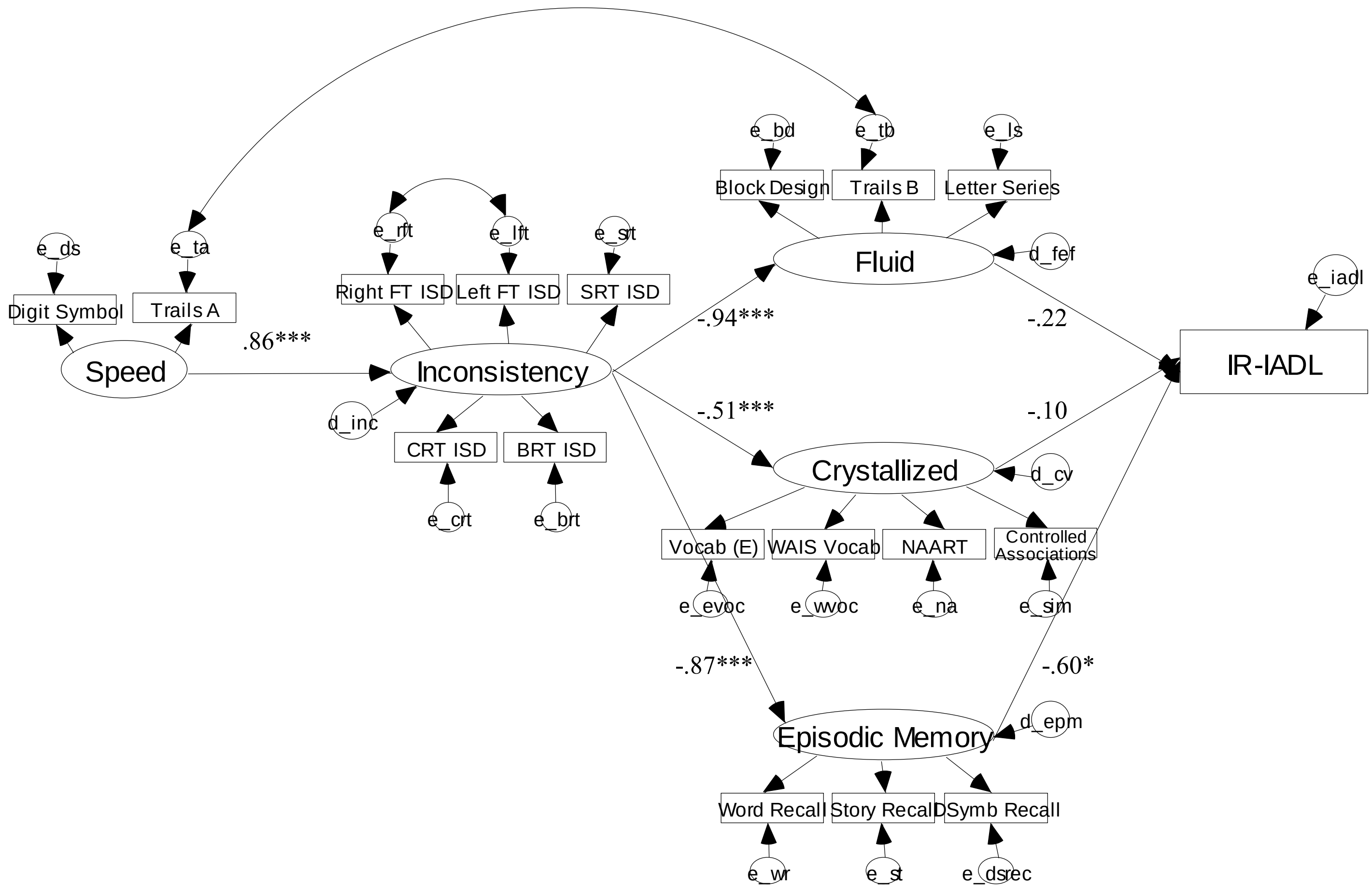

Figure 11. Mediational model of the relationship between Inconsistency and Informant-Reported IADLs using the three latent cognitive variables as mediators.

A final model using Self-Reported IADLs was tested, as shown in Figure 12. The Fluid and Crystallized latent variables were omitted in this model because they failed to show a significant relationship with Self-Reported IADLs. The fit of this model was also good (χ^2 (41) = 42.66, p = .399; NFI = .92, GFI = .97, CFI = .997; RMSEA = .01, AIC = 92.66). All of the regression coefficients were significant and in the expected direction. The addition of a direct path from Inconsistency to Self-Reported IADLs did not improve the fit of the model (χ^2 (40) = 42.33, p = .371; NFI = .92, GFI = .97, CFI = .995; RMSEA = .02, AIC = 94.33, χ^2_{diff} (1) = .33, p > .05), nor was the regression coefficient for this path significant (p > .05), suggesting that the relationship between Inconsistency and Self-Reported IADLs was mediated by the Episodic Memory latent variable. As shown in Figure 13, the same pattern of results was obtained for Informant-Reported IADLs (Modeling testing indirect effect: χ^2 (41) = 42.88, p = .391; NFI = .92, GFI = .97, CFI = .996; RMSEA = .01, AIC = 92.88); Modeling testing direct effect: χ^2 (40) = 42.82, p = .351; NFI = .92, GFI = .97, CFI = .994; RMSEA = .02, AIC = 94.82, χ^2_{diff} (1) = .06, p > .05).

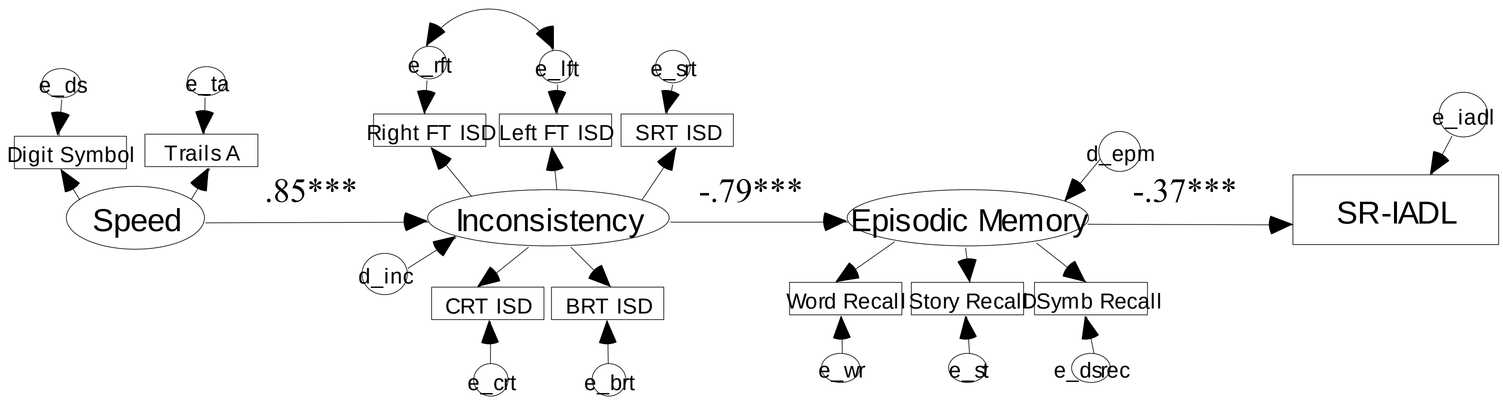

Figure 12. Final mediational model of the relationship between Inconsistency and Self-Reported IADLs.

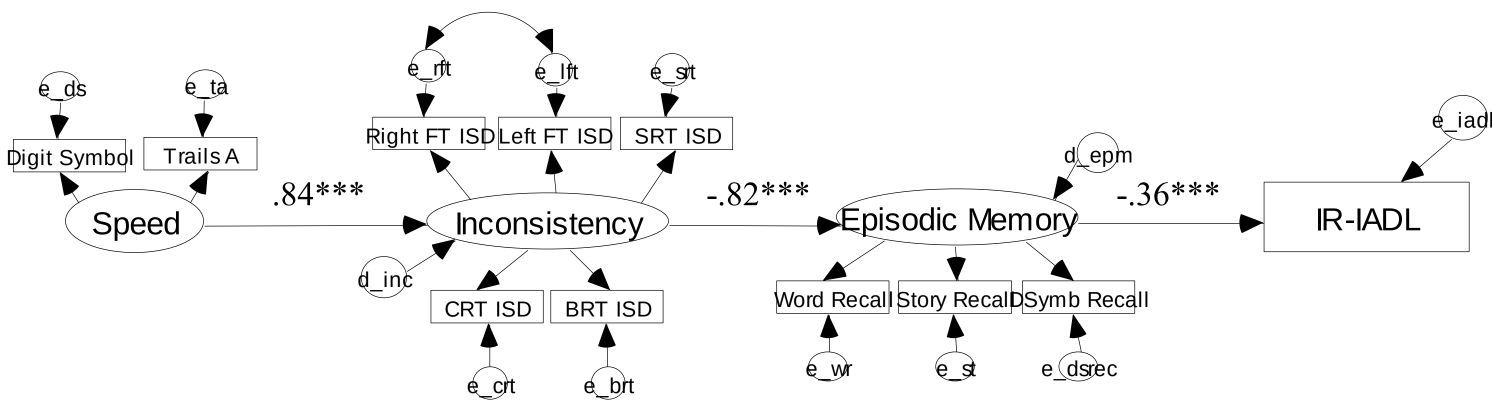

Figure 13. Final mediational model of the relationship between Inconsistency and Informant-Reported IADLs.

To summarize the above SEM analyses into a single model, one last model was run that combined the results from the Year 3 EPT and Self- and Informant-Reported IADLs analyses, as shown in Figure 14. Since the Self- and Informant-Reported IADLs demonstrated very similar results, a single latent variable representing IADL functioning was created using the Self- and Informant-Reported measures as observed variables. The fit of this model was also good (χ^2 (162) = 233.53, $p < .001$; NFI = .88, GFI = .92, CFI = .96; RMSEA = .04; AIC = 329.53). Again, all of the regression coefficients were significant and in the expected direction. The addition of direct paths from Inconsistency to Year 3 EPT and IADL functioning did not improve the fit of the model (χ^2 (160) = 232.172, $p < .001$; NFI = .88, GFI = .92, CFI = .96; RMSEA = .04; AIC = 332.17), nor were the regression coefficients for these paths significant ($p > .05$). Tables 19 and 20 present the direct, indirect, and total effects of the inconsistency and cognitive latent variables on EPT performance and IADL functioning at Year 3.

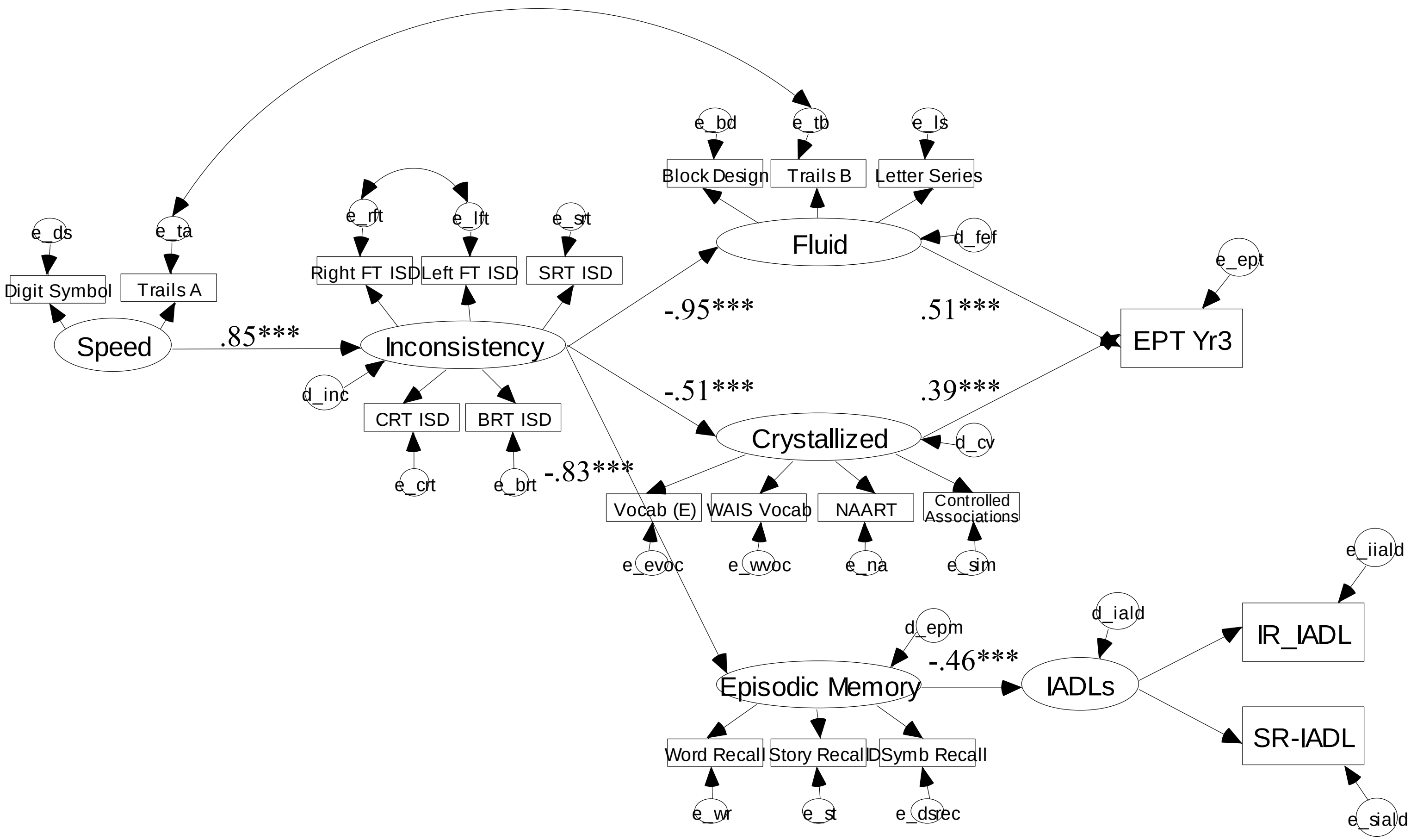

Figure 14. Final SEM model summarizing the results for EPT performance at year 3 and Self- and Informant-Reported IADLs.

Table 19

Direct, Indirect, and Total Effects on EPT Performance at Year 3

Predictor variable	Direct effect (β)	Indirect effect (β)	Total effect (β)
Speed	.00	-.59**	-.59**
Inconsistency	.00	-.69**	-.69**
Fluid Ability	.51***	.00	.51***
Crystallized Ability	.39***	.00	.39***
Episodic Memory	.00	.00	.00

*p < .05. **p < .01. ***p < .001.

Table 20

Direct, Indirect, and Total Effects on IADL Functioning at Year 3

Predictor variable	Direct effect (β)	Indirect effect (β)	Total effect (β)
Speed	.00	.32**	.32**
Inconsistency	.00	.38**	.38**
Fluid Ability	.00	.00	.00
Crystallized Ability	.00	.00	.00
Episodic Memory	-.46***	.00	-.46***

*p < .05. **p < .01. ***p < .001.

Discussion

The purpose of this last part of the study was to investigate the relationship between inconsistency in RT and changes in everyday problem solving performance across a two-year interval in a sample of community dwelling older adults. Of primary interest was whether inconsistency makes a unique contribution, over and above other basic cognitive abilities, in predicting changes in everyday problem solving across time. In addition, the congruence between the EPT, which indexes cognitive-demanding IADLs, and two other commonly used means of assessing IADLs (i.e., self- and informant-report) was examined to determine the extent to which these measures reflect the same construct.

Overall, the majority of participants demonstrated relatively little change in EPT performance across the two-year interval, with the average amount of change being a decline of less than half a point. Furthermore, change in EPT performance was not significantly related to inconsistency in RT (except for a small bivariate correlation with BRT) or with most of the basic cognitive ability measures. Change in EPT performance was also unrelated to self- and informant-reported IADL functioning. It seems likely that the lack of significant findings obtained for the EPT Change variable was due to the restricted range of scores. A 2-year interval may have been insufficient to detect any substantial changes in everyday problem solving in such a high functioning sample of older adults. It is possible that if participants had been followed for a longer interval of time, a relationship between inconsistency and changes in everyday problem solving may have been revealed.

Despite the lack of significant results for changes in EPT performance, level of EPT performance assessed at year 3 was significantly related with inconsistency in RT, at the bivariate level, as well as with all of the basic cognitive ability measures. Similar to the cross-sectional findings from the second part of the study, increased inconsistency at year 1 was associated with poorer performance on the EPT at year 3. Poorer performance on the basic cognitive ability measures at year 1 was also found to be associated with poorer performance on the EPT at year 3. Therefore, even though inconsistency in RT was not found to be related to changes in EPT performance, it was significantly related to level of EPT performance assessed two years later and, thus, may still be of some predictive value.

The potential usefulness of inconsistency indices in predicting future everyday problem solving abilities was explored by comparing the relative contributions of inconsistency and other basic cognitive abilities previously found to be important predictors of everyday problem solving in a series of hierarchical regression analyses. Measures of across-trial inconsistency in RT can be obtained relatively quickly and easily compared to the administration of an entire battery of cognitive measures. Therefore, if inconsistency in RT makes a significant and unique contribution to predicting everyday problem solving over and above other basic cognitive ability measures, it may be prove to be a useful diagnostic tool for predicting future everyday problem solving performance.

As expected, based on the lack of significant bivariate correlations for change in EPT performance, neither the measures of inconsistency nor the measures of basic cognitive ability accounted for a significant proportion of the variance in EPT Change scores. In contrast, after accounting for age and education, inconsistency in RT accounted for 12.3% and 16.8% of the variance in EPT performance at years 1 and 3. After accounting for age, education, and inconsistency, the cognitive ability measures accounted for a further 14.7% and 16.3% of unique variance in Year 1 and Year 3 EPT scores. When the order of entry for the inconsistency and cognitive ability measures was reversed, inconsistency in RT continued to account for a significant proportion of the variance in EPT scores, over and above the cognitive measures, but the magnitude was attenuated (EPT Year 1: 2.9%; Year 3 EPT: 3.4%). Thus, although both inconsistency in RT and the basic cognitive ability measures demonstrated unique predictive power for current and future everyday problem solving in the domains of IADLs, the additional proportion of variance accounted for by inconsistency, on top of the basic cognitive abilities, was relatively small in magnitude.

The relationship between everyday functioning, as indexed by the EPT, and inconsistency and basic cognitive abilities was further investigated using SEM analyses. Using a mediational model, it was hypothesized that the relationship between inconsistency and everyday problem solving is mediated by basic cognitive abilities. Some investigators have suggested that increased inconsistency is a behavioural marker of neurological dysfunction (Bruhn & Parsons, 1977; Hultsch et al., 2000; Li & Lindenberger, 1999). If so, decrements in the integrity of the neurological system should result in impairments in various cognitive domains. Furthermore, if the ability to solve everyday problems is dependent upon various cognitive abilities, as has been suggested by Willis and colleagues (e.g., Marsiske & Willis, 1998; Willis & Marsiske, 1991; Willis & Schaie, 1993), then declines in various cognitive abilities should negatively impact everyday problem solving abilities.

The proposed mediational model was partially supported by the results of the SEM analyses examining performance on the EPT at year 3. According to the final model, slower speed of processing was predictive of greater inconsistency, which was in turn predictive of poorer fluid abilities and crystallized abilities. Decreased fluid and crystallized abilities were in turn associated with poorer everyday problem solving abilities at year 3. Therefore, consistent with expectation, the relationship between inconsistency and EPT performance at year 3 was mediated by various cognitive abilities. However, not all of the basic cognitive abilities were found to be mediators of this relationship. Neither episodic memory nor speed of processing played a role in mediating this relationship and speed of processing was actually better characterized as a predictor of inconsistency.

Of note, a single latent variable representing inconsistency was formed using the ISD scores from the five reaction time tasks, as hypothesized. However, the factor loading for the left finger tapping ISD scores was quite small, and compared to other RT tasks, left finger tapping ISD scores also demonstrated weaker correlations with the EPT scores and the cognitive tasks. Perhaps classifying performance as right-hand versus left-hand, as opposed to dominant-hand versus non-dominant hand, increased the error variance for the left finger tapping measure, attenuating the relationships observed with the other variables. Alternatively, it may be that across-trial inconsistency in performance on this particular task does not reflect the same phenomenon as across-trial inconsistency on the other RT tasks. This task may be more susceptible to various exogenous influences, such as shifts in mood, pain, or fatigue.

The basic assumption underlying this study is that inconsistency in RT is a marker of neurological integrity. A link between speed of processing and age-related neurobiological changes has also been made by Salthouse (2000b), who suggested that slower speed of processing is a manifestation of declining processing efficiency directly due to age-related biological changes. He further proposed that age-related decline in speed of processing is a critical constraint for performance on many other cognitive tasks (Salthouse, 1996). Therefore, it is perhaps not surprising that speed of processing demonstrated a different relationship with inconsistency in RT than the other cognitive abilities, that is, the effect of speed of processing on cognition appeared to be mediated by inconsistency.

Salthouse and Berish (2005) have also recently argued that mean level of performance on RT measures (i.e., speed) is more fundamental than inconsistency in terms of relations with other cognitive variables. They found that the correlations between mean RT and various cognitive abilities were only slightly reduced when controlling for inconsistency, but that the correlations between inconsistency and various cognitive abilities were either eliminated or reversed in direction when controlling for mean RT. However, Salthouse and Berish (2005) examined inconsistency in RT performance across-occasions, whereas the present study examined inconsistency across-trials. Therefore, it is possible that the degree to which either speed or inconsistency appears to be more a powerful or "fundamental" predictor of other cognitive abilities may depend on the particular time frame from which measures of inconsistency are obtained. Based on the present results, however, it appears as though both inconsistency and speed of processing may be markers of neurological compromise. Whether one or the other is a “better” marker of neurological integrity or a more fundamental processing resource is beyond the scope of the present study. However, in terms of everyday functioning, the present findings indicate that across-trials inconsistency in RT may be of greater predictive value than speed of processing. Inconsistency in RT accounted for a much larger proportion of the variance in EPT performance, after accounting for age and education (16.8%) than did measures of speed (1.5% using Trails A and Digit Symbol).

The stronger association found between inconsistency and fluid abilities compared to crystallized abilities is consistent with a distinction often made in the cognitive aging literature between cognitive “process” (or “mechanics”) and “products” (or “pragmatics”) (Salthouse, 2000a). The fluid ability factor of this study is consistent with the “process” domain, which is represented by tasks where the influence of prior knowledge or experience is minimized. These abilities show negative age gradients across adulthood (Li et al., 2004b; Salthouse, 2000a) and are considered to be primarily neurobiologically based (Li et al., 2004b). The “product” domain consists of various forms of acquired knowledge (i.e., the products of past processing), as reflected in the crystallized ability factor. The “product” domain is presumed to be primarily culturally- or experience-based and performance within this domain shows relative stability across the lifespan, at least until late adulthood (Li et al., 2004b). Given that neurobiological influences are believed to play a prominent role in the “process” domain, it makes sense that inconsistency, a presumed marker of neurological integrity, would be more strongly related to the “process” ability factor (i.e., fluid ability). In fact, in a recent investigation, Li et al. (2004b) found that the age gradient for inconsistency corresponded closely to that of fluid abilities and that inconsistency was more closely related to measures of fluid ability than crystallized ability, particularly during old age (i.e., 70-89 years old). Additionally, Salthouse and Berish (2005) reported significant zero-order correlations between measures of across-occasions inconsistency in RT and measures of reasoning/spatial abilities, episodic memory, and speed of processing, but not vocabulary.

Moreover, measures of verbal ability are often used as indicators of premorbid functioning in neuropsychological assessment because they tend to be more resistant to the effects of neurological damage (Lezak, Howieson, & Loring, 2004; Strauss, Sherman, & Spreen, 2006). Therefore, it is again not surprising that crystallized abilities were not as strongly related to a potential marker of neurological compromise, inconsistency in RT, in either the present study or the studies conducted by Li et al. (2004b) and Salthouse and Berish (2005). In short, the stronger association between inconsistency and fluid abilities compared to crystallized abilities make sense when one considers that fluid abilities are more vulnerable than crystallized abilities to the effects of aging and neurological damage.

The final mediational model obtained in this study also provided further insight into the nature of the relationship between everyday problem solving and various cognitive abilities. Consistent with previous research that has examined correlates of concurrent everyday problem solving abilities (e.g., Allaire & Marsiske, 1999; Cornelius & Caspi, 1987; Diehl et al., 1995; Heidrich & Denney, 1994), fluid and crystallized abilities were found to be significant predictors of everyday problem solving performance measured two years later. These findings are similar to those reported by Willis et al. (1992) who found that fluid and crystallized abilities, but not memory span or speed of processing, accounted for a substantial proportion of the variance in everyday functioning measured 7 years later.

In the present study, episodic memory did not demonstrate a direct relationship with everyday problem solving. Although the zero-order correlations between the EPT and the observed episodic memory variables were significant, the path from episodic memory to EPT performance at year 3 was not significant, likely due to shared variance with the fluid ability latent variable. Both fluid ability and episodic ability are considered to fall within the "process" domain (Salthouse, 2000a), likely explaining the strong correlation observed between the two latent variables. In the context of the present study, the findings suggest that out of fluid and episodic memory abilities, it is fluid abilities that are particularly important for predicting everyday problem solving.

Few studies have included measures of episodic memory when examining predictors of everyday problem solving. Willis et al. (1992) and Diehl et al. (1995) examined memory but they used measures of memory span, which tap into attentional and working memory abilities, as opposed to episodic memory abilities, and thus their results are not directly comparable to the present findings. Allaire and Marsiske (1999) included a measure of episodic memory and found that it was a significant predictor of everyday problem solving. However, they used the Everyday Cognition Battery, which comprises 4 tests, each designed to assess a single cognitive ability, including declarative memory. They found that episodic memory was a predictor of everyday tasks that specifically involved declarative memory and domain-specific knowledge. On the EPT, all of the information that one would require to solve the problems is provided to the participant, thus minimizing memory demands and perhaps explaining why episodic memory abilities played a less prominent role in predicting EPT performance. It may be that the different pattern of results obtained in these two studies for episodic memory is simply an artefact of task-specific demands. Consequently, future research will be necessary in order to clarify the extent to which everyday problem solving is dependent upon episodic memory abilities.

A secondary purpose of Research Question 3 was to examine the relationship between everyday problem solving and functional abilities. The EPT was designed to assess everyday problem solving in various IADL domains and, therefore, it was expected that the EPT would be correlated with other more direct measures of IADLs, such as self- and informant-reported measures of IADL functioning. The EPT at year 3 was significantly correlated with the self- and informant-reported versions of the Lawton and Brody (1969) IADL scale, but the correlations were small in magnitude (Self-Reported IADLs: r =-.23, $p < .001$; Informant-Reported IADLs: r = -.19, $p < .01$). The strength of these associations is fairly consistent with what has been reported by previous investigators (Bertrand & Willis, 1999; Willis, 1996a; Willis et al., 1998; Willis & Marsiske, 1993), with the exception of Allaire and Marsiske (1999), who reported a large correlation (r = -.69) using a factor derived from two separate self-reported IADL measures. Although the reason for this discrepancy is not clear, it possible that a stronger relationship was obtained in Allaire and Marsiske's (1999) investigation because of an increase in reliability associated with using factor scores to represent IADL functioning and everyday problem solving.

The congruence between the EPT and the IADL measures was further investigated in a series of analyses examining the relationships of IADL functioning with inconsistency and basic cognitive abilities. At the bivariate level, both Self- and Informant-Reported IADLs were significantly related to inconsistency in RT, such that fewer difficulties with IADLs was associated with more consistent RT performance, but only on the BRT and Right Finger Tapping tasks. In addition, poorer performance on most of the speed, fluid, and episodic memory ability measures was associated with greater difficulty on both IADL scales. An examination of the relative contributions of inconsistency and basic cognitive abilities in predicting Self- and Informant-Reported IADL functioning revealed that, after accounting for age and education, inconsistency accounted for a significant proportion of the variance for both IADL scales (Self-Report: 9.2%; Informant-Report: 9.6%). The basic cognitive ability measures accounted for a further 6.9% and 4.7% of the variance in Self- and Informant-Reported scores, respectively, following the demographic variables and inconsistency. With the order of entry reversed, inconsistency continued to make a significant contribution in predicting Self-Reported (8.0%) and Informant-Reported IADLs (8.4%), over and above the basic cognitive ability measures. Overall then, the self- and informant-reported versions of the Lawton and Brody IADL scale demonstrated similar patterns of results as the EPT in that both inconsistency and basic cognitive abilities made significant and unique contributions in predicting IADL functioning. However, inconsistency appears to have greater unique predictive power for IADL functioning than for everyday problem solving. In addition, the demographic, cognitive, and inconsistency variables, altogether, accounted for a much smaller proportion of the total variance in IADL functioning (SR-IADL: 21.4%; IR-IADL: 19.1%) compared to the EPT (Year 1: 54.6%; Year 3: 55.1%).

In terms of the SEM analyses, a somewhat different pattern of results was obtained for the Self- and Informant-Reported IADLs, compared to the results obtained for the EPT. For IADL functioning, slower speed of processing was a significant predictor of greater inconsistency, which, in turn, was associated with poorer episodic memory abilities. Poorer episodic memory predicted IADL impairment. Thus, for both the EPT and the IADL scales, the relationship between inconsistency and everyday problem solving was a mediational relationship. However, for the EPT, the relationship between inconsistency and everyday problem solving was mediated by fluid and crystallized abilities, whereas for the IADL scales (both self- and informant-reported), episodic memory served as the mediator. Despite significant zero-order correlations between the EPT at year 3 and the observed fluid ability measures, the path from fluid ability to everyday problem solving was not significant, again likely due to shared variance with the episodic memory latent variable. These findings suggest that episodic memory may be particularly important in influencing the ability of older adults, and their significant others, to recall information about their functional abilities.

Crystallized abilities failed to demonstrate a significant relationship with self- and informant-reported IADL functioning in either the bivariate correlations or the structural equation models. Of the few studies that have explored the relationship between crystallized ability and IADL functioning, verbal ability has not been found to be a significant predictor of performance-based measures of functional ability either (Cahn-Weiner, Malloy, Boyle, Marran, & Salloway, 2000; Richardson, Nadler, & Malloy, 1995). The fact that crystallized abilities proved to be a significant predictor of everyday problem solving but not IADL status, may be due to the increased demands placed on language abilities in a task such as the EPT, whereby all of the stimuli are presented in a written, language-based format.

Although the present findings pertaining to crystallized abilities are consistent with past research, it is less clear whether or not the results for the other cognitive abilities are consistent as well. In fact, results from previous studies have proved to be quite inconsistent. For example, in contrast to the present findings, Cahn-Weiner et al. (2000) reported that measures of executive functioning, but not memory, were significant predictors in their sample of community dwelling older adults. Similarly, Carlson et al. (1999) reported that, for a group of cognitively intact, community dwelling older women, only executive functioning was a significant predictor of a performance-based IADL measure, out of a battery of measures that also examined memory, psychomotor speed, and spatial abilities. McCue et al. (1990) examined the relationships between a performance-based measure of functional ability and neuropsychological functioning, as assessed by a short-form of the Luria-Nebraska Neuropsychological Battery (LNNB) in a sample of geropsychiatric in-patients. Performance on the memory and motor scales of LNNB accounted for 45% of the variance in IADL functioning. In a sample of participants with dementia, Hill et al. (1995) found that visual-spatial ability, but not episodic memory, was a significant predictor for an informant-report measure of IADLs, after accounting for global cognitive functioning. Richardson, Nadler, and Malloy (1995) reported that visual-spatial ability, followed by memory ability, were the best predictors of functional abilities, as assessed by a performance-based measure, in a psychogeriatric sample.

Overall, comparisons across studies are difficult to make due to differences in how and which cognitive abilities are measured, the way in which IADLs are assessed (e.g., self-report, informant-report, performance-based), the types of samples used (e.g., cognitively-intact versus cognitively-impaired), and the types of statistical analyses used (Richardson et al., 1995). The same can be said for research investigating predictors of everyday problem solving. Thus, clarification of which specific cognitive abilities, or constellations of abilities, are most predictive of everyday problem solving and functional status will likely necessitate looking at specific IADL domains individually, as demonstrated by Allaire and Marsiske's work (1999; 2002).

In terms of the relationship between EPT performance and IADL status, as assessed by self- and informant-report, the present findings suggest that these measures reflect different, but related, constructs. Although designed for a similar purpose (i.e., providing information about an individual's functioning in the real-world), the two types of measures likely provide information about different aspects of an individual's ability to function in the real world. Measures of everyday problem solving, such as the EPT, focus more on the cognitive level, whereas measures of IADL functioning focus more on the behavioural level. Thus, from a clinical perspective, it is important to bear in mind that the EPT is not a direct measure of functional capacity. However, to the extent that each method contributes unique information, when used together, they may provide a more comprehensive picture of how an individual is able to deal with the demands of everyday living, at both a behavioural and cognitive level.

General Discussion

Through this series of investigations, our understanding of the nature of everyday problem solving as it relates to both level and inconsistency in cognitive performance was broadened. The first part of the study replicated previous findings of an age-related decline in everyday problem solving abilities using a group of community dwelling older adults and a well-structured task indexing problems within the domain of IADLs. Declines in everyday problem solving performance were also observed with mild levels of cognitive impairment. In addition, part one of the study confirmed the results of past research demonstrating significant associations between everyday problem solving and various basic cognitive abilities.

In the second and third parts of the study, the relationship between inconsistency in RT and both concurrent and future everyday problem solving abilities was investigated. The results indicated that inconsistency in RT is a significant predictor of everyday problem solving abilities, whether measured concurrently or two years down the line. In addition, inconsistency in RT accounted for a unique proportion of the variance in everyday problem solving performance, over and above that accounted for by level of cognitive performance, as measured by either mean latencies in RT or a variety of basic cognitive abilities.

From a theoretical perspective, the results of these investigations add to the growing view that inconsistency in performance is an important phenomenon to study. Previous research has demonstrated that inconsistency is predictive of level of performance on various laboratory-type measures of cognitive ability. This study, however, represents the first to demonstrate a relationship between inconsistency in RT and real-world outcomes. In addition, this study provides further support for the idea that increased inconsistency in RT is a behavioural marker of neurological compromise. Although the analyses are correlational in nature, and do not demonstrate causation, the pattern of results obtained is consistent with what one might expect to find if inconsistency in RT is in fact a marker of neurological integrity: neurological compromise, as indexed by increased inconsistency in RT, is predictive of poorer cognitive functioning, which is in turn predictive of poorer everyday problem solving abilities. Furthermore, the finding that inconsistency in RT demonstrated a stronger relationship with fluid abilities than crystallized abilities lends additional support to the view that inconsistency in RT is a marker of neurological integrity.

Although the findings from the present study are consistent with the view that inconsistency represents a vulnerability index, some investigators have suggested that certain kinds of inconsistency or variability in performance may in fact be adaptive, reflecting greater flexibility, adaptability, and creativity (Allaire & Marsiske, 2005; Li, Huxhold, & Schmiedek, 2004a; Nesselroade & Salthouse, 2004; Schultz, Kaye, & Hoyer, 1984; Siegler, 1994). For example, Li et al (2001) found that greater inconsistency on a measure of spatial memory was related to better performance on the same spatial memory task and various sensorimotor tasks. Allaire and Marsiske (2005) demonstrated that greater inconsistency was associated with higher levels of performance for measures of inductive reasoning, memory, and perceptual speed. Whether variability in task performance reflects adaptive or maladaptive processes depends, in part, on the particular cognitive task used (Allaire & Marsiske, 2005). Specifically, variability would likely reflect adaptive processes on cognitive tasks for which individuals show substantial improvement with repeated exposure, thus reflecting the active use of different performance strategies (Allaire & Marsiske, 2005; Siegler, 1994). In contrast, variability would likely be maladaptive on tasks for which individuals are unlikely to show substantial growth or improvement (e.g., reaction-time tasks), or once asymptotic levels of performance are reached (Allaire & Marsiske, 2005; Li et al., 2004a).

The index of inconsistency used in the present study was derived from reaction time measures and, according to this perspective, reflects a maladaptive form of variability. Therefore, consistent with the original hypotheses, increased inconsistency was predictive of lower levels of cognitive functioning and everyday problem solving. However, if the index of inconsistency was derived from cognitive tasks for which increased variability was likely to reflect more adaptive processes, such as the types of tasks used by Allaire and Marsiske (2005), it is possible that increased variability may have been associated with better performance on the cognitive and everyday problem solving tasks. One might even expect to find particularly strong positive relationships between adaptive variability, reflecting the active exploration and use of different strategies, and everyday problems that require more divergent or creative types of solutions, such as those characteristic of ill-structured tasks or tasks of a social/interpersonal nature. Therefore, it will be interesting to see if future research replicates the present findings using different measures of inconsistency and everyday problem solving, or if the pattern of results obtained depends upon the type of inconsistency being indexed (adaptive vs. maladaptive) and the type of everyday problem solving task used (e.g., ill-structured vs. well-structured, IADLs vs. social/interpersonal problems).

Not only is the relationship between inconsistency and everyday problem solving of theoretical interest, it also of interest from a clinical perspective, as it may serve as an early indicator of future declines in cognitive and everyday problem solving abilities. However, the ability to draw conclusions from this study regarding the usefulness of inconsistency as a predictor of declining cognitive and everyday problem solving abilities is restricted by the relatively short time frame for which participants were followed. Based on the present results alone, it would seem that the usefulness of inconsistency in RT, alone, in predicting future everyday problem solving may be limited, at least when considering a two-year interval. Inconsistency in RT accounted for 16.8% of the variance in year 3 EPT scores, after accounting for age and education, whereas the basic cognitive ability measures accounted for almost twice as much. However, one might expect that inconsistency in RT, as a marker of neurological dysfunction, may really only be a strong predictor for those individuals who go on to show neurologically-based declines in everyday functioning, which this group of participants did not, at least within this time frame. Therefore, it will be interesting to see in future studies, where participants are followed for long enough that a substantial proportion of them show significant cognitive decline, whether inconsistency does prove to be a significant and clinically useful predictor of declining everyday functioning.

In addition to the restricted time frame of the present study, there are other limitations to consider. Participants were not randomly sampled from the community, resulting in a sample of well-educated and almost exclusively Caucasian older adults, therefore limiting the generalizability of the present results. However as previously stated, it is possible that if a more varied sample had been used, even stronger associations between inconsistency and everyday problem solving may have been obtained. Furthermore, the battery of cognitive tasks was limited in the number of cognitive measures representing each domain. Accordingly, it was not possible to examine predictors of every-problem solving for each cognitive status group separately because a number of the predictor variables were also used as grouping variables. It is also important to note that the structural models were specified using a single sample, thus running the risk of sample specificity, and the final structural model examined was generated through post-hoc analyses. These limitations, along with the use of the same data set for all three parts of the study, highlights the importance of future replication in independent samples.

In summary, this series of investigations represents one of the first attempts at examining the relationship between inconsistency and everyday problem solving and the findings suggest a promising relationship. Future research into this area will be enhanced by the inclusion of multiple and varied indices of inconsistency, everyday problem solving, and cognitive abilities, as well as varied participant samples that are followed for a substantial length in time. Not only will this provide further insights into the nature of inconsistency but it will also shed light on whether inconsistency has any utility in predicting real-world outcomes.

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