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THE WORK ENVIRONMENT AND COGNITIVE FUNCTION ACROSS ADULTHOOD: RECIPROCAL RELATIONS AND MEANINGFUL OUTCOMES

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ABSTRACT

The current study examined longitudinal patterns of psychosocial work environment experiences and the association of cognitive function with work environment contexts across adulthood. Three main questions were addressed including: 1) What domains predict work environment contexts in the transition from young to middle adulthood? 2), Are there identifiable trajectory types of psychosocial work experiences over a 21-year period, and what specific covariate domains differentiate between trajectory sub-groups? 3) Are psychosocial work environment experiences in later adulthood associated with trajectories of cognitive change after accounting for characteristics of the individual?

Individual samples from the Seattle Longitudinal Study (SLS) were selected for each research question. For question 1, employed individuals with 3 occasions of data over a 14-year period, aged 39 or younger at the first time of measurement were selected (N = 492). Individual patterns of work control, work complexity, and work routine over 14 years were examined with multilevel models. The results indicated that while there was little change in the domains of work control and complexity, work routine was associated with linear decline over time, women perceived less routine compared to men, and gains in reasoning ability were associated with decline in routine.

Research question 2 identified trajectory sub-types of work experience across adulthood. For this question, SLS participants were selected who participated in 4 consecutive waves over a 21-year period and were working at each wave (N =324). Nagin mixture modeling was used to identify trajectory sub-groups of work control, complexity, and routine. The results identified significant trajectory types for each outcome and associated covariates that differentially predicted group membership. The analysis identified 3 trajectory types for work control and work routine, and 4 work complexity trajectory types. Significant covariate domains included age, gender, social engagement, job transitions, health status, and cognitive function.

For the final research question, SLS participants aged 60+ and working in 1991, with follow-up participation in 1998 and 2005 were selected. The association of late life work experiences with individual patterns of inductive reasoning (fluid ability), verbal memory (fluid ability), and verbal ability (crystallized ability) were examined over 14 years with multilevel models. The results indicated that both fluid abilities were associated with linear decline with increasing age, while verbal ability showed significant linear gain, with slight leveling off by the end of the 14-year period. All outcomes illustrated significant interindividual variability in linear change across the study. After controlling for health, perceptual speed, and education, gain in verbal memory was associated with experiences of high personal control in the work environment. Gains in inductive reasoning and verbal ability were associated with individuals who participated in work throughout the study compared to those who retired. The present study suggests that distinct types of psychosocial work experiences are common across adulthood, that baseline cognitive function was only associated with perceived work routine in early adulthood, and provided evidence that late life work experiences may be protective for cognitive maintenance in older adults.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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Chapter 1

INTRODUCTION & LITERATURE REVIEW

The purpose of the present thesis is to examine patterns of work environment experiences across adulthood and the association between cognitive function and work experiences in both early and late adulthood. Three specific aims will be addressed. First, what factors predict work environment contexts in the transition from early to middle adulthood? Second, do individuals' work environment contexts change across adulthood, and what covariates are associated with these work trajectories? Finally, are late life work experiences predictive of cognitive trajectories after accounting for characteristics of the individual?

United States Employment Demographics

In the United States, participation in paid employment is common in adulthood, although specific work experiences can vary at the individual level. The U.S. Bureau of Labor Statistics (2007) reported that over 145 million people were employed in April, 2007. However, occupations are not created equal and work experiences can differ by occupational type. For instance, a recent report by the U.S. Bureau of Labor Statistics (2007) found that in February of 2008, average weekly work hours varied by occupation; a typical work week in the manufacturing industry had an average of 41.1 hours, whereas the leisure and hospitality industry had an average work week of 23.5 hours. Beyond average hours worked, workforce characteristics can also vary by occupation type, gender, and age (Rix, 2004). Table 1 illustrates the distribution of workers in a sample of occupations by gender and age groups with data from the 2006 U.S. Census Bureau. As shown in table 1, the total workforce in 2006 consisted of roughly 53% men, and half of the workforce was aged 40 years and up. However, the gender and age distributions differ greatly when looking within various occupations. For example,

Table 1

Workforce participation rates for select occupations by gender and age groups: Data from the 2006 United States Census Bureau.

Occupation Type	Total Frequency (Thousands)	Percent by Gender		Percent by Age Group			
		Men	Women	16 – 39	40 – 49	50 – 59	60+
Total Workforce	127156415	53.4%	46.6%	50.5%	25.7%	16.7%	7.1%
Unskilled Laborers							
Food Preparation Workers	479815	40.1	59.9	68.7	14.5	9.7	7.1
Maids and Housekeeping Cleaners	1083275	12.4	87.6	43.2	26.7	18.8	11.3
Domestic Services							
Child Care Workers	1293835	5.0	95.0	59.4	19.3	12.7	8.5
Operatives/Factory Workers							
Construction Laborers	1067920	96.7	3.3	65.4	21.4	9.7	3.5
Machinists	471030	95.0	5.0	45.4	30.1	18.5	6.0
Service Occupations							
Personal and Home Care Aides	277505	12.8	87.2	38.3	23.5	21.2	16.9
Protective Services							
Police Officers	582740	87.1	12.9	64.2	23.6	10.3	1.8
Skilled Crafts							
Artists and Related Workers	217830	53.1	46.9	42.7	27.3	18.9	11.0
Clerical & Sales Workers							
Receptionists and Information Clerks	1061930	7.1	92.9	58.4	17.6	14.3	9.6

Secretaries and Administrative Assistants	3667405	3.4	96.6	42.4	27.8	21.5	8.3
Managerial							
Marketing & Sales Managers	1043145	57.5	42.5	52.6	28.2	15.3	3.8
Human Resource Managers	432515	44.6	55.4	44	30.5	20.4	5.1
Semi-Professional							
Computer Scientists and Systems Analysts	668290	66.8	33.2	55.3	27.8	14.3	2.6
Elementary and Middle School Teachers	3034075	21.1	78.9	39.8	30.1	24.9	5.1
Professional							
Physicians and Surgeons	692520	73.5	26.5	36.6	31.9	20.2	11.3
Miscellaneous Social Scientists (Sociologists)	34680	50.2	49.9	51.2	25.6	16.9	6.4

among child care workers, roughly 60% were under the age of 40, and 95% were women. In contrast, only 3% of the construction workers were women and 65 % were under 40 years old. Further, the percentage of employed adults aged 60 and older ranges from as little as 2% of police officers to 17% of personal and home health care aides. The occupations with at least 10% of workers aged 60 and up included maids and housekeeping cleaners, personal and home care aides, artists, receptionists and information clerks, and physicians and surgeons.

Differences in workforce distributions by occupation may also reflect inherent differences in income and health care access. There is evidence that employment is a major factor in an individual's access to health care. In 2006, over 60% of white Americans had some form of health care covered by employment based health insurance (U.S. Census Bureau & Current Population Survey, 2007). There is also a pattern where higher levels of education, income, and working for larger firms were associated with an increased likelihood of coverage by employment based health insurance among white Americans. Finally, 58% of individuals engaged in part-time employment and 75% of those in full-time employment were covered by employment based health insurance. This indicates that although the quality of health care coverage is not being evaluated, participating in work does provide access to some level of health care. A larger percentage of individuals with higher levels of education and in higher household income brackets had additional access to private health insurance, suggesting a positive association with higher SES and health care (U.S. Census Bureau & Current Population Survey, 2007). Wadsworth, Montgomery, and Bartley (1999) examined the lasting effects of unemployment in young adults on health and social well-being using longitudinal data from the National Child Development Study, a representative sample of men born in England, Wales and Scotland. After controlling for baseline health factors and pre-unemployment SES, the authors found that the young men who experienced periods of unemployment were significantly more likely to have poorer health consequences six years later. This trend was exacerbated when the young men experienced prolonged periods of unemployment and were blue collar workers; these individuals

developed more negative health behaviors such as smoking. This study underscores that not only does employment provide access to health care, unemployment has potentially long-lasting negative health consequences, even for young adults.

Beyond differences by occupation, the workforce age distribution is shifting in parallel to the national demographic changes toward an older society. In April of 2007, 41% of the participating workforce was 45 years old and older (U.S. Bureau of Labor Statistics, 2007). This percentage encompasses the large baby boomer cohorts, a disproportionate segment of the U.S. population and workforce. There is also evidence that the distribution of workers in various occupations is not equivalent across all age groups. The U.S. Census Bureau (2004) reported that in 2002, the top employers of older workers in Oregon were all within the service sector, including eating and drinking, business services, and health services. The service industries reflect an area that may be strongly impacted by upcoming boomer retirement, but also an area where older workers interested in delayed retirement may find extended employment opportunities. In addition to occupational differences by age, self-employment and part-time work are more likely as workers age. Specifically, 24% of adults aged 55+ are part-time workers compared to 11% of workers aged 25 – 54 (Rix, 2004). There is evidence that the majority of part-time working older adults do so by choice, which also makes them slightly more likely to be employed in retail services due to greater availability of part-time work in the retail industry (Rix, 2004).

The workplace is becoming increasingly technology-based, which poses special challenges for an aging workforce that is less experienced with advanced technology and who may be experiencing normative cognitive changes making learning new technologies difficult. Occupations across the board are using more technology, which is frequently changing and adapting. This trend in the workplace requires that employees be able to develop and maintain technology skills. The literature examining technology and older adults has shown mixed findings. Czaja et al. (2001) found that regardless of age, increased computer task experience was

associated with better task performance. However, while older adults experienced the greatest gains in performance with increased experience, they still performed significantly worse than middle aged and young adults. In a separate study, Czaja and Sharit (1998) found that while older adults completed significantly fewer computer tasks compared to younger adults, the proportion of errors was not different between the two groups. This suggests that older adults are capable of computer accuracy similar to younger adults, but they may need more time to acclimate to new technology to achieve similar rates of task completion.

There is also evidence that older workers perceive greater anxiety and perceived workloads related to technology in the workplace (Czaja et al., 2006; Sharit, Czaja, Nair, Hoag, Leonard, & Dilsen, 1998). Specifically, Czaja and authors (2006) found that as expected, older adults reported less computer and Internet usage than middle-aged and young adults, as well as higher levels of technology-related anxiety. Further, they found that the anxiety was associated with greater avoidance of computer usage. Similarly, Sharit et al. (1998) found that in more complex, challenging computer tasks, older adults perceived a larger workload compared to younger adults, even with increased task experience. These findings highlight a major issue with older workers in technological workplaces; for older adults to remain in employment they must be able to develop new technology skills, which may necessitate trainings that minimizes technology-related anxiety. The authors also found that increased computer usage decreased related anxiety and increased computer skills. And while there is evidence that older adults take longer to acquire new skills and may not reach the same level of proficiency as younger adults (Czaja & Sharit, 1998), there is also literature which suggests older adults are able to maintain skill ability over time through a process of compensation that can overcome slower reaction times and cognitive decline (Salthouse, 1991). This ability to learn and adapt to new technologies in the workplace is increasingly important with a growing proportion of older adults.

The aging society has two major implications for the workforce. First, many boomers have plans to remain employed beyond typical retirement ages (AARP, 2002). In 2007, 18% of

the Caucasian workforce was 55 years old or older (U.S. Bureau of Labor Statistics, 2007). These workers also report the desire or need to remain employed (Rix, 2004). This is in response to financial needs as well as the desire to remain active. Based on 4-year averages from 2003 – 2006, the United States Bureau of Labor Statistics (2007) found that adults aged 55 and over worked an average of 3.4 hours per day (averaged across a 7-day week). Another other major implication for the workforce is that although many aging workers plan a delayed retirement, there will still be a majority that will retire at typical ages. This will leave the workforce with too few people to sustain the social costs that the retired boomers will require. Thus, adjusting social policy to address these social security limitations is not enough. It is important to examine work contexts that will facilitate worker well-being and the effects of sustained employment in late life on individuals.

Work Environment and Occupational Status

The present thesis places a focus on psychosocial and contextual domains of the work environment, which are often discussed in the literature relative to occupational status. Three contextual domains include: complexity, control, and routine. These three domains comprise what Schooler and colleagues (1984; 1990; 1999; 2004) identify as occupational self-direction. However, the impact of the three domains on the individual are often considered in relation to outcomes such as health, cognition, and well-being. Work complexity can be operationalized as the extent to which initiative, thought and independent judgment are essential components of one's work (Miller, Kohn & Schooler, 1985). Work control is often referred to as closeness of supervision, where high levels are considered a limiting factor toward occupational self direction (Millet et al., 1985). Throughout the rest of the paper, reference to high control will indicate a job that is closely monitored and supervised by a superior. Finally, job routinization is the extent to which one performs work from a variety of approaches.

These three work environment domains are strongly related to occupational status. That is, although not all administrative work is the same, the domains of complexity, control and

routinization are often similar based on being employed as an administrative assistant. The same can be said for senior business professionals; although one professional may have a very different job from another, they are likely to experience similar levels of complexity, control and routine. Specifically, professional occupations tend to be associated with low levels of control, high complexity and low job routine (Schooler, 1984). Alternately, typical blue-collar jobs are associated with high levels of control, high routine, and low levels of complexity. These are generalizations however and do not apply to all occupations. For example, it is possible that an administrative assistant is given a list of tasks but is left alone to complete them with minimal supervision. In this case, the worker might have more flexibility and a sense of personal control over their work. It is because of these departures from the norm that assessing occupational status in individuals to understand their work environment is insufficient; assessment of the worker's perceptions of his/her specific psychosocial work domains is also needed in relation to critical outcomes for adults, such as cognitive function.

Work Environment Correlates

Because there is evidence that various individual characteristics are associated with work experiences, it is important to understand which domains are associated with an individual's work trajectory across adulthood. An important consideration includes understanding what factors predict occupational experiences at various phases in the work life, and of particular interest are perceptions of the work environment across adulthood. In the following sections, personality and gender will be considered relative work experiences in adulthood.

Personality and the Work Environment

In addition to the demographic patterns of workforce distributions discussed above, individual-level factors such as personality need to be considered. While there are likely a multitude of factors associated with work participation, the importance of individual dispositions and preferences cannot be ignored. The literature suggests that personality characteristics are related to various facets of work experience including earnings, occupational status, and

occupational gravitation. The gravitational hypothesis (Wilk, Desmarais, & Sackett, 1995) argues that with time and work experience, people sort into jobs that are well-suited to their abilities, values, and interests. Based on the gravitational hypothesis, Judge and colleagues (1999) examined the association between the "Big Five" personality factors (Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness) with gravitation to jobs described by Holland's typology. They found that after controlling for general mental ability, openness to experience was positively associated with gravitation to conventional and artistic jobs. Extraversion was positively associated with gravitation towards realistic jobs, while agreeableness was positively associated with social jobs and negatively associated with investigative jobs. Neither neuroticism nor conscientiousness was significantly associated with Holland's job types. In other studies, low neuroticism (or high self-confidence) and high extraversion have been associated with higher occupational status (Caspi, Elder, & Bem, 1987; Melamed, 1996a, 1996b; Rawls & Rawls, 1968) and with higher earnings in MBA graduates over a 20 year period (Harrell & Alpert, 1989). High extraversion, as measured by high social skills, was also associated with managerial promotions in the Management Progress Study by AT&T (Howard & Bray, 1994). Finally, Gelissen and de Graaf (2006) found that among men, high extraversion and emotional stability was associated with higher earnings while openness to experience was negatively related to earnings. Among women, emotional stability (low neuroticism) was associated with increased earnings. Taken as a whole, these findings indicate that the gravitational hypothesis may explain the association between personality and occupational experiences and illustrate the necessity of including personality when considering occupational transitions and status.

Gender and the Work Environment

Differential work experiences for men and women, whether due to discrepant entrances and exits from the workforce, varied treatment in the workplace, or disparate occupational preferences, illustrate the importance of accounting for variability due to gender when examining

work issues. The literature describes an association between gender and work contexts throughout adulthood relative to income disparities, hiring practices, work environment perceptions, and occupational status (Austin & Hanisch, 1990; Burda, Hamermesh, & Weil, 2007; Frank & McKenzie, 2006; Miller & Hayward, 2006; Buttner & McEnally, 1996). For example, women have more entrances and exits from the workforce, typically related to childbirth and childrearing (Huang, El-Khouri, Johansson, Lindroth, & Sverke, 2007). This infers that men and women will likely have differential occupational trajectories over their work lives. The effects of women's multiple entrances and exits from the workforce are negatively associated with occupational status and income; however these gender disparities are also associated with more specific examples of discrimination. Gender discrimination in the workplace is a common finding in the literature and must be considered. For example, Buttner and McEnally (1996) examined whether perceptions of assertive versus rational behavior in a job applicant differed between men and women. The results found that as predicted, assertive men were better received than assertive women. The study also found that women who took a rational approach to the interview were perceived better than those who used an assertive tactic. There is also evidence that among managers, women report less job responsibility than men (Valentine, 2001) and that job responsibility was positively associated with job satisfaction. This suggests that there may be gender differences in either how individuals perceive their work environment and/or in the level of responsibility allowed.

In addition to workplace discrimination and varied work entrances, the literature suggests that men and women partake in different types of work, resulting in trends of differential occupational status. In a series of studies, Huang and colleagues (2006; 2007) examined women's occupational career patterns longitudinally. The authors used a sample of Swedish women over a 27-year period. They found that women were only working in a handful of occupations compared to men, including services, personal care, education, and office work. It was also found that while there was little downward mobility across the study, those women in

lower status occupations had an increased likelihood for occupational fluctuations and demotions. Further, Huang found that women who remained in full-time employment across the 27 years had significantly higher rates of voluntary childlessness and their career patterns resembled that of full-time employed men. However, it was also found that most women in the study were less career-driven and devoted more time to family role activities. For these women, part-time work was much more common and afforded more time to non-work activities. For example, women partake in more hours of household chores and childcare (Blair & Lichter, 1991; Robinson, 1988) and have more work day absences due to child illnesses compared to husbands (Baruch et al., 1987). For the aforementioned reasons, there are significant differences in occupational experiences between men and women which need to be considered when examining work environment characteristics and perceptions over time.

Work Environment and Cognitive Function

Existing research on the specific relationship between the work environment and cognition is often examined relative to the findings that engaged lifestyles are associated with cognitive function (Brunner, 2005; Schooler et al., 2004; Seidler et al., 2004; Wilson, 2005). The most influential research examining the relationship between work environment domains and cognition is the collective work by Schooler (Kohn & Schooler, 1983; Schooler, 1984; 1990; Schooler et al., 1999; 2004). Schooler has examined the relationship between occupational self direction (a combination of work complexity, supervisor control, and routinization) and cognition in adulthood. The study began in 1964 with a large, nationally representative sample of men working at least 25 hours a week. This sample was followed up in 1974, when the wives of the male participants were recruited and added to the study. A final wave was measured in 1994 to follow-up the 1974 sample. At each wave of analysis, measures of complexity, control and routine in the work environment were taken. Unfortunately, the cognitive measures in this study only included a measure of intellectual flexibility. Intellectual flexibility evaluates the extent to which an individual can cope with the cognitive demands of complex situations. This domain has

been strongly correlated with global measures of intellectual functioning, but does not give information specific to reasoning ability, memory, or processing speed. Schooler, Mulatu and Oates (2004) found that, of those who were working at both 1974 and 1994, there was a reciprocal relationship between intellectual flexibility and occupational self-direction. Additionally, this relationship was found even when controlling for health status and was maintained in late life.

De Frias and Schaie (2001) found additional support for the association between substantively complex work and intellectual functioning. A sub-sample of the Seattle Longitudinal Study was used with a wide age-range (21-93). Retired participants were included in the analyses, reporting retrospective work environment perceptions based on their last job. The results indicated that after controlling for age, education, and income, the perceived work environment (autonomy, control, innovation) predicted three domains of cognitive style (attitudinal flexibility, motor-cognitive flexibility, psychomotor speed). Similarly, Avolio and Waldman (1987) examined the association among age groups, skilled versus unskilled workers, and cognitive function. The authors found that based on personnel aptitude tests given to skilled and unskilled mining employees, lower cognitive function was associated with increased age. However, the effect was stronger for the unskilled laborers. This finding suggests that there may be a protective or negative cumulative effect based on workplace factors such as control, complexity and routine, on cognitive function. Combined with the collective work by Schooler (eg. Schooler, 1984), there is significant evidence of an association between psychosocial domains of the work environment and cognitive status in adulthood (De Frias & Schaie, 2001); however, this relationship needs to be examined with more specific cognitive abilities.

Another concern/question with this line of research is that the influence of the work environment may have a lagged effect on cognitive abilities that are not noticeable until after the individual is no longer working. The SEM models that Schooler and colleagues used for the 1994 follow-up only selected participants that were employed in 1974 and 1994. This is a somewhat

select sample and likely includes individuals that are still performing well on cognitive tasks. An important question for the future is how the accumulated experience of the work environment across adulthood influences cognitive outcomes after an individual is no longer in the labor force. Schooler and colleagues (2004) found that in addition to predicting intellectual flexibility, occupational self-direction also predicted a self-directed lifestyle. This finding suggests that the work environment has an important behavioral influence which may affect development into late adulthood. If positive behaviors, such as a self-directed orientation, are promoted from one's work environment, individuals may be able to maintain their cognitive abilities for an extended period of time, prolonging their ability to live independently. It is also possible that the cumulative effect of a self-directed orientation throughout adulthood, both in and out of work, is what influences the development of cognitive reserve in late life.

Using a different sample, Brunner (2005) examined social and biological predictors of cognitive decline in a sample from the Whitehall II study. Cognitive measures included short-term memory, inductive reasoning, vocabulary, and verbal fluency. The sample was examined over a 10-year period, consisting predominantly of office workers. Brunner (2005) found a positive association between occupational status and level of cognitive performance. Although this study had adequate measures of cognitive ability and a longitudinal design, it did not assess any specific contextual domains within the work environment, only measuring occupational status. Thus, one must make the assumption that occupational status is sufficient in measuring the influence of the work environment on various cognitive tasks. However, one cannot assume that occupational status and psychosocial domains of the work environment are perfectly related. Specifically, professional occupations tend to be associated with low levels of control, high complexity and low job routine (Schooler, 1984). Alternately, typical blue-collar jobs are associated with high levels of control, high routine, and low levels of complexity. However, the association is not perfect and there is a great deal of interindividual variability in work experiences, even when looking within one type of occupation. Thus, the results reported by

Brunner (2005) cannot extrapolate which domains of the work environment were driving the association between occupational status and cognitive function. Finally, there may be individual level differences, such as gender, in the association between of cognitive function and occupational status. Austin and Hanisch (1990) found that in a large sample measured over an 11-year period, men were more likely than women to end up in jobs of higher occupational status, even after cognitive ability was considered.

Work, Cognitive Function, and Age

Young Adults

One of the major questions regarding work experience and cognitive function is whether the association is entirely reciprocal or whether there are any causal paths at different times throughout adulthood. The literature suggests a reciprocal relationship between aspects of the work environment and cognitive ability throughout adulthood, but issues of directionality are better addressed within specific age groups. Based on the aims of this thesis, the focus on the following sections will be on the association between work and cognitive function specifically for young and older adults. First, the literature illustrates that cognitive ability may be a predictor of occupational status and occupational preferences in young adults (Bajema, 1968; Heckman, Stixrud, & Urzua, 2006; Wooten, Barner, & Silver, 1994). An individual with higher cognitive functioning in childhood and early adulthood is more likely to achieve higher educational goals (Bajema, 1968; Heckman et al., 2006). Accordingly, educational attainment is associated with occupational status and the types of work environments experienced (Bajema, 1968). Heckman, Stixrud and Urzua (2006) found that in addition to risk behaviors, low levels of cognitive skills in young adults were negatively associated with employment domains such as wages, work experience and choice of occupation. However, there is also evidence that the importance of educational attainment on occupational status in young adults varies by social origin. Specifically, Tinto (1984) found that when comparing male college graduates of elite versus “nonelite” social backgrounds, the attendance of high-quality colleges was an important factor in occupational

status only for the “nonelite” social graduates. The college graduates with elite social origins seemed to have enough pre-existing resources to ensure occupational success and attending a high-quality college was superfluous to their later occupational achievements.

Further, the increased use of technology in the workplace has also been associated with a bias toward younger workers who typically possess faster processing speeds, more technological experience, and less technology-related anxiety (Czaja et al., 2001; Sharit et al., 1998). Czaja and colleagues (2001) found that while older adults showed larger magnitude gains in technology performance with increased task experience, younger adults still performed significantly better on the computer tasks due in part to higher levels of processing speed and memory. This finding illustrates that cognitive function may influence the work contexts young adults are likely to experience, such as a complex work environment. It is also important to note that cognitive ability and educational attainment are often so highly correlated that it is difficult to disentangle which domain is influencing later work environments (Cawley, Heckman, & Vytlacil, 2001).

Older Adults

A major issue with older workers is whether they are capable of learning and maintaining new skills necessary in today’s technological workplace. While the evidence for successful learning and training of technology skills is mixed, there are arguments which support the potential of older workers to successfully maneuver technology at work. Stoltz-Loike and colleagues (2005) investigated whether older adults could gain skills in common computer applications from e-learning materials. The results indicated that with special adaptation of the e-learning devices, adults aged 50 – 69 did achieve successful acquisition and retention of basic computer skills. However, there is evidence that underlying cognitive function may moderate the association between age and technological skill learning. Morrell, Park, Mayhorn and Kelley (2000) found that when comparing young-old adults (60 – 74) and old-old adults (75+), the young-old adults were significantly better at learning the computer skills, but the effect for both groups was attenuated by cognitive function. Further, it was found in a separate study that spatial

and verbal working memory specifically moderated the acquisition of computer skills (Echt, Morrell, & Park, 1998).

Alternately, work by Dollinger and Hoyer (1995; 1996) suggests that task-specific experience may ameliorate the detrimental age effects on work performance. In a study simulating medical technician tasks, a sample of control participants and experienced medical technicians were used to examine age and experience on task performance. The authors found that the technicians tended to sacrifice speed for accuracy in task performance compared to the control group. Further, when partaking in a dual task simulation, the control participants showed significant age-related declines in performance, while the technicians with task-relevant expertise showed no age-related declines. This suggests that expertise in work-related tasks can negate age-related deficits.

The work environment has also been examined as a predictor of cognitive function in late life via social and cognitive stimulation. The impact of accumulated work experiences on cognitive function in late life is associated with the theory of cognitive reserve (Stern, 2002). Specifically, the contextual influence of social and cognitive stimulation via education and exposure to complex, autonomous, novel work environments lessens age-related cognitive declines, even when brain physiology would predict major cognitive deficits (Brunner, 2005; Bunce & Macready, 2005; Churchill et al., 2002; Gribbin, Schaie, & Parham, 1980; Louvden, Ghisletta, & Lindenberger, 2005; Raz, 2000; Schooler et al., 2004; Shadlen et al., 2005; Stern, 2002). In other words, the development of cognitive reserve through an active, engaged lifestyle is one process by which the work environment may exert an influence on cognitive ability in adulthood. Cognitive reserve may be developing in young and middle adulthood , prior to noticeable, population-level cognitive declines. However, cognitive reserve associated with the work environment likely has a lagged effect that would be more pronounced in late life when normative and pathological cognitive declines are more likely (Schaie, 1989a).

After considering the evidence regarding the reciprocal relationship between the work environment and cognition in adulthood, one could argue that the work environment may influence cognitive trajectories by magnifying one's early level of ability and preferences. Specifically, individuals with high cognitive functioning in early adulthood are more likely to be exposed to stimulating and enriching work environments that will enhance their cognitive processing and create a cognitive reserve for later life. Conversely, individuals with poor cognitive functioning in early adulthood are likely to participate in work environments that provide little cognitive stimulation. Thus, exposure to low complexity, high supervisor control, and highly routine work may hamper the development of cognitive reserve in later life. This is particularly detrimental because those with poor cognitive function in early adulthood are those who would benefit most from cognitive reserve in late life. Based on this model of reciprocal relations, future research needs to pay special attention to the cognitive trajectories of those with low baseline cognitive function in young adulthood relative to their work life experiences.

Health Status, Cognitive Function, and Work Experiences

Work and Health Benefits

There is ample evidence that work environment conditions, health status, and cognitive function have a variety of reciprocal associations. Specifically, several processes are at play between work and health status, including access to health insurance and work-stress. There may also be an indirect association between work and health from work-related cognitive stimulation and associated improved medical adherence. First, participation in work increases access to health insurance, although this does not totally account for variation in health insurance quality (Schwartz & Stevenson, 2001). Thus, regardless of the contextual differences of various occupations, participation in work is indicative of some degree of health maintenance through associated health care access (Hintsa et al., 2006; Schwartz & Stevenson, 2001). However, there is also evidence that work, health, and cognitive function can have negative associations.

Cognition and Health

Higher cognitive function has been positively associated with health status relative to medical adherence, such as correctly taking prescription medications (Insel, Morrow, Brewer, & Figueredo, 2006). Specifically, higher levels of reasoning and memory function in late life when individuals often have multiple medication prescriptions are critical for accurate medical adherence. Medications are often taken on different schedules and keeping track can be a demanding task for older adults. Thus, maintenance of high function in reasoning and memory abilities can have a positive effect on health outcomes in late life relative to medical adherence.

However, many studies have found associations between diseases such as diabetes, stroke, hypertension, and chronic obstructed pulmonary disease with negative cognitive function in adults (Barclay, Weiss, Mattis, Bond, & Blass, 1988; Hertzog, Schaie, & Gribbin, 1978; Roehrs et al., 1995). Further, the association between health status and cognition may be moderated by the work environment through work-associated stress responses. Specifically, the literature describes a significant association among perceived work stress and physiological stress responses with negative health outcomes (Cobb & Steptoe, 1996; Cohen, Tyrrell, & Smith, 1991; Cohen et al., 1998). Due to the potential for health-associated risks on cognitive function, health status needs to be included when examining cognitive change in adulthood.

Stress and Health

The transactional model of stress (Lazarus & Folkman, 1984) argues that one must consider stress in terms of perceived demands and perceived resources. Relative to the work environment, perceived demands relate to work load, whereas perceived resources correlates with work control. Therefore, an individual's ability to cope with stress associated with perceived work load is relative to that individual's perception of control over their work environment. Work environments with high supervisor control may then exacerbate the effects of stress on various health outcomes such as CVD and atherosclerosis. For example, Etzion and Westman (1994)

examined the relationship between job stress, sense of control, and burnout in a sample of Israeli military officers. As predicted, perceived job stress was positively associated with burnout. However, this relationship was mediated by sense of control and work support. Specifically, a strong sense of control over one's environment and high perceived work support ameliorated the influence of job stress on burnout. Although burnout is not necessarily a health outcome, Etzion and Westman's (1994) findings illustrate the influence of work control on stress.

The literature also suggests that work-related stress is associated with shift-work (Volkoff et al., 1995) supervisor control (Gimeno et al., 2004; Ziff et al., 1995; Vaananen et al., 2003), and job routinization (Borg, Kristensen, & Burr, 2000). Thus, shift-work, supervisor control, and job routine are indicated as key domains of the work environment in relation to health. Specifically, high supervisor control has been associated with health-related work absences, low subjective health status, and increased physiological risks, such as CVD. It is also possible that gender moderates the association between stress and health. There is evidence that men and women have differential stress responses (Smith & Reise, 1998) and that women tend to have greater stress responses and experience more physiological reactions to stress than men (Zeidner, 2006). Therefore, the literature suggests that there is a reciprocal association between health status and cognitive function (Barclay et al., 1988; Hertzog, Schaie, & Gribbin, 1978; Insel et al., 2006; Roehrs et al., 1995) and that the relationship may be mediated by work stress (Cobb & Steptoe, 1996; Cohen, Tyrrell, & Smith, 1991; Cohen et al., 1998; Etzion & Westman, 1994; Lazarus & Folkman, 1984).

In sum, the literature indicates that a variety of work experiences and cognitive function domains are associated across adulthood. Measures of general mental ability have been positively associated with earnings (Gottfredson & Crouse, 1986; Siegel & Ghiselli, 1971) and promotions (Dreher & Bretz, 1991; Howard & Bray, 1988), and are positively associated with movement into more complex work environments (Wilk & Sackett, 1996). And although the last few decades have shown a concerted effort to increase the understanding of how exposure to different work

environments is related to development in adulthood (Schooler, 1984; Schooler et al., 2004; Wilson, 2005), there is a great deal that is not understood. In particular, aspects of the work environment (in terms of complexity, routine and control) need to be examined longitudinally with better cognitive measurement (Brunner, 2005; Schooler et al., 2004; Seidler et al., 2004; Wilson, 2004). Additionally, the direction and theoretical underpinnings of these relationships are not well understood because much of the prior literature is based on cross-sectional studies (Singh-Manoux, Richards, & Marmot, 2003; Seidler et al., 2004; Wilson, 2005; Wooten et al., 1994) that are confounded with major cohort differences in occupational status and worker characteristics such as education and health care practices. Therefore, it is imperative that future studies have adequate measurement of both psychosocial work domains and cognitive function. Finally, a discussion of important domains associated with cognitive functioning across adulthood is necessary to adequately examine the work-cognition relationship.

Cognitive Function Correlates

Context and Cognitive Function

Context can be defined as any set of variables that affect cognition in a given situation. Contextual influences on cognitive function can be at the micro level, such as conditions of the testing environment or psychosocial factors such as environmental perceptions. Contextual domains at the macro level have also been associated with cognitive processes in adulthood, including the accumulation of life experiences such as education, work, and social activity. It is the macro level that is most relevant for the present thesis and will be discussed below.

Associations between an engaged lifestyle and cognitive outcomes are common in the cognition literature (eg. Lovden et al., 2005). Although there are several definitions of an engaged lifestyle, Lovden and colleagues (2005) defined it as a combination of instrumental activities, leisure activities, social activities, and work. Participation in work and differential work environments are a common thread in an engaged lifestyle and will be discussed further.

Engaged Lifestyles and Cognitive Function

Activity and engagement, including physical activity, social participation, and participation in paid work, have been found to be positively associated with various cognitive abilities (Bunce & Macready, 2005; Chruchill et al., 2002; Hogan, 2005; Lambert, Fernandez & Frick, 2005; Louvden et al., 2005; Miller, Kohn, & Schooler, 1985; Shadlen et al., 2005). For instance, Miller, Kohn and Schooler (1985) found that in a sample of high school and college aged students, schoolwork complexity was positively associated with intellectual flexibility. Further, Louvden and colleagues (2005) found that in a sample of the old and very old, social activity buffered declines in perceptual speed. The literature has described a positive association among engaged lifestyles, including highly complex, low supervisor control, and low routine work environments, with improved cognitive function (Brunner, 2005; Lovden et al., 2005; Schooler et al., 2004; Seidler et al., 2004; Wilson, 2004). There is also evidence that participation in increased physical, social, and cognitively stimulating activities are related to maintenance of perceptual/processing speed, memory, and brain physiology. In a review of the literature, Churchill and colleagues (2002) found evidence that physical fitness is related to vascular health in the brain, whereas neuronal functioning may be related to learning. Thus, physical and mental stimulation may each account for unique variance in cognitive functioning across adulthood.

Ghisletta, Bickel and Lovden (2006) also examined the direction of the association between an engaged lifestyle and cognitive function. Although there had been prior evidence that lifestyle and cognitive function were associated, the direction of the relation had not been sufficiently examined. Ghisletta and colleagues (2006) found that in a sample of the oldest old in the Berlin Aging Study, increased media and leisure activity was protective for cognitive function as opposed to the other direction. This study provides further evidence that experience and activity in late life are important factors related to cognitive change.

Social Activity and Cognitive Function

Social participation and activity are also related to cognitive outcomes in older adults. Lovden, Ghisletta and Lindenberger (2005) examined the reciprocal relationship between social participation and processing speed. Social participation included measures of instrumental activities, social activities, leisure activities, and work. The results indicated that increased social participation predicted faster processing speed. This relationship was stronger than the effect of processing speed predicting social participation; thus it was concluded that social participation, particularly within the oldest segment of the population, mitigates losses in processing speed. This gives additional credence to the argument that an engaged and active lifestyle can assist in diminishing the effects of age on cognitive decline. Lovden and colleagues (2005) findings support the disuse hypothesis (Salthouse, 1991) where an event in late life, such as retirement, resulting in diminished cognitive stimulation could exacerbate cognitive decline. Thus, remaining employed into late life may help to diminish cognitive declines by providing mental and social stimulation (Lovden et al., 2005; Schooler et al., 1999; Schooler et al, 2004).

There is also evidence that social activity in midlife is associated with cognitive function. Singh-Manoux, Richards, and Marmot (2003) examined the association between leisure activities and cognitive function in a middle-aged sample from the Whitehall II Study. The authors found that after controlling for age and SES differences, participation in cognitively complex and/or social leisure activities was associated with better cognitive performance. This finding illustrates the importance of social activity and cognitive stimulation to cognitive function throughout adulthood, not just in late life.

Educational Attainment and Cognitive Function

Another aspect of an engaged lifestyle often associated with cognitive outcomes is educational attainment. Education is strongly and positively associated with both level and rate of change in cognitive function (Anstey & Christensen, 2000; Katzman, 1993) and is important at all ages throughout adulthood (Farmer, Kittner, Rae, Barko, & Regier, 1995). There is also evidence

that cognitive function is associated with educational attainment. For example, an individual with strong cognitive functioning in childhood and early adulthood is more likely to achieve higher educational goals (Bajema, 1968). Accordingly, educational attainment is positively associated with occupational status and differential types of work experiences (Bajema, 1968). Thus, there is evidence that cognitive function may influence the work contexts one is likely to experience, such as a complex work environment. Finally, the literature suggests that educational activities may buffer cognitive decline via brain reserve, by having a direct influence on brain activity (Greenough, Larson, & Withers, 1985) or by attenuating the effects of neurological decline (Shadlen et al., 2005).

Background on Inductive Reasoning, Memory and Perceptual Speed

Fluid abilities such as inductive reasoning and memory have been identified as cognitive abilities associated with reliable age-related declines beginning in the sixties (Finkle, Reynolds, McArdle, Gatz, & Pedersen, 2003; Hess, 2005; Schaie, 1996; Singer, Verhaeghen, Ghisletta, Lindenberger, & Baltes, 2003). Additionally, there is evidence that age-related slowing in processing speed may underlie declines in memory performance and to a lesser degree inductive reasoning (Schaie, 1989; Sliwinski & Bushke, 1997). Based on various works by Salthouse (eg. Salthouse, 1991; Salthouse et al., 1996), Sliwinski and Bushke (1997) tested the hypothesis that processing speed mediates the relationship between age and memory performance. The mediation model of age, processing speed and memory seemed to fit well, where increased age was associated with poorer performance on episodic memory tasks and processing speed significantly mediated the relationship. Thus, the domains of processing speed and memory are independent constructs yet both are interrelated and associated with age related declines. Similarly, Schaie (1989b) examined associations between inductive reasoning, processing speed, and age. The results indicated that change in processing speed did indeed account for some of the age-associated declines in inductive reasoning, though not completely.

Cognitive performance throughout adulthood, particularly in old age, is critical to activities of daily living and one's ability to live independently (eg. Hogan, 2005; Owsley, Sloane, McGwin & Ball, 2001). It is also well documented that fluid abilities (problem-solving, memory, reasoning) exhibit decline in the late sixties whereas crystallized abilities (vocabulary, general knowledge) remain stable on average until the mid seventies (Cattell, 1963), and that there are interindividual differences in both the rate and timing of cognitive changes. Thus, it is important to focus future research on understanding the process of decline in cognitive abilities as well as ways to slow decline in late life at the individual level.

Inductive reasoning is operationalized as the ability to identify, comprehend, and evaluate relationships among parts of a problem, novel concepts, and to solve similar problems in the future. It is closely associated with working memory (Salthouse et al., 1996) and is conceptualized in a variety of approaches to the study of cognitive function. The psychometric approach to cognitive function identifies inductive reasoning as a critical component of the fluid abilities (Cattel, 1963; Thurstone, 1949) and has been associated with maintained independence in adulthood. Specifically, Lawton and Brody (1969) found that many of the instrumental activities associated with daily living (IADLs) rely on inductive reasoning.

The executive functioning literature also identifies reasoning as a critical component of neuropsychological function. Executive function is defined as one's ability to successfully engage in complex, goal-directed, everyday activities in a socially acceptable manner (Lamar, Zonderman, & Resnick, 2002; Lezak, 1995; Rabbitt, 1997). It has also been noted that executive function embodies a neuropsychological perspective for many of the processes associated with inductive reasoning as a fluid ability (Baddeley, 1990; Woodruff-Pak, 1997). Executive function is especially important when an individual is presented with novel information (Rabbitt, 1997). Exposure and successful engagement in novel tasks may be particularly important for older adults in a rapidly advancing technological workforce.

Memory function, often studied in terms of verbal memory, is described as a fluid ability in the psychometric literature (Cattel, 1963; Thurstone, 1949). Episodic memory is of interest because the literature has found strong support for age-associated declines (Hess, 2005). However, there is alternate evidence that after accounting for time to death, age effects for memory decline are significantly reduced (Thorvaldsson, Hofer, & Johansson, 2006). The literature also suggests that after parceling out perceptual speed effects on memory decline in late life, the age effects are further reduced (Hertzog, 1989; Hess, 2005; Schaie, 1989b; Sliwinski & Buschke, 1997). The finding of memory decline in late life is important because it is associated with an individual's ability to perform IADL's and to live independently (Lawton & Brody, 1969). Further, memory is a potentially critical domain for older adults interested in continued employment. The rapid technological developments in the workplace require that an individual can learn and remember new computer programs and technology. Thus, older adults' memory processing is critical to their ability to function in the work environment.

Finally, perceptual speed is a cognitive domain of great interest not only as an important outcome to study, but also as an explanatory variable for declines in other, higher-level cognitive abilities such as inductive reasoning and verbal memory and has been found to show age related declines beginning in young adulthood (Hertzog, 1989; Hess, 2005; Schaie, 1989; Schaie, 2005; Sliwinski & Bushke, 1997). As an important factor associated with trajectories of critical fluid abilities in late life, perceptual speed must be considered when examining reasoning and memory performance in older adults.

Unanswered Questions and Future Directions

The literature discussed above was intended to give an overview of several components of the research on work environments and cognition. First, it is apparent that several processes are likely operating to predict work experiences in young adults. While there is evidence that educational attainment is predictive of occupational status in young adults, cognitive function and educational attainment are so highly correlated that it's difficult to identify whether one is more

important in predicting occupational outcomes (Bajema, 1965; Heckman, Stixrud, & Urzua, 2006; Wooten, Barner, & Silver, 1994). Additionally, it is possible that the gravitational hypothesis, where individual characteristics such as personality act as filters for slotting adults in to good-fitting occupations, is also playing a role in early work experiences (Judge et al., 1999; Wilk et al., 1995). Unfortunately, the existing literature is limited by only using measures of global cognitive function (Judge et al., 1999) or by measuring work experiences via occupational status (Bajema, 1965). Because of the indications that psychosocial domains of the work environment including complexity, control, and routine may be important to cognition in late life (Schooler et al., 1999, 2004), it is also critical that future research identify which cognitive domains are associated with trajectories of the psychosocial work domains in the transition from young to middle aged adults.

Alternately, there are definite demographic indicators that have illustrated the importance of societal level trends in workforce distributions within different occupational types (U.S. Census Bureau, 2006). Specifically, there are noticeable gender and age distribution differences within different occupation categories. Service occupations seem to employ higher numbers of older adults than some other occupation categories (U.S. Census Bureau, 2004), while the research also shows that younger adults are more likely to have more occupation status changes (Gelissen & de Graaf, 2006). There is also evidence that individual-level factors are associated with work experiences across adulthood, including cognitive function (Brunner, 2005; Schooler et al., 2004; Seidler et al., 2004; Wilson, 2004) and personality (Caspi, Elder, & Bem, 1987; Melamed, 1996a, 1996b; Rawls & Rawls, 1968). However, the current literature has several limitations, specifically that no study has yet mapped patterns of psychosocial work domains longitudinally and examined what specific factors are associated with the work experience trajectories. Thus, it is important for future work to examine individual patterns of work complexity, work control, and work routine across adulthood, especially because there are

indications that accumulated work experiences may serve as protective or risk factors for later cognitive decline in late life (Avolio & Waldman, 1987; Schooler et al., 2004; Stern, 2002).

Finally, there are several existing studies that illustrate the association between psychosocial work domains and cognitive function in older adults (Avolio & Waldman, 1987; De Frias & Schaie, 2001; Schooler, 1984; Schooler et al., 1999; Schooler et al., 2004). Specifically, it appears that more mentally stimulating work environments, those high in complexity and low in supervisor control and routine, are related to higher levels of cognitive functioning. The major limitation of this research in the past has been inadequate cognitive measurement and/or the failure to assess the perceived work environment. For example, while Schooler's collective work has been ground breaking by highlighting the importance of psychosocial work domains, the cognitive measurement only included a generalized measure of intellectual flexibility. Other research has had sufficient cognitive measurement, but failed to measure specific psychosocial work perceptions (Brunner, 2005). Thus, the major gap in the existing literature is a study which incorporates adequate measurement of both cognitive function and psychosocial work domains.

Based on the reviewed literature, there are three aims in the present thesis. First, what factors are associated with trajectories of psychosocial work experiences in early to middle aged adults? The second aim of the present thesis is to examine whether there are typical trajectories of psychosocial work experiences across adulthood, and to identify what factors are associated with various work trajectories. Finally, the third aim is to examine the association of psychosocial work experiences in late life with trajectories of cognitive change.

Chapter 2

STATEMENT OF THE PROBLEM

Based on the reviewed literature, the overall aim of the present study was to examine trajectories of psychosocial work experiences across adulthood, and the association between the psychosocial work environment and cognitive function in a sample of Seattle Longitudinal Study participants. Three questions will be addressed. The first will examine which domains, including cognitive function, are associated with psychosocial work environment trajectories in the transition from young to middle adulthood. The second question will examine whether there are identifiable trajectory types of psychosocial work experiences over a 21-year period, and whether specific covariate domains differentiate between trajectory sub-groups. Finally, the third question will examine whether psychosocial work experiences in older adults are associated with individual patterns of cognitive change over 14 years.

For each of the three main questions, the detailed issues to be examined are described below.

I. What domains predict work environment contexts in the transition from young to middle adulthood?

Demographic

The psychosocial work environment domains examined in the present study include work control, work complexity, and work routine. The reviewed literature has indicated that early work experiences are associated with a variety of domains. The literature suggests that demographic factors including educational attainment and gender are associated with a variety of work experiences including occupational status, earnings, and hiring practices. For example, individuals with higher educational attainment are more likely to have a higher occupational status in the workforce (Bajema, 1968; Tinto, 1984). Relative to gender, women have more workforce exits and entrances (Huang et al., 2007); women and men are often perceived differently in hiring situations (Buttner & McEnally, 1996); and men and women tend to work in

different types of occupations (Census, 2006; Huang et al., 2006, 2007), with women more often found in lower occupational status positions such as in the service sector. Further, occupational status is positively associated with the psychosocial work environment domains of low supervisor control, high complexity, and low routine (Schooler, 1984). While there is limited research examining these demographic factors relative to psychosocial work experiences in young adulthood through midlife, it is hypothesized based on the existing literature that high educational attainment and being male will be associated with longitudinal trajectories of low level routine, high complexity and high worker (low supervisor) control.

Cognitive Function

The positive association between cognitive function and psychosocial work experiences has been discussed primarily regarding middle aged and older adults, but can be applied to the transition from young to middle adulthood. A major existing question regarding the association is direction, such that it is difficult to disentangle whether cognitive function drives work experiences or vice versa. Cognitive function has been positively associated with occupational status (Heckman et al., 2006; Wooten et al., 1994), which is then associated with psychosocial work experiences (Schooler, 1984). There is also evidence that intellectual flexibility, associated with general cognitive function, is positively associated with high work control (low supervisor control), high work complexity, and low work routine (Schooler et al., 1999, 2004). Further, faster processing speed was found to moderate the association between age and computer skill performance (Czaja et al., 2001) which is increasingly important in the work environment. While there is evidence of interindividual variability of cognitive change (Christensen et al., 1999), normative decline in fluid abilities is not common until the mid-60's (Finkel et al., 2003; Hickman et al., 2000; Schaie, 1996; Singer et al., 2003) and crystallized abilities have been shown to increase throughout adulthood into late life (Cattel, 1963; Schaie, 2005). However, cognitive function in young adults is often so highly correlated with educational attainment that it is difficult to tease apart which is more influential to work experiences (Cawley et al., 2001), thus

both must be accounted for when examining early work experiences. It is hypothesized that during the transition from young adulthood to middle age while fluid abilities are typically stable and crystallized abilities are gaining, level differences in cognitive function will be positively associated with high work control (low supervisor control), high complexity, and low routine.

Personality

Finally, the Big Five personality domains of neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness have been associated with occupational movement relative to the gravitational hypothesis (Wilk et al., 1995; Judge et al., 1999) and to other work domains such as occupational status (Caspi et al., 1987; Melamed, 1996a, 1996b; Rawls & Rawls, 1968), earnings (Gelissen & de Graaf, 2006), and promotions (Howard & Bray, 1994). The gravitational hypothesis suggests that personal ability, values and dispositions filter individuals in to good-fitting jobs over time (Wilk et al., 1995). This hypothesis was supported relative to gravitation towards specific occupations based on individual's Big Five personality characteristics (Judge et al., 1999). Further, high neuroticism (low emotional stability) has been related to lower occupational status (Caspi et al., 1987; Melamed, 1996a, 1996b; Rawls & Rawls, 1968) and lower earnings (Gelissen & de Graaf, 2006). High extraversion has been associated with higher occupational status (Caspi et al., 1987; Melamed, 1996a, 1996b; Rawls & Rawls, 1968) and increased managerial promotions (Howard & Bray, 1994). Finally, the conscientiousness factor is related to achievement orientation, so it is likely that individuals high in conscientiousness will have a stronger drive for higher occupational status, which is then positively associated with psychosocial work environment experiences (Schooler, 1984). Based on the previous literature, it is hypothesized that in the present study, low neuroticism, high extraversion, and high conscientiousness will be related to high work control (low supervision), high complexity, and low routine in young and middle aged adults. No specific hypotheses will be presented for the personality domains of openness of experience and agreeableness based on the existing literature.

II. Identify and describe trajectory sub-groups in psychosocial work environment experiences across adulthood.

A. Are there Typical Trajectory Types of Work Environment Experiences over 21 years?

B. What Factors Differentiate Trajectory Types?

Demographic

To examine trajectories of work experiences across adulthood, a sample of SLS participants with 21-year longitudinal data, aged 22 – 65 at the first occasion was selected. There is little known about the trajectories of work control, complexity and routine across adulthood therefore no specific hypotheses will be made regarding expected trajectory types. However, psychosocial work experiences are associated with occupational status (Schooler, 1984), and there is much literature that has examined factors associated with occupational status in adults. Relative to demographic factors, age, educational attainment, and gender have all been associated with occupational status. Younger adults typically experience more frequent gains in occupational status compared to middle aged and older adults (Gelissen & de Graaf, 2006); thus it is hypothesized that age will be positively associated with stable trajectories and that younger age will be related trajectories describing gains in psychosocial work experiences over time. Educational attainment is also positively associated with occupational status (Bajema, 1968; Tinto, 1984), which then leads to the hypothesis that education will be positively associated with level differences in psychosocial work environment experiences. Finally, because gender differences exist in the workplace, such that men have fewer entrances and exits (Huang et al., 2007) and gravitate towards higher occupational status jobs (Huang et al., 2006, 2007), it is hypothesized that men will be associated with more stable and higher level psychosocial work experience trajectories (high complexity, low supervisor control, low routine). Relative to occupational changes, it is also hypothesized that individuals who report more changes in jobs

and changes in professions across the 21-year period will experience less stability in the psychosocial work experience trajectories.

Personality and Social Engagement

As discussed for question 1, it is also important to consider the influence of personality characteristics in association with work experiences over time (Wilk et al., 1995; Judge et al., 1999). Based on the previous literature, it is hypothesized that individual personality traits will be associated with level differences in trajectories of psychosocial work environment experiences. Specifically, it is hypothesized that trajectories of high complexity, high work control (low supervision), and low routine will be associated with individuals low in neuroticism, high in extraversion, and high in conscientiousness (Caspi et al., 1987; Melamed, 1996a, 1996b; Rawls & Rawls, 1968). Further, social engagement, which is related to the personality domains of extraversion and agreeableness, and has also been associated with cognitive maintenance in older adults (Louvden et al., 2005), is an important factor to consider relative to work experiences. The extent to which individuals participated in social activities has been positively associated with processing speed (Louvden et al., 2005) and memory function (Churchill et al., 2002). There is also evidence that cognitive function, specifically processing speed, is important for lessening the negative age-associated effects on technology use (Czaja et al., 2001). Because social engagement seems has been positively associated with work experiences specifically, and work environment correlates, it is hypothesized that individuals who partake in more social engagement activities will be associated with positive level and/or gains in psychosocial work experience trajectories (high complexity, low supervisor control, low routine).

Health Status

Health status and the work environment have a complex and reciprocal association with both positive and negative effects, suggesting that when examining patterns of work experiences health status should be considered. Access to health care is associated with paid employment (U.S. Census Bureau & Current Population Survey, 2007), although the quality of care is not

equivalent across all occupations. However, work-related stress responses are also associated with negative health risks, such as heart disease and hypertension (Barclay et al., 1988; Hertzog et al., 1978). Specifically, psychosocial work environments high in both supervisor control and routine have been related to more stress (Borg et al., 2000; Gimeno et al., 2004; Vaananen et al., 2003; Ziff et al., 1995), which is then associated with negative health consequences. Thus it is hypothesized that individuals in poor health will be associated with psychosocial work trajectories of low work control (high supervision), low complexity, and high routine.

Cognitive Function

Finally, differences in level and change of cognitive function are likely to be associated with the psychosocial work environment trajectories. The cumulative work by Schooler (e.g. Schooler, 1984; Schooler et al., 1999, 2004) has found longitudinal associations between intellectual flexibility and the psychosocial work domains of control, complexity and routine. In addition, individual's perceived work environment (autonomy, control, and innovation) has been related to cognitive style (De Frias & Schaie, 2001), and occupational status has been shown to attenuate the effects of age on cognitive function in a sample of mining workers (Avolio & Waldman, 1987). Finally, Brunner (2005) found that perceptual speed, inductive reasoning, verbal fluency, and vocabulary were all positively associated with occupational status. Thus, it is hypothesized that for the present study, individuals with faster perceptual speed and higher functioning reasoning and word fluency will be associated with higher level and gains in trajectories of psychosocial work experiences (high complexity, high worker control, low routine).

III. Are psychosocial work environment experiences in older adults associated with trajectories of cognitive change after accounting for characteristics of the individual?

While there is evidence that psychosocial domains of the work environment, such as control, complexity, and routine, are associated with intellectual flexibility (Schooler et al., 1999, 2004) and cognitive style (De Frias & Schaie, 2001), a major question about the work – cognition

association is whether earlier work experiences are associated with cognitive change in older adults. Specifically, it is possible that there is an accumulated effect of psychosocial work experiences on cognitive change in older adults that is not measurable until post-retirement. To study this process would require longitudinal data over all adulthood. However, to have a sample size large enough to evaluate this effect over time prohibited the inclusion of work environment data in young and middle aged adults. Thus a sample of those aged 60 and up, who were working at the first occasion were selected from the Seattle Longitudinal Study to evaluate how work experiences in late life associated with trajectories of cognitive change over 14 years.

Psychosocial Work Environment

Contextual influences have been linked to age-related cognitive declines in reasoning, memory, and processing speed (Churchill et al., 2002; Raz, 2000; Shadlen et al., 2005). Further, evidence suggests that an active and engaged lifestyle, of which work participation is a key component, is positively associated with cognitive function in older adults (Bunce & Macready, 2005; Chruchill et al., 2002; Hogan, 2005; Lambert, Fernandez & Frick, 2005; Louvden et al., 2005; Shadlen et al., 2005). The literature also indicates that the specific domains of work complexity, control and routine as defined by Schooler (1984) are predictive of intellectual flexibility and cognitive style (De Frias & Schaie, 2001; Schooler et al., 1999). Based on the literature, it is expected that level differences in the experience of work control, complexity, and routine in older adults will be associated with patterns of individual change in both fluid and crystallized abilities. Specifically, it is hypothesized that high work control (low supervision), high complexity, and low routine will be associated with slower rates of decline in memory, reasoning, and verbal ability. Further, because the domain of perceptual speed shows normative declines beginning in young adulthood, and some would argue is a better predictor of cognitive decline in older adults than age (Hertzog, 1989; Schaie, 1989; Schaie, 2005; Sliwinski & Bushke, 1997), speed needs to be controlled for when examining patterns of cognitive change in older adults.

Demographic

When examining cognitive change in older adults, there are several other domains that must be accounted for including demographics, health status, and social engagement. The strongest predictors of cognitive decline in older adults are age and education (Finkle et al., 2003; Hess, 2005; Schaie, 2005; Singer et al., 2003). Normative age-related declines in memory and reasoning ability begin in the mid-60 (Finkle et al., 2003; Schaie, 2005), and higher educational attainment has been associated with both higher level and slower rate of cognitive decline (Anstey & Christensen, 2000; Katzman, 1993). Therefore, both age and educational attainment need to be controlled for when examining alternate covariates of cognitive decline in older adults.

Health Status

Health status and cognitive function are associated, such that poor health status has been related to negative cognitive functioning. For example, diseases such as diabetes, stroke, hypertension, and chronic obstructed pulmonary disease are predictive of poor cognitive function (Barclay et al., 1988; Hertzog et al., 1978; Roehrs et al., 1995; Scherr et al., 1988). Alternately, older adults with strong cognitive function adhere to medication directions better, resulting in better health consequences (Insel et al., 2006). Because poor health status is a pervasive issue in older adults and is associated with cognition, it is important to account for it when examining patterns of individual differences in cognitive change. For the present study, measures of subjective and objective health status will be considered.

Social Engagement

Finally, as described in question 2, social engagement has been positively associated with cognitive function in old age (Ghisletta et al., 2006; Louvden et al., 2005). For example, Ghisletta and colleagues (2006) examined the causal relations among social activity and cognitive function in a sample of the oldest old. The authors found that leisure activity was a significant predictor of cognitive function and concluded that social activity was an important aspect of cognitive stimulation for older adults. For the present study, measures of social activity, solitary activity,

and communication activity are hypothesized to be positively associated with cognitive change in older adults.

Chapter 3

METHODS

The methods section will be separated into three parts, each describing the specific sample and measures separately for the three main questions of the present study. Refer to Table 2 for descriptive statistics and Table 3 for item descriptions of all key variables for questions 1, 2, and 3.

Question 1: What domains predict work environment contexts in the transition from young to middle adulthood?

Sample

The sample for the first research question consisted of Seattle Longitudinal Study (SLS) aged 22 – 39 at the first occasion of measurement who were participating in paid work. Specifically, participants were selected who were working throughout 3 occasions spanning a 14-year period (7 years apart). To increase the sample size participants were selected based on 14-year period age and employment status criteria between the 1977 through 2005 SLS waves (sampled from 1977-1991, 1984-1998, 1991-2005, or 1989-2003). Participant data will be referred to as time 1 (T1), time 2 (T2), and time 3 (T3) instead of referencing specific years because the T1 years differ depending on the specific waves participants were selected from. Within the selected sample, 5 individuals were missing data for work routine at all 3 waves. Sample sizes based on the three outcomes are: Control/Complexity N = 492 (male = 190, female = 302); Routine N = 487 (male = 190, female = 297). For both subsamples, the average age = 33.4 (SD = 4.3; range = 21-39) and the participants were fairly well-educated (mean= 15.5 years; SD = 2.2; range=11-20 years). Fifteen percent of the sample was 21 - 28 years old (median = 25; n = 74), 48% was 29 – 35 years old (median = 32; n = 235), and 37% was 36 – 39 (median = 37.5; n = 183), and 37% was 36 – 39 years old. The sample was 19% unskilled/white collar workers, 38% clerical/sales/managerial, and 43% semi-professional/professionals at the first time of measurement. The only noticeable gender differences in occupational status were for

clerical/sales and semi-professional (requiring a college degree) occupations. Specifically, there was a higher proportion among women who worked clerical/sales occupations (27%) compared to men (13%) and a higher proportion of men in semi-professional jobs (33%) compared to women (27%).

Attrition

Attrition analyses examined mean differences between the final sample selected for the present study versus the participants at the first occasion who fit the selection criteria (working, aged 22 – 39) that did not participate in all 3 occasions. Of all possible participants fitting the selection criteria at the first occasion (N = 655), 492 participated in 3 consecutive waves, resulting in a 25% attrition rate over the 14 years. Further, after running independent samples t-tests between the sample used in the present study and the sample of those who attrited over the 14 years, there were no significant mean differences in educational attainment [t (653) = 1.20, p = .15], PMA reasoning at T1 [t (653) = 1.14, p = .31], PMA word fluency at T1 [t (653) = 1.07, p = .57), or Finding A's at T1 [t (653) = 1.23, p = .12).

Measures

Dependent Variables

Psychosocial work environment factors. Exploratory factor analysis was previously conducted on work variables derived from the work of Schooler (e.g. Kohn & Schooler, 1983; Schooler, 1984) with items contained in the Life Complexity Inventory (Gribbin, et al., 1980). The work environment factors were assessed at all three occasions of measurement and t-scored for comparability. Three work environment factors were created (DeFrias, 1998; See Table 2 for descriptive statistics of all key variables):

> *Work Control:* This factor assessed the extent to which an individual experiences supervisor control and able to make decisions in the workplace. This factor was reverse scored such that high scores represent high decision making ability and worker control over one's own work environment. The work control factor was created from variables

Table 2

Descriptive statistics for key variables in questions 1, 2, and 3.

	Question 1	**Question 2**	**Question 3**
Dependent Variables (Time 1)	**Mean (SD) (N = 492)**	**Mean (SD) (N = 268)**	**Mean (SD) (N = 271)**
Work Control	49.3 (7.6)	49.7 (8.0)	----
Work Complexity	50.2 (6.1)	51.3 (6.0)	----
Work Routine	49.1 (5.2)	49.7 (4.8)	----
Verbal Memory	----	----	47.7 (8.4)
Inductive Reasoning	----	----	49.5 (7.0)
Verbal Ability	----	----	52.4 (7.9)
Covariates (Time 1)			
# Job Changes	---	0.6 (1.2)	---
# Profession Changes	---	1.3 (1.0)	---
PMA Reasoning	21.9 (4.8)	19.3 (5.7)	---
PMA Word Fluency	47.3 (11.9)	46.7 (12.0)	---
Finding A's	30.1 (8.6)	29.1 (8.5)	---
Social Activities	---	48.6 (9.3)	47.9 (8.8)
Communication Activities	---	52.3 (10.0)	46.3 (5.8)
Solitary Activities	---	49.2 (9.4)	50.3 (10.1)
Neuroticism	3.0 (7.6)	1.5 (8.1)	---
Extraversion	24.3 (8.2)	26.5 (9.0)	---
Openness	5.8 (9.0)	5.8 (9.2)	---
Agreeableness	89.2 (9.1)	92.3 (10.1)	---
Conscientiousness	10.1 (8.0)	12.4 (8.7)	---

Age	33.4 (4.3)	48.5 (11.1)	67.6 (5.3)
Years of Education	15.5 (2.1)	15.3 (2.6)	15.1 (2.3)
Percent Women	61%		52%
Work Control	---	---	49.8 (8.2)
Work Complexity	---	---	50.1 (6.0)
Work Routine	---	---	49.6 (5.3)
Perceptual Speed	---	---	48.9 (5.7)
Subjective Health Status	---	51.2 (8.8)	51.6 (9.1)
Objective Health Status	---	51.8 (7.8)	49.6 (10.0)

measuring: 1) the number of employees one deals with on a daily basis, 2) work speed, and 3) work pressure.

Work Complexity: This factor assessed the extent to which an individual partakes in varied, multifaceted tasks throughout the day in their work environment. High levels indicate that an individual has highly complex work. The work complexity factor was created from variables measuring: 1) the number of hours spent reading at work, 2) the number of hours spent talking to people at work, 3) the number of employees one deals with on a daily basis, and 4) work pressure.

Work Routine: This factor assessed the extent to which an individual partakes in repetitive tasks throughout the workday. High levels of work routine indicate a job that is highly repetitive. The work routine factor was created with variables measuring: 1) the number of hours one works with their hands at work, 2) the type of work one does, and 3) how long it takes to complete a task at work.

The Schooler factors of work control, complexity, and routine are related but distinct variables. Work routine was not significantly correlated with either work complexity ($p = .18$) or work control ($p = .73$), whereas work complexity and work control were significantly correlated ($r = .38$, $p < .001$). Refer to Table 3 for item descriptions of all factor scores in the present study.

Covariates

Demographic. Measures of age, years of education and gender were obtained from the Life Complexity Inventory (Gribbin et al., 1980).

Cognitive function. Cognitive ability was measured at all occasions with 3 tests of cognitive function including Primary Mental Ability (PMA) reasoning (Thurstone & Thurstone, 1949), Finding A's (Ekstrom et al., 1976), and PMA word fluency (Thurstone & Thurstone, 1949) and are in raw score form. PMA reasoning is a timed letter series test, where participants are given 6 minutes to examine several letter series and correctly identify what letter should come next. PMA reasoning has been associated with inductive reasoning ability (Schaie, 2005). The

Table 3

Item description for key factors of questions 1, 2 and 3.

Factor Name	Items	Response
Work Control	# Employees You Talk With	Open Ended
	Work speed	Likert
	Work Pressure	Likert
Work Complexity	# Hours Reading	Open Ended
	# Hours Talking to People	Open Ended
	# Employees You Talk With	Open Ended
	Work Pressure	Likert
Work Routine	# Hours Working with Hands	Open Ended
	Kind of Work	Likert
	Time to Finish Tasks	Likert
Verbal Memory	Immediate Recall	Timed Recall
	Delayed Recall	Timed Recall
Inductive Reasoning	PMA Reasoning	Timed Letter Series
	ADEPT Letter Series	Timed Letter Series
	Word Series	Timed Word Series
	Number Series	Timed Number Series
Verbal Ability	PMA Verbal Meaning	Timed Synonym Test
	ETS Vocabulary	Timed Synonym Test
	ETS Advanced Vocabulary	Advanced Synonym Test

Social Activities	# Hours Shopping/Week	Open Ended
	# Hours Being Visited/Week	Open Ended
	# Hours Visiting Others/Week	Open Ended
	# Hours of Social Activities/Week	Open Ended
Communication	# Hours Talking/Week	Open Ended
Activities	# Hours Daydreaming/Week	Open Ended
	# Hours Writing/Week	Open Ended
Solitary Activities	# Hours of Outdoor Hobbies/Week	Open Ended
	# Hours Solitary Activities/Week	Open Ended
	# Hours doing Crafts/Week	Open Ended
Neuroticism	Affectothymia	True/False
	Superego Strength	True/False
	Untroubled Adequacy	True/False
	Conservatism of Temperament	True/False
	Inflexibility	True/False
	Community Involvement	True/False
Extraversion	Superego Strength	True/False
	Premsia	True/False
	Untroubled Adequacy	True/False
	Conservatism of Temperament	True/False
	Low Self-Sentiment	True/False
	Honesty	True/False
	Community Involvement	True/False

Openness	Premsia	True/False
	Low Self-Sentiment	True/False
	Inflexibility	True/False
Agreeableness	Superego Strength	True/False
	Threctia	True/False
	Premsia	True/False
	Untroubled Adequacy	True/False
	Low Self-Sentiment	True/False
	Honesty	True/False
	Community Involvement	True/False
Conscientiousness	Affectothymia	True/False
	Superego Strength	True/False
	Threctia	True/False
	Untroubled Adequacy	True/False
	Conservatism of Temperament	True/False
	Low Self-Sentiment	True/False
	Inflexibility	True/False
	Community Involvement	True/False
Perceptual Speed	Identical Pictures	Timed Scanning Test
	Finding A's	Timed Scanning Test
	Number Comparison	Timed Scanning Test
Subjective Health	Self-Rated Good Health	Likert
Status	Self-Rated Good Vision	Likert
	Self-Rated Good Hearing	Likert
	Self-Rated Health Decline	Likert

Objective Health	# Doctors Visits in Last Year	Open Ended
Status	# Days in Hospital in Last Year	Open Ended
	Assistance with Stairs	Likert
	Use a Walker	Likert

Finding A's test measures perceptual speed, where participants have 2 minutes to scan columns of words and find 5 words in each column that contain the letter "a." The PMA word fluency test gives participants 5 minutes to write as many words beginning with one letter as they can. This measure has been associated with verbal memory (Schaie, 2005).

Personality. Confirmatory factor analysis estimated the 5 NEO personality factors: 1) neuroticism: the extent to which an individual is emotionally unstable, 2) extraversion: the extent to which an individual seeks stimulation from others and is high in positive emotions, 3) openness to experience: the extent to which individuals are curious, have appreciation for art, and enjoy unusual, novel experiences, 4) agreeableness: the extent to which an individual is compassionate and cooperative, and 5) conscientiousness: the extent to which an individual is achievement oriented, disciplined, and responsible. The 5 personality factors were estimated from 13 TBR personality facets (affectothymia, community involvement, conservatism of temperament, group dependency, honesty, inflexibility, interest in science, low self-sentiment, political concern, premsia, superego strength, threctia, untroubled adequacy; Schaie, Willis & Caskie, 2004; See Table 3) at each occasions. The final CFA model fit well (X^2 [df = 1,453] = 5924.22, $p < .001$; GFI = .920, RMSR = .04). The following TBR facets significantly loaded on the NEO factors:

Neuroticism: Affectothymia, superego strength, untroubled adequacy, conservatism, inflexibility, community interest.

Extraversion: Superego strength, premsia, untroubled adequacy, conservatism, low self esteem, interest in science, inflexibility, community interest.

Openness: Premsia, low self esteem, inflexibility.

Agreeableness: Superego strength, threctia, premsia, untroubled adequacy, low self esteem, honesty, community interest.

Conscientiousness: Affectothymia, superego strength, threctia, untroubled adequacy, conservatism, low self esteem, inflexibility, community interest.

Question 2: Are there Typical Trajectory Types of Psychosocial Work Environment Experiences over Time, and What Factors Differentiate Trajectory Type?

Sample

The present sample used SLS participants working throughout 4 waves of data collection spanning 21 years. The selection criteria retained those who were listed as working at least part-time for four consecutive waves, and were no older than 65 at the first time of measurement. The selected dataset (N = 324; men = 175, women = 149), had an average age = 47.7 (SD = 10.7; range = 32 - 65) and they were fairly well-educated (mean = 15.4 years; SD = 2.5; range = 7-20 years). The participants were sampled from four waves of SLS data collections including those who participated in 1977, 1984, 1991, and 1998 and those who participated in 1984, 1991, 1998, and 2005. Roughly 10% of the sample reported a retired occupational status at T1. These individuals also reported working full-time or part-time at T1. This group likely retired from their main occupation and was engaged in other employment and thus was retained in the sample. Further, 2% of the sample self-identified as homemaker occupational status that were retained in the sample because they also self-identified as employed throughout the 21 years. Excluding, those individuals with an occupational status of retired or homemaker at T1, the distribution of occupational status at T1 is described in Table 4. Semi-professional occupations had the largest proportion of individuals (31%), followed by clerical and sales (17%), professional (15%), managerial (12%), and skilled crafts (6%). Unskilled laborers, domestic services, operatives and factory workers, service occupations, and protective services constituted less than 6% of the total sample. Over the 21 year study period, 228 of the 324 participants identified an occupational status of retired as well as still employed. For those who did not identify retirement occupational status during the study (n = 96), 46% had no change in occupational status, 24% had overall gain in occupational status, and 30% had overall decline in occupational status.

Table 4

Occupational status distribution for those not self-identified as retired at time 1.

Occupation Type	Frequency	Percent of Sample
Unskilled Laborers	4	1.2
Domestic Services	0	0
Operatives/Factory Workers	4	1.2
Service Occupations	7	2.2
Protective Services	4	1.2
Skilled Crafts	20	6.2
Clerical & Sales Workers	55	17.0
Managerial	39	12.0
Semi-Professional	101	31.2
Professional	48	15.0

Attrition

Attrition analyses examined mean differences between the final sample selected for the present study versus the participants at the first occasion who fit the selection criteria (working, up to age 65 at T1) that did not participate in all 4 occasions. Of all possible participants fitting the selection criteria at the first occasion (N = 1001), 324 participated in 4 consecutive waves, resulting in a 68% attrition rate over the 21 years. Further, after running independent samples t-tests between the final selected sample compared to the sample of those who attrited over the 21 years, there were no significant mean differences in educational attainment [t (999) = 1.14, p = .18], PMA reasoning at T1 [t (999) = 1.16, p = .13], PMA word fluency at T1 [t (999) = 1.10, p = .32), or Finding A's at T1 [t (999) = 1.11, p = .27).

Measures

Dependent Variables

Psychosocial work environment factors. Exploratory factor analysis was previously conducted on work variables derived from the work of Schooler (e.g. Kohn & Schooler, 1983; Schooler, 1984) from items contained in the Life Complexity Inventory (Gribbin, et al., 1980). The work environment factors were assessed at all four occasions of measurement and t-scored for comparability. Three psychosocial work factors were created (DeFrias, 1998):

Work Control: This factor assessed the extent to which an individual experiences supervisor control and able to make decisions in the workplace. This factor was reverse scored such that high scores represent high decision making ability and worker control over one's own work environment. The work control factor was created from variables measuring: 1) the number of employees one deals with on a daily basis, 2) work speed, and 3) work pressure (See Table 3).

Work Complexity: This factor assessed the extent to which an individual partakes in varied, multifaceted tasks throughout the day in their work environment. High levels indicate that an individual has highly complex work. The work complexity factor was

created from variables measuring: 1) the number of hours spent reading at work, 2) number of hours spent talking to people at work, 3) the number of employees one deals with on a daily basis, and 4) work pressure.

Work Routine: This factor assessed the extent to which an individual partakes in repetitive tasks throughout the workday. High levels of work routine indicate a job that is highly repetitive. The work routine factor was created with variables measuring: 1) the number of hours one works with their hands at work, 2) the type of work one does, and 3) how long it takes to complete a task at work.

Covariates

Demographic. Measures of age, years of education, and gender were obtained at the first time of measurement from the Life Complexity Inventory (Gribbin et al., 1980).

Occupational change. Occupation change factors, including the number of job changes and the number of profession changes were obtained from the Life Complexity (Gribbin et al., 1980) at each occasion (Gribbin et al., 1980). Sum scores were created, such that the total number of job changes over 21 years and total number of profession changes over 21 years were used.

Cognitive function. Cognitive ability was measured at time 1, time 4, and overall 21-year change scores were computed. Three tests of cognitive function were used including PMA reasoning (Thurstone & Thurstone, 1949), Finding A's (Ekstrom et al., 1976), and PMA word fluency (Thurstone & Thurstone, 1949) and are in raw score form. PMA reasoning is a timed letter series test, where participants are given 6 minutes to examine 30 letter series and correctly identify what letter should come next. PMA reasoning has been associated with inductive reasoning ability (Schaie, 2005). The Finding A's test measures perceptual speed, where participants have 2 minutes to scan columns of 40 words and find 5 words per column that contain the letter "a." There are 50 columns included with a 1.5 minute time limit. The PMA word fluency test gives participants 5 minutes to write as many words beginning with one letter as they can. This measure has been associated with verbal memory (Schaie, 2005).

Social engagement. Social engagement was measured via three activity factors including social activity, communication activity, and solitary activity (O'Hanlon, 1993). Exploratory factor analysis on a randomly split half of the 1977 SLS sample and confirmatory factor analysis in the 1984 SLS sample confirmed the activity factors (O'Hanlon, 1993). The social activity factor was created from items measuring the number of hours per week an individual reported spending time shopping, being visited, visiting others, and partaking in social activities (See Table 3). The communication activity factor was derived from individual's reports of hours per week spent talking, daydreaming, and writing. The solitary activity factor was created from self-reported hours per week spent on outdoor hobbies, in solitary activities, and doing crafts. The activity factors were t-scored for comparability and assessed at the first occasion.

Health status. Measures of objective and subjective health status at the last occasion were obtained from the Health Behavior Questionnaire, an 85-item measure of various health behaviors. A confirmatory factor analysis (Meir, 1995) identified objective health status factor and health status factors (See Table 3). Subjective health status was derived from measures of self-rated good health, self-rated good vision, self-rated good hearing, and self-rated health decline. Objective health status was derived from items measuring the number of doctor visits in the last year, the number of days in the hospital in the last year, needing assistance with stairs, and use of a walker.

Personality. Confirmatory factor analysis estimated the 5 NEO personality factors: 1) neuroticism: the extent to which an individual is emotionally unstable, 2) extraversion: the extent to which an individual seeks stimulation from others and is high in positive emotions, 3) openness to experience: the extent to which individuals are curious, have appreciation for art, and enjoy unusual, novel experiences, 4) agreeableness: the extent to which an individual is compassionate and cooperative, and 5) conscientiousness: the extent to which an individual is achievement oriented, disciplined, and responsible. The 5 personality factors were estimated at the first occasion from 13 TBR personality facets:

Neuroticism: Affectothymia, superego strength, untroubled adequacy, conservatism, inflexibility, community interest.

Extraversion: Superego strength, premsia, untroubled adequacy, conservatism, low self esteem, interest in science, inflexibility, community interest.

Openness: Premsia, low self esteem, inflexibility.

Agreeableness: Superego strength, threctia, premsia, untroubled adequacy, low self esteem, honesty, community interest.

Conscientiousness: Affectothymia, superego strength, threctia, untroubled adequacy, conservatism, low self esteem, inflexibility, community interest.

Question 3: Are Psychosocial Work Environment Experiences in Older Adults Associated with Trajectories of Cognitive Change after Accounting for Characteristics of the Individual?

Sample

For the present study, participants were selected from the SLS who were 60 years or older in 1991, participated in the 1991, 1998 and 2005 waves, and were working in 1991 (N=271). The resulting sample had an average age of 67.6 (SD = 5.3; range = 60-84). The sample had 130 men and 141 women and they were fairly well-educated (average = 15.1 years; SD = 2.8; range = 7-20 years). Only individuals with at least one value for work control, work complexity and work routine in 1991 were selected. Fifteen percept of the sample (n = 41) were working only at wave 1, 36% (n = 98) were working during 2 occasions, and 49% were working during all three waves of measurement.

Attrition

Attrition analyses examined mean differences between the final sample selected for the present study versus the participants at the first occasion who fit the selection criteria (working in 1991, aged 60+) that did not participate in all 3 occasions. Of all possible participants fitting the selection criteria at the first occasion (N = 800), 271 participated in 3 consecutive waves,

resulting in a 66% attrition rate over the 14 years. Further, after running independent samples t-tests between the final selected sample compared to the sample of those who attrited over the 14 years, there were no significant mean differences in educational attainment [t (798) = 1.01, p = .94], inductive reasoning at T1 [t (798) = 1.22, p = .06], or verbal memory at T1 [t (798) = 1.19, p = .10). However, there were significant group differences in verbal ability and perceptual speed, such that the attrited sample had significantly lower verbal ability at T1 (M = 49.0, SD = 9.8) compared to the final selected sample [t (798) = 1.53, p < .001) and significantly slower processing speed (M = 43.4, SD = 7.0) compared to the final selected sample [t (798) = 1.53, p < .001).

Measures

Dependent Variables

Verbal memory. The domain of verbal memory represents the fluid ability to encode, store and recall meaningful language units (Schaie, Caskie, Revell, Willis, Kaszniak & Teri, 2005). A factor representing verbal memory was computed from three indicators: 1) PMA (Thurstone & Thurstone, 1949) word fluency, 2) immediate recall (Zelinski, Gilewski & Schaie, 1993), and 3) delayed recall (Zelinski et al., 1993). The PMA word fluency test gives participants 5 minutes to write as many words beginning with one letter as they can. The immediate recall test has participants examine 20 words for 3.5 minutes, and allows them another 3.5 minutes to recall as many as possible. For the delayed recall task, the participants are asked to recall the same words from the immediate recall task an hour later after participating in other tasks. Verbal memory was obtained at all occasions and was t-scored for comparability.

Inductive reasoning. Inductive reasoning is a fluid ability that measures one's capacity to identify novel associations in serial patterns in addition to assessing the use of principles and rules for determining further serial patterns. Four indicators were used to create the inductive reasoning factor: 1) PMA reasoning (Thurstone & Thurstone, 1949), 2) ADEPT letter series (Blieszner, Willis, & Baltes, 1981), 3) word series (Schaie, 1985), and 4) Number Series

(Thurstone, 1962). PMA reasoning is a timed letter series test, where participants are given 6 minutes to examine several letter series and correctly identify what letter should come next. ADEPT letter series (Blieszner et al., 1981) parallels the PMA reasoning task with 20 items and a 4.5 minute time limit. The Word Series (Schaie, 1985) task has participants examine a series of related words and asks to identify the next word, with 30 items and a 6 minute time limit. The Number Series task (Thurstone, 1962) is a 4.5 minute timed, 20-item task with series of numbers, asking participants to identify the next number. Inductive reasoning was assessed at each occasion and has been converted to a t-score.

Verbal ability. Verbal ability is a crystallized measure of cognitive function which evaluates word comprehension from reading and listening tasks. Three indicators were used to create the verbal ability factor at each occasion: 1) PMA verbal meaning (Thurstone & Thurstone, 1949), 2) ETS (Educational Testing Service) Vocabulary V-2 (Ekstrom et al., 1976), and 4) ETS Vocabulary V-4 (Ekstrom et al., 1976). PMA verbal meaning is a 4-choice, 50-item synonym with a time limit of 4 minutes. ETS Vocabulary V-2 is a 5-choice synonym task in two parts with 18-items each, and a 4 minute time limit. ETS Vocabulary V-4 is an advanced vocabulary synonym task in two parts with 18 items each. While PMA verbal meaning is a highly speeded task, the ETS synonym tasks are essentially unspeeded (Schaie, 2005). Verbal ability was converted to a t-score for comparability.

Covariates

Demographic. Measures of age, years of education, and gender were assessed in 1991 from the LCI (Gribbin et al., 1980).

Psychosocial work environment factors. Baseline values for work complexity, work control, and work routine were derived from the LCI (Gribbin et al., 1980) and were converted to t-scores. Exploratory factor analysis was previously conducted on work variables derived from the work of Schooler (e.g. Kohn & Schooler, 1983; Schooler, 1984) from items contained in the

Life Complexity Inventory (Gribbin, et al., 1980). Three psychosocial work factors were created (DeFrias, 1998):

Work Control: This factor assessed the extent to which an individual experiences supervisor control and able to make decisions in the workplace. This factor was reverse scored such that high scores represent high decision making ability and worker control over one's own work environment. The work control factor was created from variables measuring: 1) the number of employees one deals with on a daily basis, 2) work speed, and 3) work pressure.

Work Complexity: This factor assessed the extent to which an individual partakes in varied, multifaceted tasks throughout the day in their work environment. High levels indicate that an individual has highly complex work. The work complexity factor was created from variables measuring: 1) the number of hours spent reading at work, 2) number of hours spent talking to people at work, 3) the number of employees one deals with on a daily basis, and 4) work pressure.

Work Routine: This factor assessed the extent to which an individual partakes in repetitive tasks throughout the workday. High levels of work routine indicate a job that is highly repetitive. The work routine factor was created with variables measuring: 1) the number of hours one works with their hands at work, 2) the type of work one does, and 3) how long it takes to complete a task at work.

For participants who were only working at the first time of measurement, the baseline was their 1991 levels of work control, work complexity and work routine. Participants who continued to work throughout 1998 and/or 2005 had baselines computed as an average of their levels in 1991, 1998 and/or 2005. A dummy coded variable was created to control for employment status differences, such that individuals who only worked in 1991 were coded as 0 and those who continued to work in 1998 and/or 2005 were coded as 1.

Perceptual speed. Perceptual speed is an established factor (Schaie, 2005), derived from Identical Pictures (Ekstrom, French, Harman, & Derman, 1976), Finding A's (Ekstrom et al., 1976), and Number Comparison (Ekstrom et al., 1976). It evaluates one's ability to find pictures, make comparisons, and basic visual perception ability with accuracy and speed (Schaie, 2005). Identitical Pictures asks participants to identify which of 5-numbered pictures is identical to the model. The test has 50 items with a 1.5 minute time limit. The Finding A's test measures perceptual speed, where participants have 2 minutes to scan columns of words and to find 5 words per column that contain the letter "a." The Number Comparison test is a 40-item tasks that gives participants 1.5 minutes to examine pairs of multidigit numbers and evaluate whether they are identical or not. Perceptual speed was evaluated at all occasions and converted to a t-score for comparability.

Health status. Measures of objective and subjective health status in 1994 were obtained from the Health Behavior Questionnaire, an 85-item measure of various health behaviors. A confirmatory factor analysis (Meir, 1995) identified objective health status and health status factors. Subjective health status was derived from measures of self-rated good health, self-rated good vision, self-rated good hearing, and self-rated health decline. Objective health status was derived from items measuring the number of doctor visits in the last year, the number of days in the hospital in the last year, needing assistance with stairs, and use of a walker (See Table 3).

Social engagement. Social engagement was ascertained at each occasion via three activity factors including social activity, communication activity, and solitary activity (O'Hanlon, 1993). Exploratory factor analysis on a randomly split half of the 1977 SLS sample and confirmatory factor analysis in the 1984 SLS sample confirmed the activity factors (O'Hanlon, 1993). The social activity factor was created from items measuring the number of hours per week an individual reported spending time shopping, being visited, visiting others, and partaking in social activities (See Table 3). The communication activity factor was derived from individual's reports of hours per week spent talking, daydreaming, and writing. The solitary activity factor was

created from self-reported hours per week spent on outdoor hobbies, in solitary activities, and doing crafts. The activity factors were t-scored for comparability.

Chapter 4

RESULTS

Question 1: What domains predict work environment contexts in the transition from young to middle adulthood?

Statistical analyses were performed using SAS, version 9.1 (SAS Institute, 2005). Repeated-measures multi-level modeling (MLM) was conducted with SAS proc mixed. MLM is a commonly used technique in assessing time-varying outcomes with three or more measurement times and it decomposes variance of the outcome into interindividual and intraindividual components (Singer & Willett, 2003). Although this method is particularly useful for studies with many levels, such as students, nested within class rooms, nested within schools, MLM can be applied to a developmental framework, where time is nested within the individual (Browne & Rasbash, 2004).

Model specifications followed three steps including empty models, unconditioned growth curve models, and conditioned growth curve models. Linear mixed models (empty models) were first estimated using SAS PROC MIXED to examine the pattern of individual differences in worker control, job complexity and job routine across three test waves. The empty models estimate the outcome without any covariates other than estimations of random intercepts. These models produce saturated means and interclass correlations. Restricted maximum likelihood (REML) estimates were used to report the parameter estimates and assess random effects. Degrees of freedom were estimated with the Satterthwaite method (Brown & Rasbash, 2004).

Work Complexity

Using the unconditional means models (empty models), an interclass correlation coefficient (.50) was obtained for work complexity (mean = 50.2), indicating equal variance attributable to between and within person variability. Fixed linear terms for age and time-in-study were tested separately and neither was statistically significant, indicating that no significant

change in work complexity occurred with increasing years in the study or with increasing years of age.

After testing individual conditioned growth curve models of work complexity with each covariate (age, education, gender, PMA reasoning, Finding A's, PMA word fluency, NEO personality factors), no significantly improved models were found beyond the unconditional means models. Covariates were tested as both time invariant and fixed, but neither combination produced significant findings. Figure 1 provides an illustration of the overall pattern of mean work complexity across the 14-year period.

Work Control

Using the unconditional means models (empty models), an interclass correlation coefficient (.41) was obtained for work control (mean = 49.4), indicating that 41% of the variance in work control across the three waves was attributable to between persons and 59% is intraindividual variance. Fixed linear terms for age and time-in-study were tested separately and neither was significant, indicating that no significant change in work control occurred with increasing years in the study or with increasing age.

After testing individual conditioned growth curve models of worker control with each covariate, no significantly improved models were found beyond the unconditional means model. Covariates were tested as both time invariant and fixed, but neither combination produced significant findings. Figure 2 provides an illustration of the overall pattern of mean work control across the 14-year period.

Work Routine

Using the unconditional means models (Empty Models), an interclass correlation coefficient (.32) was obtained for work routine (M = 48.3), indicating that 30% of the variance in routine across the three waves was attributable to between persons and 70% to intraindividual variance. While the addition of a fixed linear age term did not improve model fit, the fixed linear term for time-in-study was significant ($p < .001$), indicating an average decline in work routine

Figure 1

Pattern of mean stability of work complexity over 14 years.

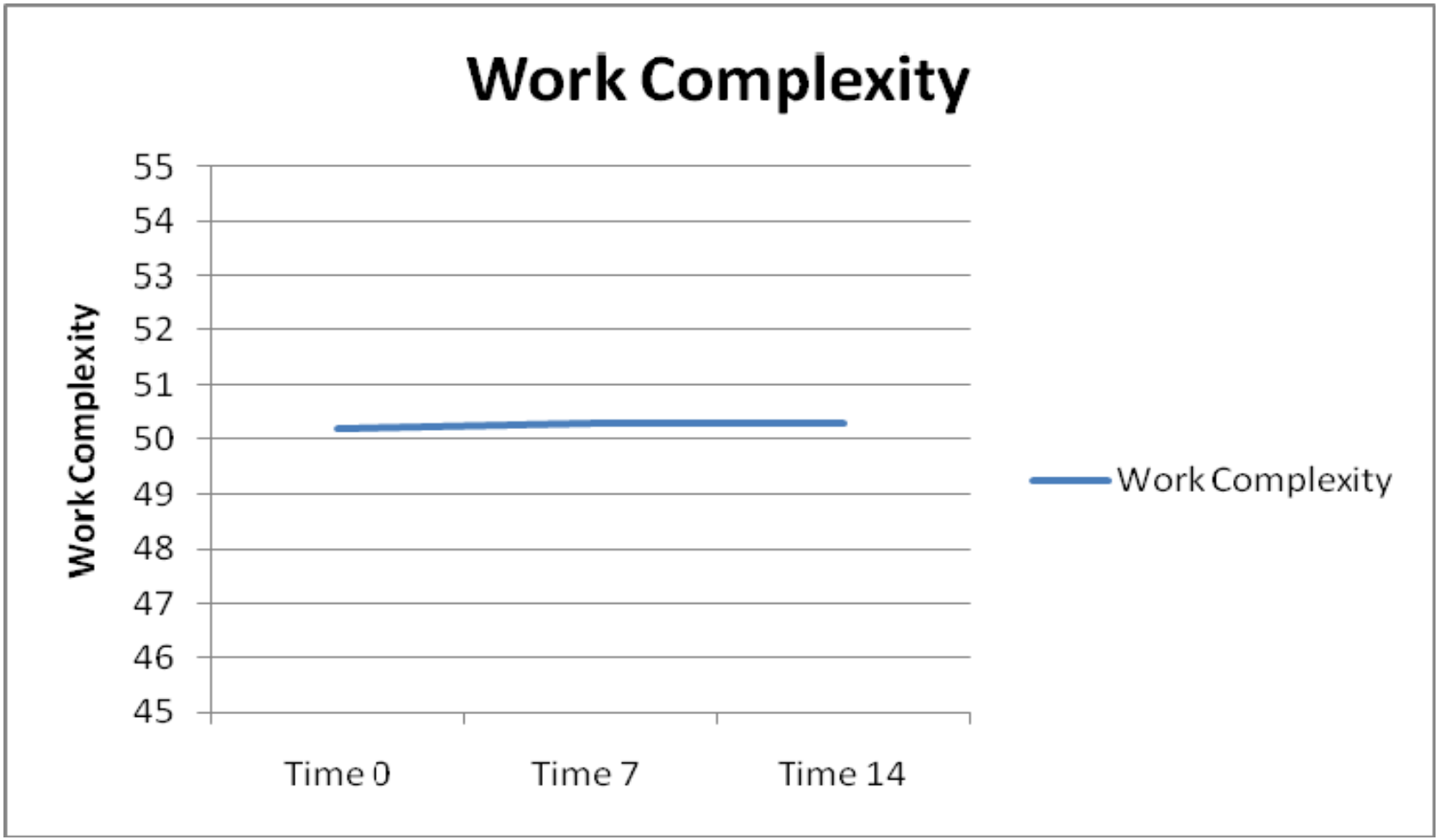
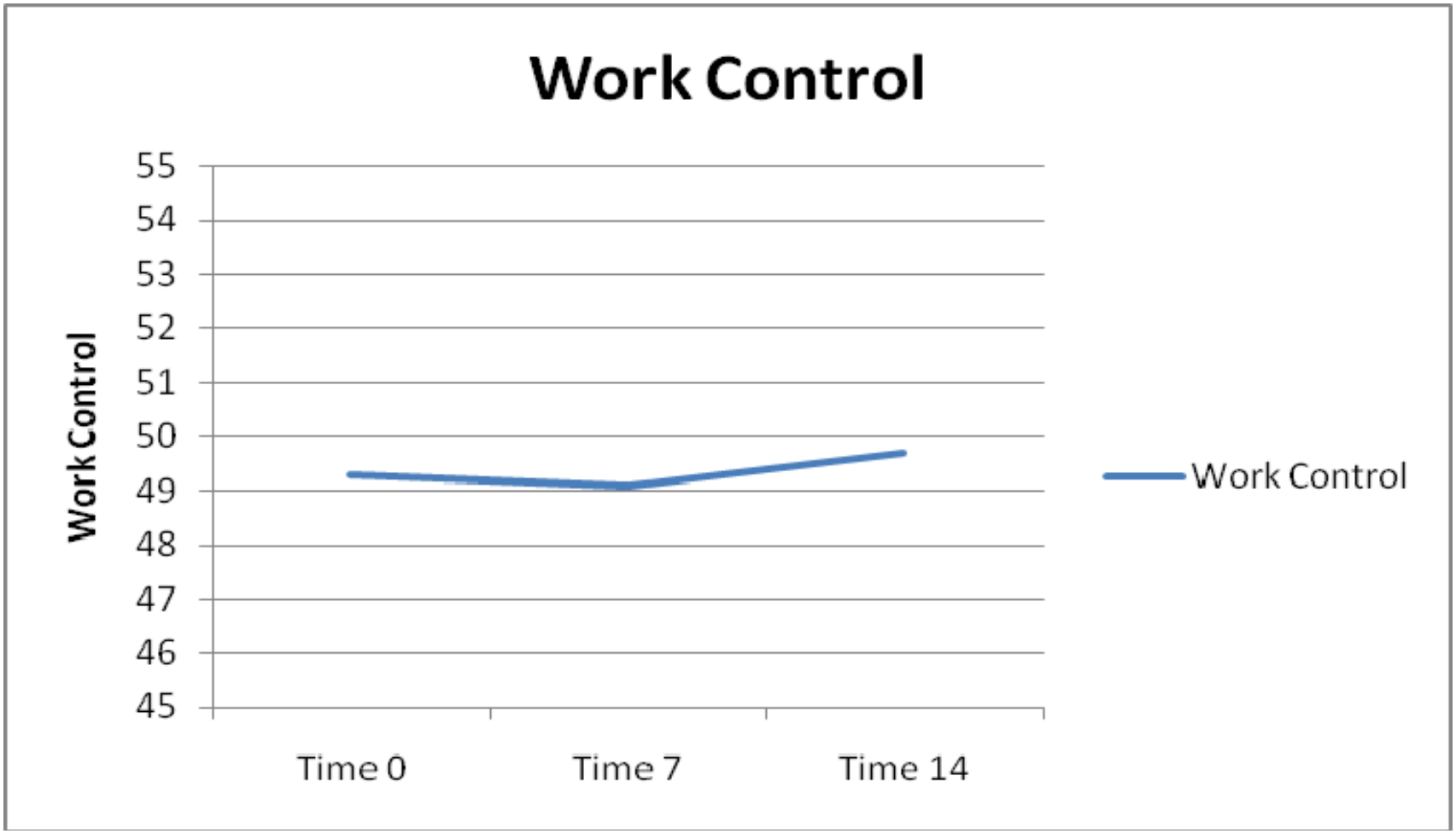


Figure 2

Pattern of mean stability of work control over 14 years.



with increasing years in the study. A random effects for time-in-study was tested but did not improve model fit and was not included in the final model.

In the conditioned growth curve model, PMA reasoning was a significant factor associated with work routine that improved model fit. After adding demographic variables (years of education and gender), reasoning remained significant and improved the model fit. Every increased raw score unit of reasoning ability was associated with a .09 *t-score* decrease in work routine ($p < .01$; Table 5). In addition, being male ($p < .001$) was associated with higher work routine. Table 5 provides a summary of the final model for routine and Figure 3 depicts predicted work routine over 14 years based on gender and reasoning estimates from the final model.

Question 2: Are there Typical Trajectory Types of Work Environment Experiences over Time, and What Factors Differentiate Trajectory Groups?

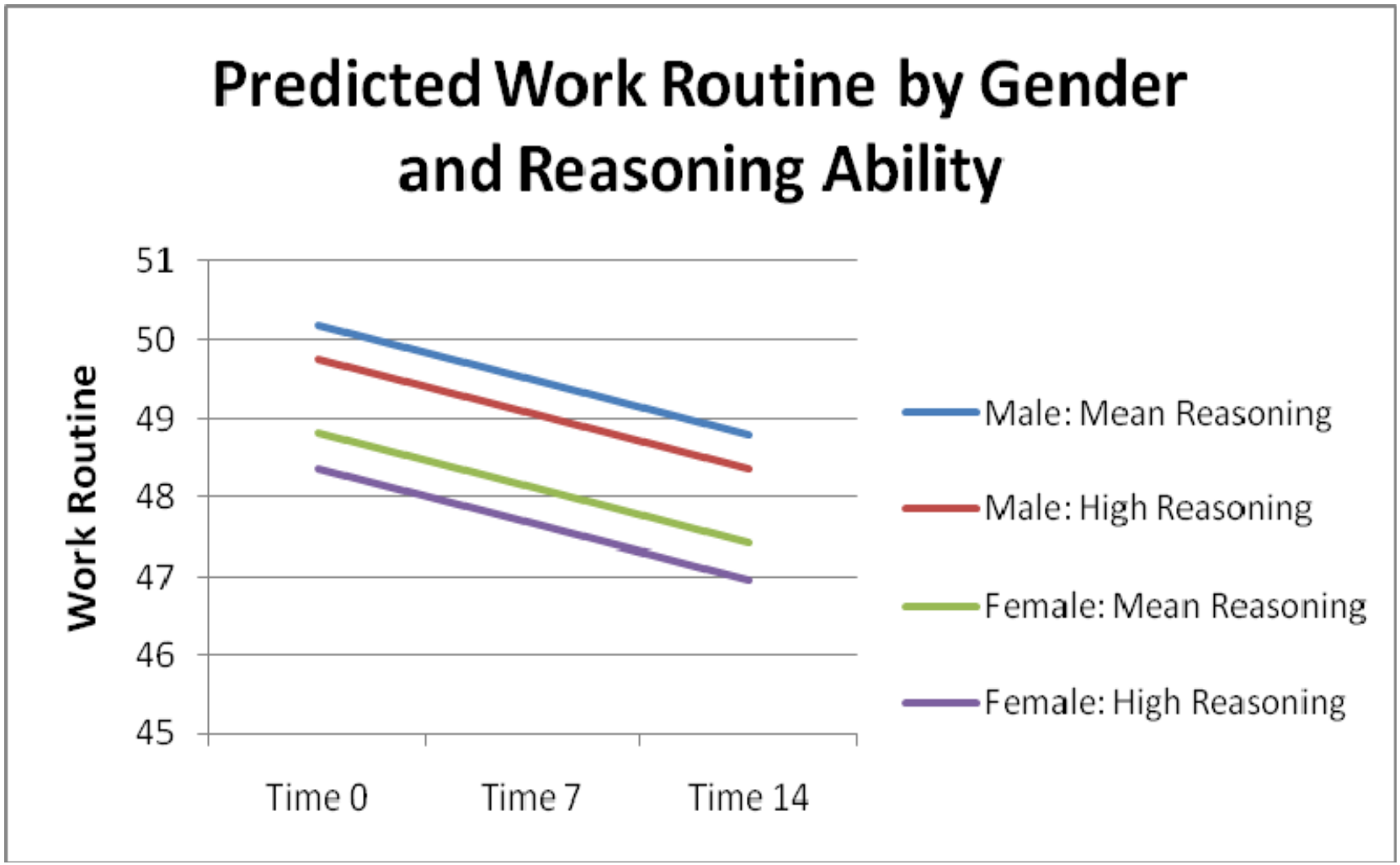
Statistical analyses were performed using SAS, version 9.1 (SAS Institute, 2005). Nagin mixture models were computed with SAS PROC TRAJ (Nagin, 1999). Individual analyses were conducted for work control, work complexity, and work routine to identify common patterns of work experience trajectories over a 21-year period. The best-fitting models for each outcome will be discussed individually below. The computational method is to first identify whether sub-groups showing similar trajectories exist in the sample, and to find the optimal number of such sub-groups using the Bayesian information criterion (BIC). BIC's preferred because it searches for the most parsimonious solution by favoring models with fewer groups (Kass & Raftery, 1995). Next, the ideal shape of each trajectory is examined, starting with quadratic slopes (Nagin, 1999). After the ideal number of groups and trajectory slopes are identified, covariates can then be added to examine factors that discriminate membership between groups.

Table 5

Growth curve parameter estimates for work routine (N = 362).

Parameter	Final Model		
	Estimate	SE	p-value
Fixed Effects:			
Intercept	52.0	.91	<.001
Time-in-study	-0.10	0.02	<.001
Reason	-0.09	0.04	<.01
Education	-0.01	0.08	<.92
Gender	-1.38	0.39	<.001
Variance Components:			
Residual Variance	18.00	1.0	<.001
Intercept Variance	8.1	1.2	<.001
Model Fit:			
REML Deviance	6560.7		
AIC	6564.7		
BIC	6572.9		
Number of Parameters	2		

Figure 3


Predicted Work Routine by Gender and Reasoning Ability
Work Routine
51
50
49
48
47
46
45
Time 0
Time 7
Time 14
Male: Mean Reasoning
Male: High Reasoning
Female: Mean Reasoning
Female: High Reasoning

Work Control

Nagin mixture models were computed to identify work control trajectory types over a 21-year period. To evaluate the optimal number of trajectory groups in the sample, it is customary to test best fitting models from one to ten groups. The number of groups resulting in the largest BIC (least negative) with significant group membership prediction identifies the best fitting model. In other words, if a five-group solution has a worse BIC than the six-group model, but some of the groups in the six-group solution are not significant, the five-group model would be the best fitting model. The analyses indicated that there are 3 groups of work control trajectories in the present sample. Table 6 lists the BIC for each model tested. Large standard errors indicated that the quadratic slope did not fit the three groups well. After testing various combinations of shapes, the best-fitting combination included a 3 group model where Group 1 had a zero-order shape illustrating stability across the 21 years ($p < .001$), Group 2 had a positive quadratic shape ($p < .05$), and Group 3 had a zero-order shape ($p < .001$). Groups 1 and 2 significantly predicted group membership at the ($p < .001$) level and Group 3 significantly predicted group membership at ($p < .01$). The final model had small standard errors for each trajectory shape, indicating good fit with the sample. Refer to Table 7 for means (SD) of work control across all occasions by group type and Figure 4 which illustrates the trajectory group types.

Group 1

A zero-order slope was the best fit for Group 1 (Y = 44.2; $p < .001$). The flat trajectory indicates that this group was relatively stable over the 21-year period in work control. The posterior probabilities indicated that 42.5% of the sample would be placed in Group 1 (N = 140; $p < .001$). The mean work control at T1 = 44.5 (SD = 5.6; Range = 33.9 – 63.3) was more than a half-standard deviation lower than the total sample at T1 (Mean = 49.7; SD = 8.0; Range = 33.9 – 68.7; Table 7). Group 1 was comprised of 83 men and 57 women, its' mean age at T1 = 48.9 (SD = 10.3; Range = 25 – 65) and mean years of education = 15.5 (SD = 2.7; Range = 7 – 20).

Table 6

Nagin modeling groups: Work control (N = 324).

# of Groups	BIC
1	-4231.09
2	-4137.29
3	-4135.69
4	-4141.47
5	-4145.59
6	-4144.35
7	-4149.68
8	-4163.84
9	-4182.82
10	-4186.69

Figure 4

Nagin group mixture modeling trajectories for work control over 21 years.

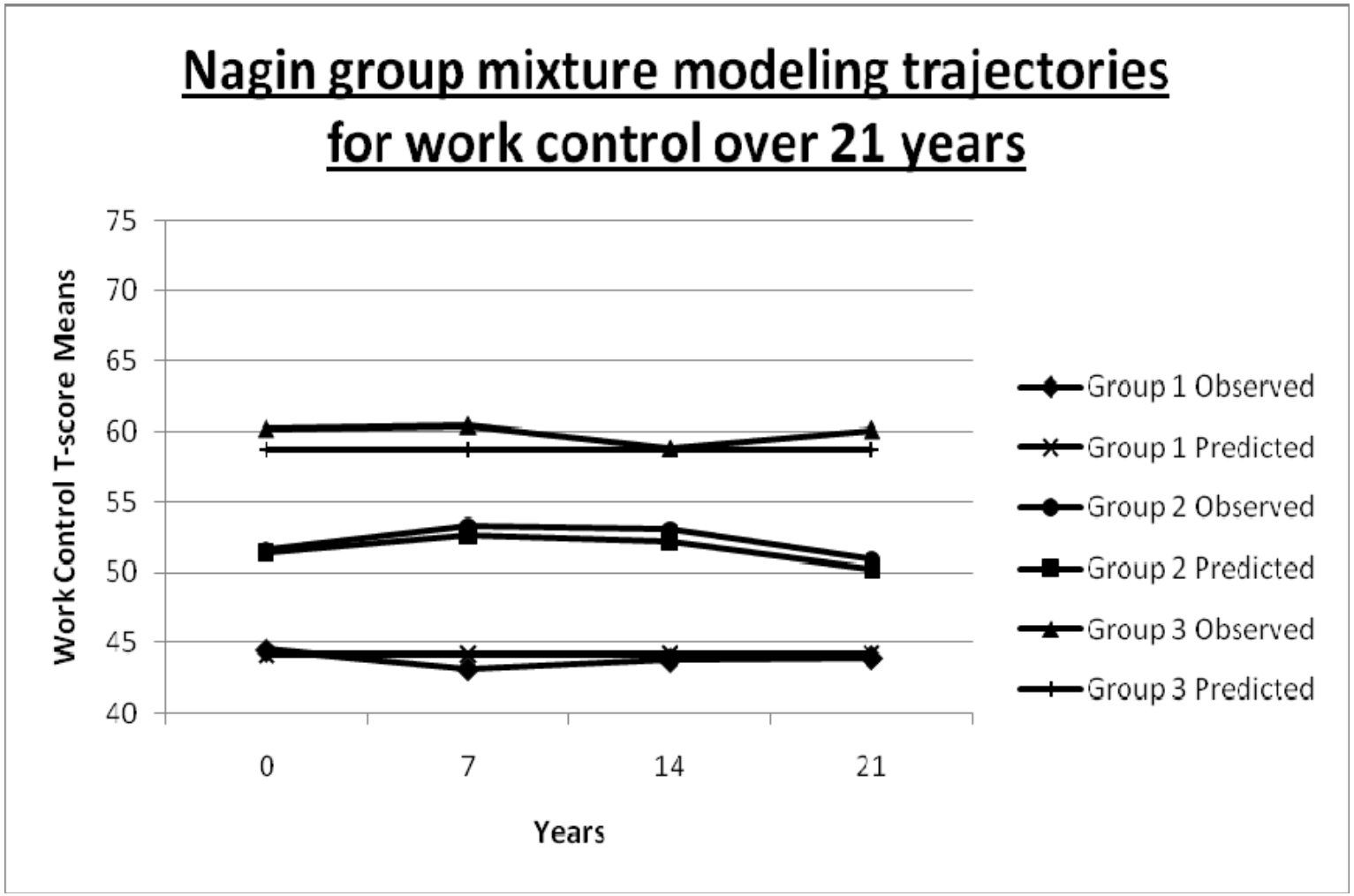


Table 7

Work control means (SD) by trajectory types and wave.

Trajectory Group	Time 1	Time 2	Time 3	Time 4
Total Sample (N = 324)	49.7 (7.9)	49.7 (8.0)	49.7 (8.1)	49.1 (8.1)
Group 1 (N=140)	44.5 (5.6)	43.2 (4.1)	43.8 (5.0)	44.0 (5.6)
Group 2 (N=144)	51.6 (6.5)	53.3 (6.0)	53.1 (6.8)	50.9 (7.0)
Group 3 (N=40)	60.2 (5.0)	60.4 (4.7)	58.8 (5.7)	60.0 (4.8)

Group 2

A quadratic shape was the best fit for Group 2 ($Y = 48.6 + 3.6T - .8T^2$; $p < .05$). The posterior probabilities indicated that 42.7% of the sample was in Group 2 (N = 144; $p < .001$). The mean work control at T1 = 51.6 (SD = 6.5; Range = 40.8 – 64.0), similar to the mean for the total sample (See Table 7). Group 2 showed patterns of gain in work control between T1 and T2, was relatively stable between T2 and T3, and had a slight decline between T3 and T4 (See Table 7). Based on posterior probability assignments, Group 2 was comprised of 73 men and 71 women, had an average age at T1 = 47.4 (SD = 10.9; Range = 23 – 65), and had an average of 15.4 years of education (SD = 2.5; Range = 10 – 20).

Group 3

A zero-order slope was the best fit for Group 3 ($Y = 58.7$; $p < .001$), indicating stability over the 21 years. At T1, the Group 3 mean work control level was roughly 1 standard deviation above the total sample's mean for work control (Mean = 60.2; SD = 5.0; Range = 48.7 – 68.7). Posterior probabilities indicated that 14.8% of the sample was assigned to Group 3 (N = 40; $p < .01$), with 19 men and 21 women. The average age at T1 for Group 3 = 44.6 (SD = 10.9; Range = 26 – 64) and Group 3 had an average of 14.8 years of education (SD = 2.3; Range = 12 – 20).

Covariates

After identifying the best-fitting number of trajectory types and slopes for work control, potential covariates were included in the analysis to discriminate group membership. All groups are compared to Group 1, with reports of multinomial logits for significant covariates providing probabilities of group membership based on tested covariates. Several covariate domains were tested individually and significant factors from each domain were then included in the final mode. The covariate domains tested included: demographics (age, education, sex), occupational changes (# job changes over 21 years, # profession changes over 21 years), cognitive function (PMA reasoning, PMA word fluency, Finding A's at T1, T4, and 21-year change), social engagement (social activities, communication activities, solitary activities), health status (objective and

subjective health status), and personality (neuroticism, extraversion, openness, agreeableness, conscientiousness).

Using start values from the three group (zero-order, quadratic, zero-order) model, individual covariate domains were included to discriminate membership. Among the demographic covariates, younger adults and women had a higher probability to be assigned to Group 3 compared to Group 1 ($p < .05$). Thus, both age and sex were retained for the final model. Education did not significantly differentiate Groups 2 and 3 from Group 1 and was not included. While the social engagement factors did not discriminate between Groups 1 and 3, the results indicated that members assigned to Group 2 were significantly more likely to have higher solitary ($p < .01$) and communication ($p < .05$) activities compared to Group 1, and both were retained for the final model. No occupational change, cognitive, or personality factors significantly discriminated group membership.

Based on covariate domain-specific analyses, the final model for work control covaried for age, sex, communication activities, and solitary activities (See Table 8). The final model (BIC = -4107.48) indicated that compared to Group 1, members assigned to Group 2 were significantly more likely to be involved in communication activities ($p < .05$) and solitary activities ($p < .05$). Further, the analysis indicated that younger adults and women were significantly more likely to be members of Group 3 compared to Group 1 ($p < .05$).

Table 8

The impact of age, gender, communication activities, and solitary activities on group membership probabilities: Work Control (BIC = -4107.48; N = 324).

	Group		
	1	2	3
Constant	-	-4.59 (1.65)	1.84 (2.17)
Age	-	0.0 (0.0)	0.05 (0.02)*
Gender	-	0.17 (0.35)	1.07 (0.45)*
Communication Activities	-	0.05 (0.02)*	-0.01 (0.03)
Solitary Activities	-	0.04 (0.02)*	-0.01 (0.03)

NOTE: Values reported are multinomial logit coefficients (standard Error). All groups are compared to Group 1.

* $p < .05$

Work Complexity

Nagin mixture models were run to identify the optimal number and shape of trajectory types for work complexity over 21 years. To ascertain the best-fitting number of trajectory types using SAS PROC TRAJ and BIC fit criteria, 1 through 10 quadratic group solutions were examined. Table 9 reports the BIC indices. The BIC became closer to zero with each additional group up to 5 groups where it was no longer a better fit. The four group solution resulted in the largest BIC and had significant group membership for all trajectory types (Group1: $p < .01$; Groups 2 and 3: $p < .001$; Group 4: $p < .05$). The BIC was further improved after evaluating the best-fitting shapes for each trajectory. After examining the trajectory shapes and testing various shape combinations, the best fitting model included 4 groups, 2 groups had zero-order slopes showing no change and 2 groups showed linear trajectories with a constant rate of change over the 21-year period. After finding the best-fitting shape for each trajectory type, all group shapes were significant ($p < .001$) and had small standard errors, indicating that the model was a good fit with the sample. Refer to Table 10 for mean work complexity by occasion and group, and Figure 5 for an illustration of the final trajectory groups.

Group 1

The best fitting model for Group 1 was a linear shape ($Y = 48.4 - 0.8T$; $p < .01$). The negative slope indicates that this group experienced gradual decline in work complexity over the 21-year period. At the first occasion, the mean work complexity for Group 1 was over a half-standard deviation lower than for the total sample at T1 (See Table 10) and declined to 44.3 (3.7) by the fourth occasion. The posterior probabilities indicated that 30.5% of the sample would be classified in Group 1 ($N = 93$; $p < .001$). Based on the posterior probabilities, Group 1 was comprised of 57 men and 36 women, with an average at T1 = 47.0 (SD = 10.7; Range = 23 – 65), and had an average of 15.0 years of education (SD = 2.6; Range = 7 – 20).

Table 9

Nagin modeling groups: Work complexity (N = 324).

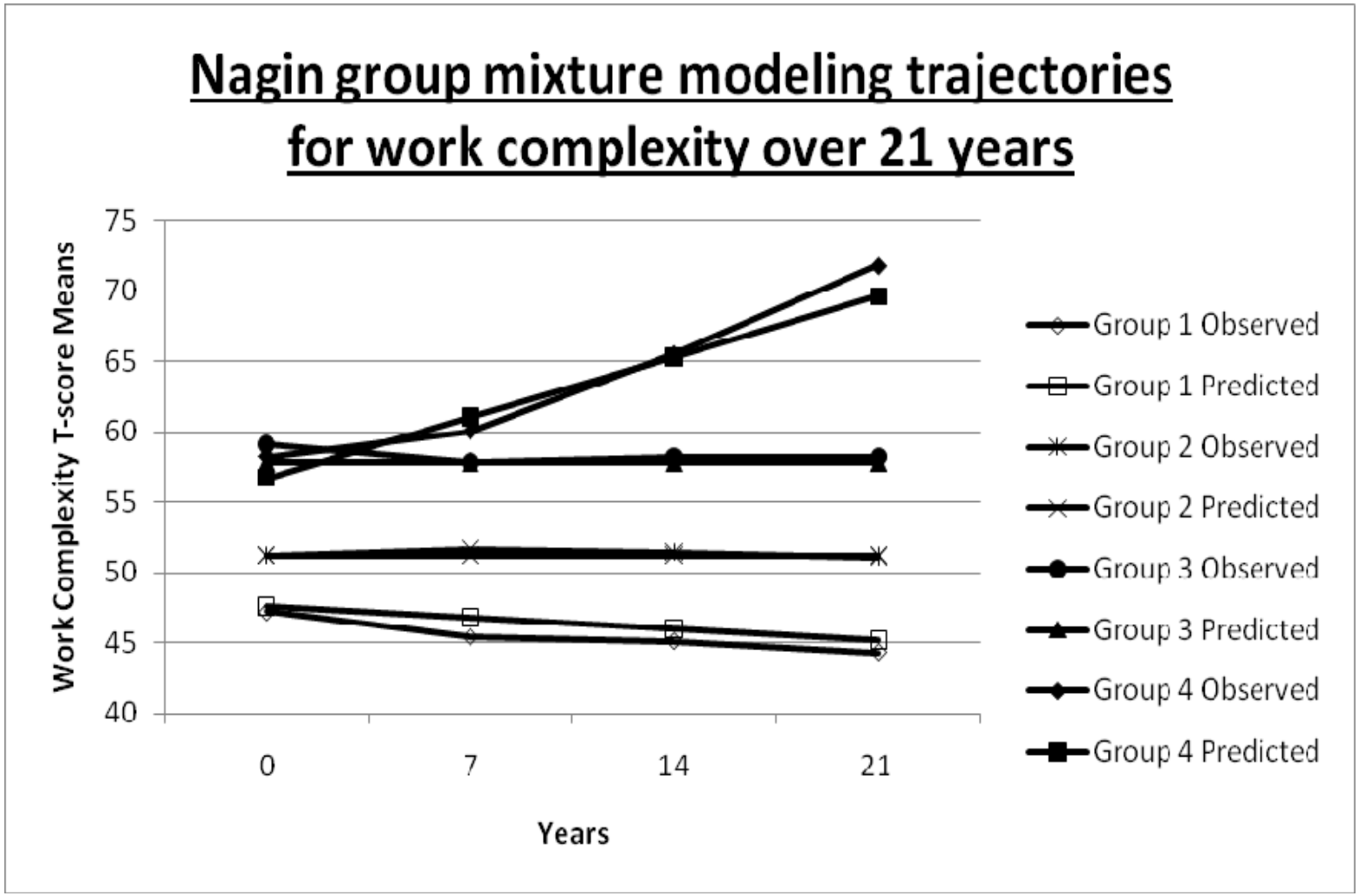
# of Groups	BIC
1	-3963.65
2	-3867.29
3	-3846.62
4	-3839.20
5	-3840.17
6	-3854.39
7	-3851.07
8	-3861.48
9	-3868.89
10	-3882.16

Table 10

Work complexity means (SD) by trajectory types and wave.

Trajectory Group	Time 1	Time 2	Time 3	Time 4
Total Sample (N = 324)	51.2 (5.9)	50.9 (5.8)	50.7 (6.0)	50.4 (6.8)
Group 1 (N = 93)	47.2 (4.3)	45.4 (3.5)	45.1 (3.5)	44.3 (3.7)
Group 2 (N = 185)	51.2 (4.2)	51.6 (4.3)	51.4 (3.8)	51.1 (4.6)
Group 3 (N = 40)	59.1 (6.9)	57.8 (4.8)	58.2 (5.0)	58.2 (5.3)
Group 4 (N = 6)	58.2 (3.4)	60.0 (9.1)	65.5 (4.3)	71.8 (4.0)

Figure 5. Nagin group mixture modeling trajectories for work complexity over 21 years.



Group 2

The best-fitting shape for Group 2 was zero-order, indicating stability over the 21-year period (Y = 51.2; $p < .001$). The mean work complexity level for Group 2 over the 21 years was close to the mean for the overall sample at all 4 occasions (See Table 10), indicating that Group 2 maintained an average level of work complexity. The posterior probabilities indicated that 54.6% of the sample (N = 185; $p < .001$) was in Group 2, comprised of 96 men and 89 women. The average age at T1 = 48.4 (SD = 10.9; range = 24 – 65) and individuals in Group 2 had an average of 15.5 years of education (SD = 2.5; Range = 11 – 20).

Group 3

The best-fitting shape for Group 3 was zero-order, illustrating stability across the 21 years (Y = 57.8; $p < .001$). The mean work complexity at T1 for Group 3 = 59.1 (6.9) was greater than a standard deviation higher than the mean for the whole sample at T1 (See Table 10). This high level of work complexity was maintained across the study for these individuals. Posterior probabilities indicated that 12.6% of the sample was classified in Group 3 (N = 40; $p < .001$). Group 3 included 20 men and 20 women, who had an average age at T1 = 46.0 (SD = 9.8; Range = 52 – 63) and an average of 15.5 years of education (SD = 2.7; Range = 12 – 20).

Group 4

The best-fitting shape for Group 4 was linear, indicating a gain in work complexity over the 21 years (Y = 52.4 + 4.3T; $p < .001$). The mean work complexity at T1 for Group 4 = 58.2 (3.4), more than a standard deviation above the mean for the entire sample (See Table 10). Further, the mean work complexity by T4 for Group 4 = 71.8 (4.0) was roughly 3 standard deviations higher than the total sample. The posterior probabilities indicated that only 2.2% of the sample was classified in Group 4 (N = 6; $p < .05$). Group 4 had 2 men and 4 women, with an average age at T1 = 49.8 (SD = 8.1; Range = 41 – 59) and an average of 15.7 years of education (SD = 2.9; Range = 12 – 19).

Covariates

Using start values from the four group (linear, zero-order, zero-order, linear) model, individual covariate domains were included to discriminate group membership and identify factors to be included in the final model. The only demographic factor to significantly discriminate group membership was education, such that individuals assigned to Group 2 were significantly more likely to have more years of education compared to Group 1 ($p < .05$). Thus, education was retained for the final model while age and sex were excluded. The occupational change factors differentially discriminated between Groups 3 and 4 from Group 1. Specifically, individuals with few job changes were significantly more likely to be assigned to Group 3 compared to Group 1 ($p < .05$), while individuals with fewer profession changes had a higher probability of being assigned to Group 4 compared to Group 1 ($p < .05$). Relative to the health status domain, both subjective and objective health status (at 1991) were retained. Membership in Groups 2 and 4 was significantly more probable for individuals with higher subjective health status ($p < .01$) and lower objective health status ($p < .05$) compared to Group 1. The cognitive and personality domains failed to discriminate group membership. Thus, the final model covaried for education, number of job changes, number of profession changes, subjective health status, and objective health status.

The final model (BIC = -2838.56) indicated that compared to Group 1, individuals had a higher probability of membership in Group 2 compared to Group 1 if they had high subjective health status ($p < .01$), and there was a trend of fewer job changes ($p = .07$; See Table 11) associated with Group 2 members compared to Group 1. Individuals in Group 3 were more likely to have fewer job changes ($p < .05$) and showed a trend of higher subjective health status ($p = .08$) compared to Group 1. Finally, those assigned to Group 4 did not significantly discriminate by the included covariates compared to Group 1; however there was a trend such that membership in Group 4 was more probable for individuals with high subjective health status ($p = .08$).

Table 11

The impact of age, education, profession changes, and word fluency on group membership probabilities: Work Complexity (BIC = -2838.56; N = 324).

	Group			
	1	2	3	4
Constant	-	-1.80 (2.28)	-3.23 (2.66)	-3.42 (4.77)
Years of Education	-	0.08 (0.10)	0.12 (0.12)	0.09 (0.24)
# Job Changes	-	-0.20 (0.11)	-0.57 (0.27)*	-0.01 (0.27)
# Profession Changes	-	0.03 (0.16)	0.27 (0.19)	-0.64 (0.40)
Objective Health Status	-	-0.06 (0.04)	-0. 06 (0.05)	-0.10 (0.09)
Subjective Health Status		0.10 (0.03)**	0.07 (0.04)	0.13 (0.08)

NOTE: Values reported are multinomial logit coefficients (standard Error). All groups are compared to Group 1.
* $p < .05$
** $p < .01$

Work Routine

Nagin mixture models were run to identify the optimal number and shape of trajectory types for work routine over 21 years. To identify the best-fitting number of trajectory types using SAS PROC TRAJ and BIC model fit criteria, 1 through 10 group solutions, all quadratic, were examined. Table 12 reports the BIC indices. Based on the BIC reports, a 3 group solution was the best fit; however high standard error estimates for the 3 quadratic groups suggested that the model would be improved after testing different shapes for the groups. After examining the trajectory shapes and testing various shape combinations, the best fitting model included 3 groups, where Group 1 was linear, Group 2 was zero-order, and Group 3 was cubic (BIC = -3626.74). The shapes for Groups 1 and 2 were significant ($p < .001$) and had significant prediction of group membership ($p < .001$). The cubic term for Group 3 was not significant ($p = .14$); however, the cubic shape approached significance and was the best fit compared to zero-order, linear, and quadratic shapes, and it significantly predicted group membership ($p < .05$). The final 3-group model and slopes resulted in small standard errors, further indication that the model was a good fit with the sample. Refer to Table 13 for the means of work routine by group and Figure 6 for an illustration of the final trajectory groups.

Group 1

The best-fitting slope for Group 1 was linear ($Y = 48.2 - 0.8T$; $p < .001$), indicating regular decline in work routine across the 21-year period. As illustrated in Table 13, the mean work routine at T1 for Group 1 = 47.2 (SD = 4.2), roughly a half standard deviation lower than the average work routine for the whole sample at T1 (See Table 13). For Group 1, work routine gradually declined over the 21 years, ending at an average of 46.1 (SD = 4.2) at the fourth occasion. The posterior probabilities indicated that 41% of the sample (N = 135) was classified

Table 12

Nagin modeling groups: Work routine (N = 324).

# of Groups	BIC
1	-3684.12
2	-3638.26
3	-3634.80
4	-3639.46
5	-3650.56
6	-3656.92
7	-3668.21
8	-3674.55
9	-3685.07
10	-3697.60

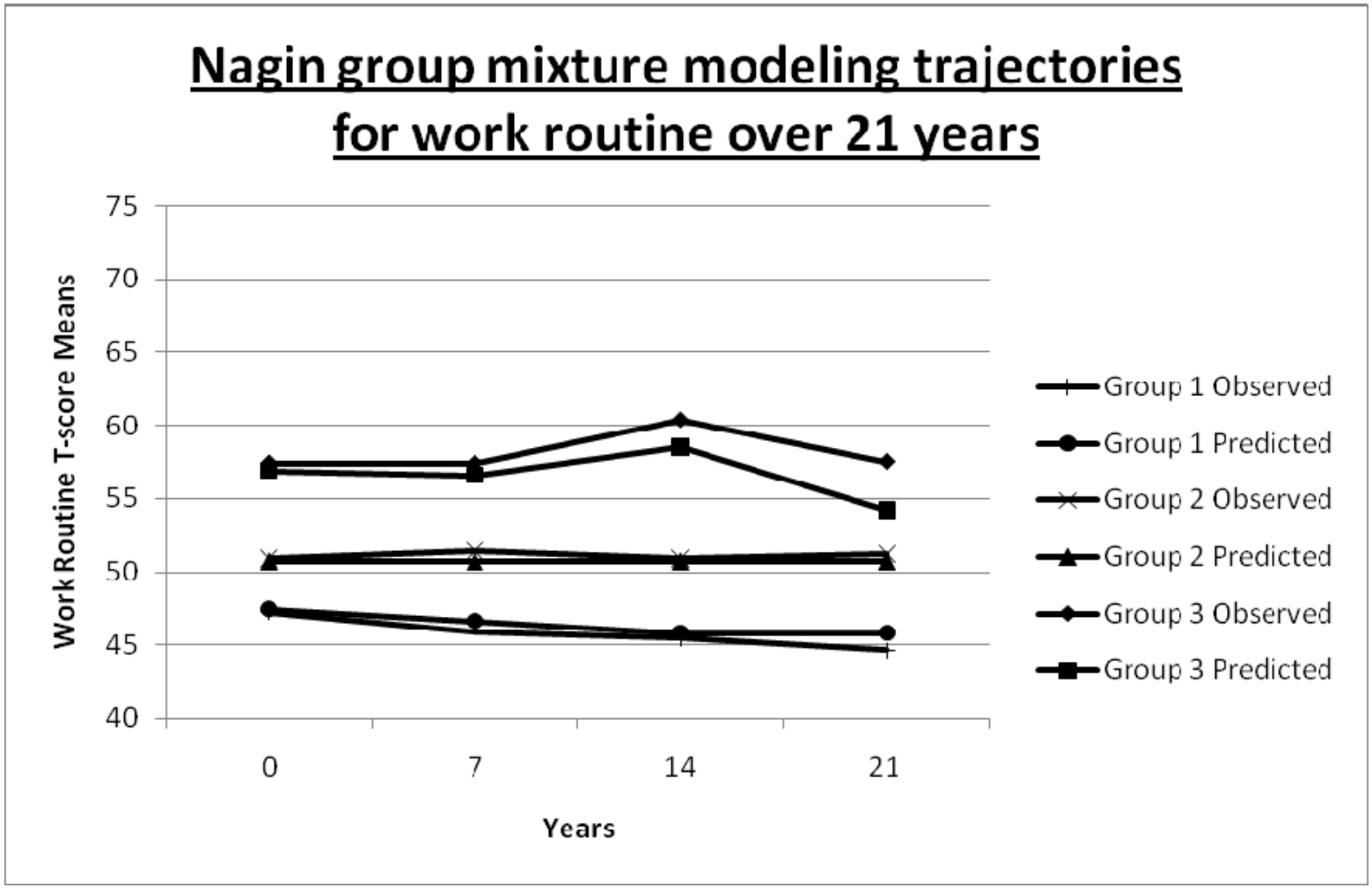
Table 13

Work routine means (SD) by trajectory types and wave.

Trajectory Group	Time 1	Time 2	Time 3	Time 4
Total Sample (N = 324)	49.7 (4.8)	49.5 (5.2)	49.1 (5.4)	48.7 (5.8)
Group 1 (N = 135)	47.2 (4.2)	45.9 (4.2)	45.4 (4.4)	46.1 (4.2)
Group 2 (N = 175)	50.9 (4.1)	51.4 (3.8)	50.9 (3.7)	51.2 (4.5)
Group 3 (N = 14)	57.4 (3.7)	57.4 (5.7)	60.4 (3.6)	57.5 (5.7)

Figure 6

Nagin group mixture model trajectories for work routine over 21 years.



in Group 1 ($p < .001$). Further, Group 1 was comprised of 69 men and 66 women, with an average age at T1 = 46.1 (SD = 11.2; Range = 24 – 65) and an average of 15.4 years of education (SD = 2.5; Range = 11 – 20).

Group 2

The best-fitting shape for Group 2 was zero-order, indicating that individuals in this group were stable in work routine across the 21 years (Y = 50.7; $p < .001$). The mean work routine at T1 for Group 2 = 50.9 (SD = 4.1), close to the average for the entire sample at T1 (M = 49.7; SD = 4.8) and did not significantly change over the 21 years. The posterior probabilities indicated that 53.9% of the present sample was classified in Group 2 (N = 175; $p < .001$). Specifically, Group 2 was comprised of 96 men and 79 women, who had an average age at T1 = 46.1 (SD = 11.2; Range = 24 – 65) and an average of 15.4 years of education (SD = 2.5; Range = 11 – 20).

Group 3

The best-fitting shape for Group 3 was cubic, showing an overall pattern of gain and decline over the 21-year period ($Y = 67.8 – 19.0T + 9.5T^2 – 1.4T^3$; $p = .14$). Individuals in Group 3 had an average work routine at T1 = 57.4 (SD = 3.7), roughly 1.5 standard deviations higher than the total sample at T1 (See Table 13). The average work routine was stable between T1 and T2, experienced gain in work routine between T2 and T3, and decline in work routine between T3 and T4. The resulting mean work routine at T4 (M = 57.5; SD = 5.7) returned to the levels experienced at T1 and T2. The posterior probabilities indicated that 5.1% of the sample (N = 14) was assigned to Group 3 ($p < .05$). Specifically, Group 3 included 10 men and 4 women, with an average age at T1 = 51.9 (SD = 9.0; Range = 30 – 64) and an average of 13.6 years of education (SD = 1.7; Range = 12 – 17).

Covariates

Using start values from the 3 group (linear, zero-order, cubic) solution, domains of covariates were added individually into the model for work routine. Among the demographic

covariates, the results indicated that older individuals and those with more education had a higher probability to be assigned to Group 2 compared to Group 1 ($p < .05$), and older adults were also significantly more likely to be assigned to Group 3 compared to Group 1 ($p < .05$). Gender was not significantly different in Groups 2 and 3 compared to Group 1 and was not included in the final model. Among the occupational change variables, the number of job changes was not significant; however, individuals with more profession changes were significantly more likely to be a member of Group 1 compared to Group 3. The only significant cognitive factor was PMA word fluency at the fourth occasion, such that individuals with better word fluency were more likely to be in Group 1 compared to Group 3. No social engagement, health, or personality factors significantly discriminated group membership and were not included in the final model.

Based on the covariate domain-specific model analysis described above, the final model for work routine included age, education, # of profession changes, and word fluency (at T4). The final model (BIC = -336.2) indicated that compared to Group 1, individuals with more education were significantly more likely to be members of Group 2 ($p < .05$; See Table 14). Further, there were two trends which indicated that older individuals had a higher probability of being assigned to Group 2 compared to Group 1 ($p = .07$) and that individuals with higher functioning word fluency at time 4 were more likely to be assigned to Group 1 compared to Group 2 ($p = .06$). The only significant covariate to discriminate between Groups 1 and 3 was word fluency at T4, such that individuals with high functioning word fluency at time 4 had a greater probability of being assigned to Group 1 compared to Group 3 ($p < .05$).

Table 14

The impact of age, education, profession changes, and word fluency on group membership probabilities: Work Routine (BIC = -3316.02; N = 324).

	Group		
	1	2	3
Constant	-	-7.30 (4.80)	2.57 (4.73)
Age	-	0.08 (.04)	0.04 (0.04)
Years of Education	-	0.48 (0.22)*	-0.14 (0.27)
# Profession Changes	-	0.03 (0.20)	-0.07 (0.21)
Word Fluency	-	-0.04 (0.02)	-0.05 (0.03)*

NOTE: Values reported are multinomial logit coefficients (standard Error). All groups are compared to Group 1.
* $p < .05$

Question 3: What Domains are Associated with Cognitive Change Trajectories in Older Adults?

Statistical analyses were performed using SAS, version 9.1 (SAS Institute, 2005). Repeated-measures multi-level modeling (MLM) was conducted with SAS proc mixed. Model specifications followed three steps including empty models, unconditioned growth curve models, and conditioned growth curve models. Linear mixed models (empty models) were first estimated using SAS proc mixed to examine the pattern of individual differences in verbal memory, inductive reasoning, and verbal ability across three test waves. Empty models, which examine the pattern of each dependent variable with random intercepts, were run to compute means and interclass correlations. Restricted maximum likelihood (REML) estimates were used to report the parameter estimates and assess random effects. Degrees of freedom were estimated with the Satterthwaite method (Browne & Rasbash, 2004).

Verbal Memory

The empty model for verbal memory identified an interclass correlation coefficient (.62), indicating that 62% of the variance in memory across the three waves was attributed to between persons and 38% to intraindividual variance. The intercept estimate for the empty model also indicated that before predictors are added, the mean memory score is 45.2 *t-score units*. Polynomial models tested fixed effects for age, age^2, and time in study. Model examination indicated significant linear age effects, while the fixed effects for quadratic age and time-in-study were not significant. Significant individual differences in linear age slopes were also found so a random effect for linear age was included in the model.

Parameter estimates for the final model of memory can be found in Table 15. The results indicated that relative to a 60-year old, every increased year of age was associated with a 0.16 *t-score* decline in memory function ($p < .001$), every increased *t-score* unit of worker control was associated with a .11 *t-score* gain in memory function ($p < .05$), every increased *t-score* unit of

Table 15

Growth curve parameter estimates for verbal memory (N = 272).

Parameter	Final Model		
	Estimate	SE	p-value
Fixed Effects:			
Intercept	19.38	3.8	<.001
Age	-.16	.04	<.001
Worker Control	.11	.05	<.05
Perceptual Speed	.43	.05	<.001
Gender	3.69	.83	<.001
Education	.42	.15	<.01
Variance Components:			
Residual Variance	21.2	1.7	<.001
Intercept Variance	39.2	8.0	<.001
Intercept-Linear Variance	-0.6	.4	= 0.13
Linear Variance	.08	.03	<.01
Model Fit:			
REML Deviance		5400.1	
AIC		5408.1	
BIC		5422.5	
Number of Parameters		4	

perceptual speed (faster speed) is associated with .43 *t-score* gains in memory ($p < .001$), women outperform men by 3.7 *t-score* units of memory function ($p < .001$), and every year of education beyond high school is associated with a .42 *t-score* gain in memory function ($p < .01$). Refer to Figure 7 for verbal memory predicted by model estimates of age, work control, and perceptual speed.

Inductive Reasoning

An interclass correlation coefficient (.67) was obtained for reasoning function, indicating that 67% of the variance in memory across the three waves was attributed to between persons and 33% to intraindividual variance. The empty model intercept estimate = 46.9 *t-score* units, which provides the reasoning score mean before predictors are added to the model. Polynomial models tested fixed effects for age, age^2, and time in study. Model examination indicated significant linear and quadratic age effects, while the fixed effect of time-in-study was not significant. Significant individual differences in linear age slopes were also found. A random effect for linear age was therefore included.

Model parameter estimates for reasoning can be found in Table 16. Results indicated that for a 60-year old, every additional year of age was associated with a .13 *t-score* decline in reasoning function ($p < .01$), individuals employed during all 3 waves throughout the 14-year period averaged .14 *t-score* units higher compared to individuals who worked during only 1 or 2 waves of measurement ($p < .05$), every increased *t-score* unit of perceptual speed (faster speed) was associated with a .54 *t-score* gain in reasoning ability ($p < .001$), and every extra year of education beyond the high school level was associated with .25 more *t-score* units of reasoning ability ($p < .05$). The significant fixed effects included in the final model resulted in quadratic age as no longer significant. Refer to Figure 8 for an illustration of inductive reasoning predicted by estimates from the final model of age, work status, and perceptual speed.

Figure 7

Verbal memory predicted by age, work control, and perceptual speed.

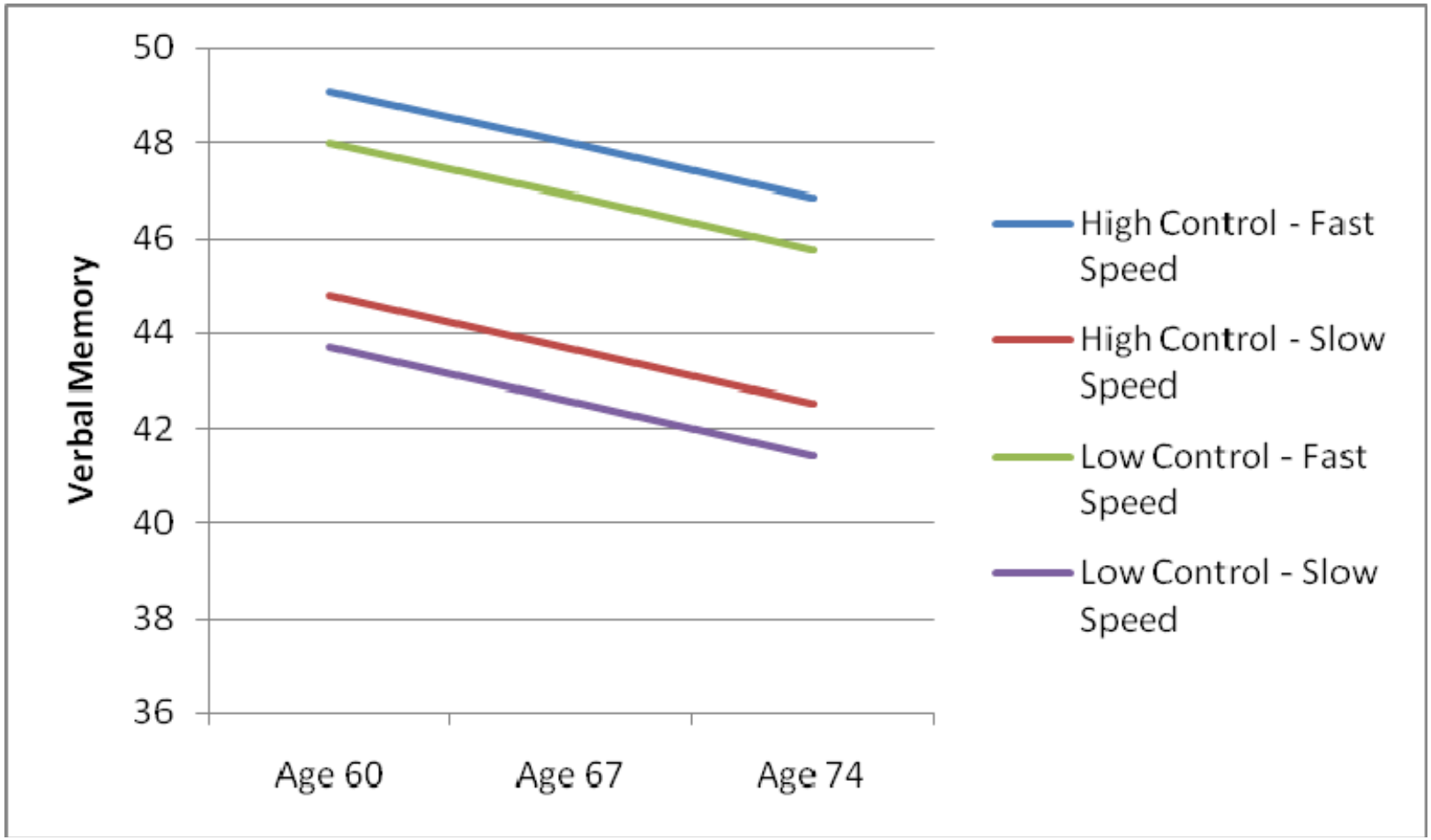


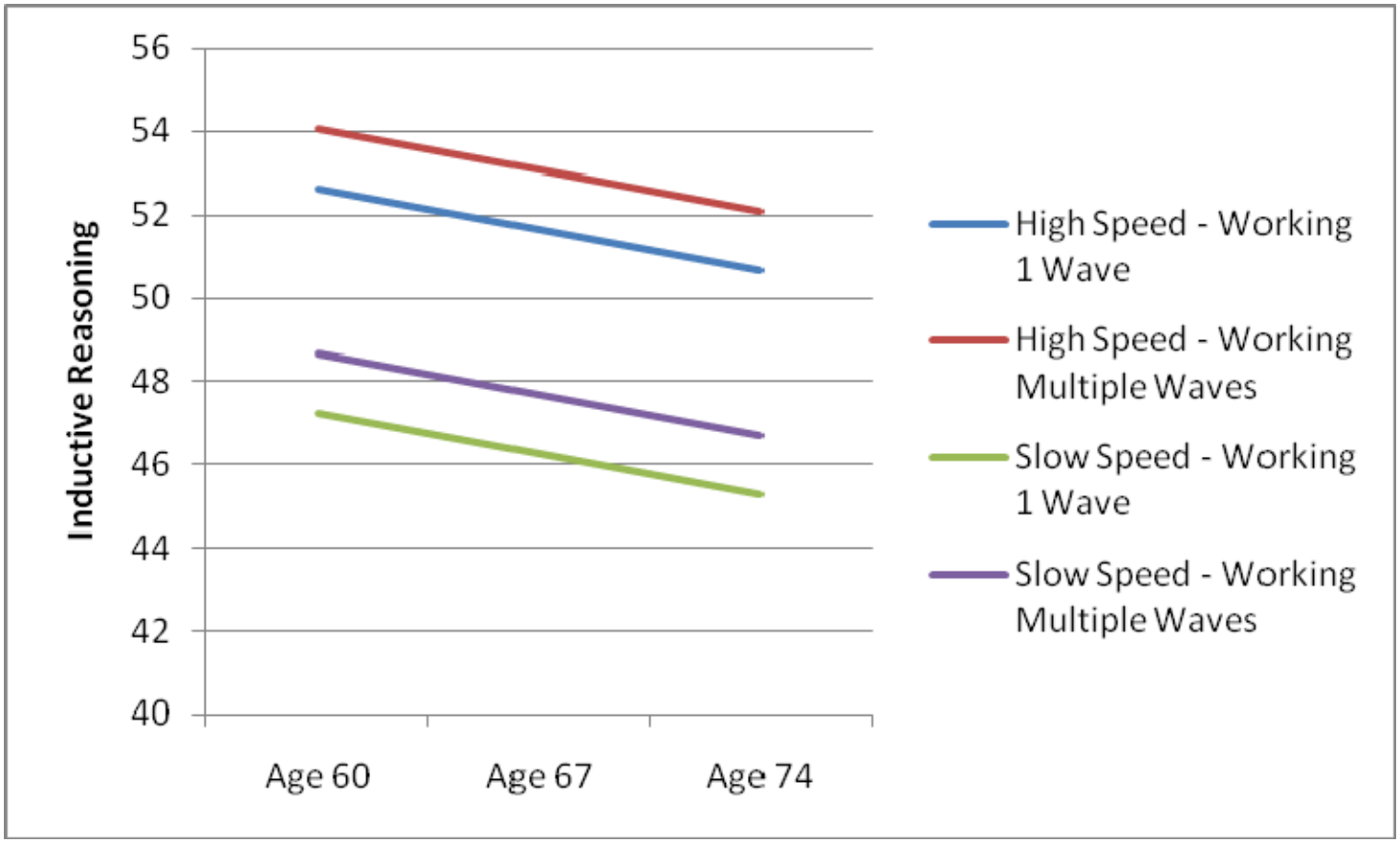
Table 16

Growth curve parameter estimates for inductive reasoning (N = 272).

Parameter	Final Model		
	Estimate	SE	p-value
Fixed Effects:			
Intercept	22.93	1.61	<.001
Age	-.136	.05	<.01
Age^2	0.00	0.00	= .43
Work Status	1.42	.59	<.05
Speed	.54	.03	<.001
Education	.25	.11	<.05
Variance Components:			
Residual Variance	5.12	.04	<.001
Intercept Variance	30.7	3.9	<.001
Intercept-Linear Variance	-0.5	.15	<.001
Linear Variance	.03	.01	<.001
Model Fit:			
REML Deviance		4483.3	
AIC		4491.3	
BIC		4505.7	
Number of Parameters		4	

Figure 8

Inductive reasoning predicted by age, work status, and perceptual speed.



Verbal Ability

An empty model was run for verbal ability indicating that the mean verbal ability = 51.2 *t-score* units. The interclass correlation for verbal ability was computed to equal .84, indicating that 84% of the variability in verbal ability was due to between person differences. To estimate time, age convergence was tested and the assumptions held indicating no cohort effects in the sample. Thus, a time-in-study approach was not needed. Polynomial models tested linear and quadratic fixed age effects for verbal ability, where the inclusion of fixed quadratic age was significant ($p < .001$) and negative, rendering the fixed linear age term not significant ($p = .12$). Finally, model estimation indicated an improved model fit after adding random linear age effects ($p < .001$). The final time estimation for verbal ability included fixed terms for linear and quadratic age, and a random effect for linear age.

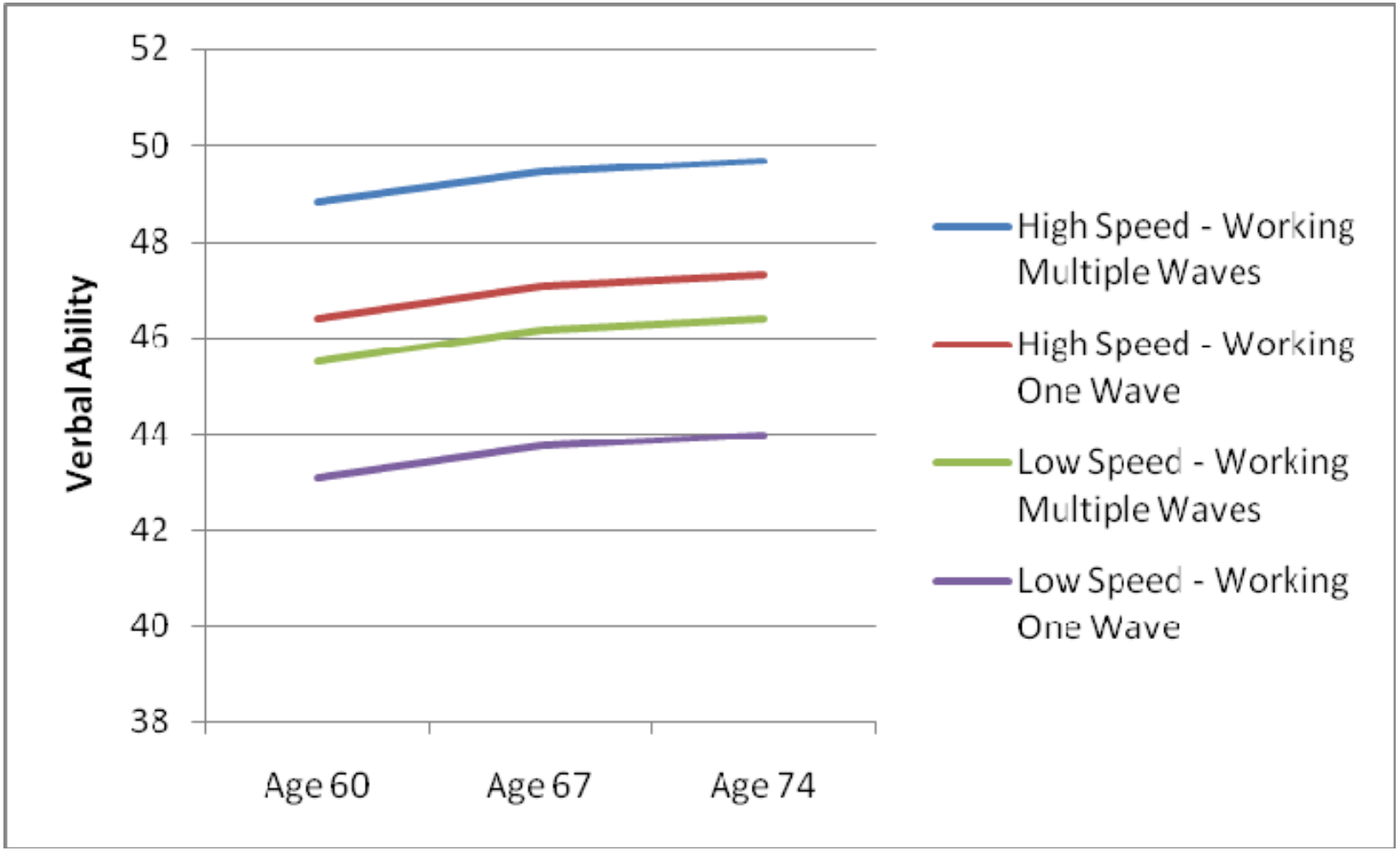
After running model estimations with each covariate, the final model estimations can be found in Table 17. Using restricted maximum likelihood estimation (REML) fit statistics, the final model for verbal ability indicated that for a 60-year old with a high school education, every year older was associated with a .12 *t-score* gain ($p < .05$), every year older^2 was associated with a .004 *t-score* unit decline ($p < .05$), working during more than one wave of measurement was associated with a 2.4 *t-score* gain ($p < .01$), every extra year of education was associated with a 1.1 *t-score* higher verbal ability ($p < .001$), every increased *t-score* unit of perceptual speed was associated with a .32 *t-score* gain ($p < .001$), every raw unit gain in objective health status was associated with .03 *t-score* gain ($p = .05$), and being a woman was associated with a 2.8 *t-score* higher level compared to men ($p < .001$). Refer to Figure 9 for verbal ability predicted by parameter estimates from the final model for age, work status, and perceptual speed.

Table 17

Growth curve parameter estimates for verbal ability (N = 272).

Parameter	Final Model		
	Estimate	SE	p-value
Fixed Effects:			
Intercept	28.24	1.97	<.001
Age	.12	.05	<.05
Age^2	-0.004	0.00	<.05
Work Status	2.4	.77	<.01
Education	1.1	.13	<.001
Perceptual Speed	.33	.04	<.001
Objective Health Status	.03	.02	=.05
Gender	2.8	.78	<.001
Variance Components:			
Residual Variance	5.77	.49	<.001
Intercept Variance	50.0	6.0	<.001
Intercept-Linear Variance	-0.9	.22	<.001
Linear Variance	.05	.01	<.001
Model Fit:			
REML Deviance		4571.5	
AIC		4579.5	
BIC		4593.8	
Number of Parameters		4	

Figure 9. Verbal ability predicted by age, perceptual speed, and work status.



Chapter 5

DISCUSSION

The aim of the present thesis was to identify patterns and predictors of psychosocial work experiences across adulthood, and to examine the association between cognitive function and work experiences during the transition from young to middle adulthood, and in late life. This section includes a review and discussion of the major findings. First, factors associated with psychosocial work experiences in the transition from young to middle aged adults will be discussed. Second, variations in trajectory patterns for those same work experience domains across adulthood will be described, as well as factors significantly associated with trajectory membership. Third, patterns of individual change in cognitive function in older adults will be discussed in relation to work variables and theoretically important controls. Lastly, the strengths and limitations of the study, and future directions will be addressed.

Overview of Main Findings

The purpose of the present study was to examine trajectories of psychosocial work experiences across adulthood, predictors of the trajectories, and how work experiences relate to cognitive function in young and older adults. Specifically, the domains of work complexity, work control, and work routine were studied, as well as abilities representing crystallized and fluid cognitive function. The work by Schooler (Schooler, 1984; Schooler et al., 1999, 2004) has indicated an association between psychosocial work experiences and general cognitive ability. Specifically, Schooler and colleagues (1999, 2004) found that the accumulation of substantively complex work was the strongest predictor of higher intellectual flexibility. However, further research is needed on the association of work domains with cognitive abilities showing different age-related patterns of change across adulthood. Refer to Table 18 for a summary of major findings.

Table 18

Summary of key findings: Research questions 1, 2, and 3.

Research Question	Outcome Domain	Trajectory & Sub-Group	Baseline Work Level	Percent of Sample	Predictors/Correlates
1	Work Control/Complexity	Stable	--	100%	--
	Work Routine	Linear Decline	--	100%	Reasoning ability – decline in routinization Time – decline in routinization Women – lower routinization Male – higher routinization
2	Work Control	Stable - Group 1	Low	43%	--
		Gain/Loss - Group 2	Average l	42%	More Activity Engagement than Group 1
		Stable - Group 3	High	15%	More Women, Young Adults than Group 1
	Work Complexity	Linear Decline - Group 1	Average	31%	--
		Stable - Group 2	Average	55%	Higher Health Status than Group 1
		Stable - Group 3	High	13%	Fewer Job Changes than Group 1
		Linear Gain-Group 4	High	2%	Higher Health Status than Group 1

	Work Routine	Linear Decline-Group 1	Average Routine	41%	--
		Stable (Group 2)	Average Routine	54%	Higher Educational Attainment than Group 1
		Cubic – Mid Study Spike (Group 3)	High Routine	5%	Lower Word Fluency than Group 1
3	Verbal Memory	Linear Decline	--	100%	Gain in Age – Decline in Memory Less Supervision – Gain in Memory Faster Speed – Gain in Memory Women – Higher Memory More Education – Higher Memory
	Inductive Reasoning	Linear Decline	--	100%	Gain in Age – Decline in Reasoning Continued Employment – Gain in Reasoning Faster Speed – Gain in Reasoning More Education – Higher Reasoning
	Verbal Ability	Linear Gain, Slight Quadratic Slowing	--	100%	Gain in Age – Gain in Verbal Ability Continued Employment – Gain in Verbal Ability More Education – Higher Verbal Ability Faster Speed – Gain in Verbal Ability Better Health – Higher Verbal Ability Women – Higher Verbal Ability

Question 1

The first major question addressed the influence of cognitive ability and demographics on experiences of work complexity, control, and routine during the transition from young to middle adulthood. A major question in the literature (Schooler et al., 2004) regards the direction of the work-cognition association. While it is possible that certain work environment conditions influence cognitive function later in the work life (Schooler et al., 2004; Brunner, 2005; De Frias & Schaie, 2001), in the young adulthood transition, there is literature to suggest that individuals with different levels of cognitive function self-select into different types of work environments (Bajema, 1968; Heckman et al., 2006; Wooten et al., 1994). For example, Bajema (1968) found that cognitive ability and educational attainment were highly correlated in a sample of adolescents and young adults, and both were positively associated with an individual's future occupational status. Hence, the transition from young to middle adulthood is of particular interest; it is important to examine whether baseline cognitive abilities in early adulthood are associated with the psychosocial work experiences of control, complexity and routine. Cognitive function in young to middle aged adults is relatively stable, although there is evidence that processing speed begins to decline in the early 20's and there are individual differences in the rates of cognitive change (Christensen et la., 1999; Schaie, 2005). However, due to the normative cognitive stability in early adulthood, it was of interest to associate cognitive function with work experience change.

Overall, routininization in work demands was the only work domain exhibiting a change trajectory over the 14 year period. Specifically, adults transitioning from young to middle age showed linear decline in work routine over time. Over the 14-year period, routine had mean change of -1.5 t-score units. Lower routine was associated with higher reasoning ability and women reported less routinized work demands. While it was surprising that routine was the only domain to produce significant associations, it was also the most distinct of the three psychosocial work domains. Remember that while complexity and control were positively correlated in the present study, routine was not significantly associated with either. It is possible that in the present

sample examining work patterns in early adulthood, routine was the only domain to exhibit significant change over time due to the nature of entry-level jobs typical of younger adults. For example, it is plausible that young workers begin work with a small set of specific tasks, and overtime are given additional tasks to complete, creating a pattern of increased variety of work overtime. That this pattern of change in routine was not also associated with change in control and complexity highlights the importance of examining the psychosocial experiences individually, and also why one cannot assume that occupational status is an adequate measure of work experience. The literature would suggest that because occupational status is associated with work complexity, control, and routine (Schooler, 1984), all psychosocial domains would change together. However the present study of work experience in early adulthood has shown that the association is not that simple. As reported in the results, both work control and work complexity exhibited relative stability, with 14 year change of only 0.2 t-score units for control and -.01 for complexity. Thus, in the young to middle aged adults, there was very little intraindividual change experienced on average for both work control and work complexity in the present sample.

Question 2

The second question identified subgroups of individuals showing differing change trajectories for work complexity, work control, and work routine over a 21-year period. Significantly distinct trajectory groups were found for all three work domains. However, trajectories for subgroups differed by the slope of the change trajectory and in the number of subgroups found for each work domain. All trajectory groups will be described in detail and the associated covariates will be discussed in later sections.

Three trajectory types were identified for work control: low control (high supervision), stable (Group 1); average control, quadratic change (Group 2), illustrating gain and then decline in control around the sample mean; and high control (low supervision), stable (Group 3). In addition, four trajectory groups were identified for work complexity. Group 1 (average complexity, linear decline) had an intercept at the sample mean on complexity and experienced

linear decline over time. Group 2 (average complexity, stable) exhibited mean level stability in work complexity over time. Group 3 (high complexity, stable) had high, stable levels of work complexity over time, and Group 4 (high complexity, linear gain) had an intercept above the sample mean (high complexity) and exhibited moderate linear gain over time. Finally, there were three groups with differing trajectories of work routine. Group 1 (average routine, linear decline) had an intercept on work routine slightly below average, and illustrated gradual linear decline over time. Group 2 (average routine, stable) exhibited a trajectory of average level, stable routine over time. Lastly, Group 3 (high routine, 14-year gain) had a trajectory of high routine across the study, with a spike at the third occasion (after 14 years).

The third question addressed the impact of psychosocial work experiences in older adults on cognitive change over 14 years. Each cognitive outcome (verbal memory, inductive reasoning, and verbal ability) illustrated significant change over the 14-year period in the present sample of older workers. Specifically, both verbal memory and inductive reasoning, examples of fluid cognitive abilities, showed patterns of general decline over the course of the study. This finding is supported by past research suggesting that fluid abilities typically begin normative declines in the mid 60's (Finkle et al., 2003; Schaie, 2005). Also concordant with previous findings (Cattell, 1963), crystallized cognitive function measured by verbal ability in the present study of older workers, showed a pattern of gain over the 14 years, with slight leveling off by the end of the study. This supports past findings that crystallized abilities gain well into late life. Further, inductive reasoning, verbal memory, and verbal ability each had significant interindividual variability in the rates of change. In other words, individuals in the present study significantly varied in how quickly they changed in their cognitive function. This trajectory pattern also supported past research, which finds high interindividual variability in cognitive change (Christensen et al., 1999). The specific findings for all three questions and links to existing research will be discussed further.

Predictors of Psychosocial Work Experiences in the Transition from Young to Middle Age

Work Control and Work Complexity

As discussed earlier, it was surprising that neither work control nor work complexity illustrated change over the 14 year period in the present study. It was hypothesized that there would be change in all three psychosocial work environment domains for young and middle aged adults based on the existing literature (Gelissen & de Graaf, 2006). For example, Gelissen and de Graff (2006) found that younger adults had more changes in occupational status compared to older workers. This led to the hypothesis that changes in work control and work complexity would also be present. It was also expected that young to middle aged women in particular would experience significant change in work control and work complexity, due to increased exits and entrances from the workforce (Huang et al., 2007). However the present study did not support these hypotheses. It is possible that the present, highly educated sample is not representative of the general population. Seattle Longitudinal Study participants are typically highly educated and healthy with strong cognitive ability. This is not what would be found in a nationally representative sample, possibly explaining why the current study findings differed with the existing literature. Because the SLS is highly educated, participants may experience fewer transitional jobs and enter into their chosen profession earlier, leading to greater stability. The lack of change in both work complexity and work control suggests that these domains are relatively stable in young to middle aged, highly educated adults.

Work Routine

In contrast to trajectories of stability in work control and complexity, SLS participants reported reliable decline in routinization of work demands over the age period from young adulthood to midlife. In particular, the present study found that among young and middle aged adults, higher inductive reasoning ability was associated with linear declines in work routine. This partially supported the hypothesis that inductive reasoning, word fluency, and perceptual speed would be associated with routine. This finding suggests that young individuals with high

functioning inductive reasoning, a fluid cognitive ability, are more likely to have novel, variable work experiences. Inductive reasoning is often considered a higher order cognitive ability, associated with executive function (Cattell, 1963; Lamar et al., 2002; Rabbitt, 1997), while word fluency and perceptual speed are more basic abilities. Perhaps, based on the present finding, lower work routine experiences are more likely in individuals with stronger higher level cognitive processes such as reasoning ability.

Education, however, was no longer a significant predictor of work routine after adding reasoning suggesting that reasoning ability rather than education is the primary association with routinization. This provides insight into the previous finding by Crawley and colleagues (2001), that researchers must be careful when examining cognitive ability and educational attainment since both are highly correlated in younger samples. The present findings suggest that for work routine, the variance attributed to reasoning ability was unique enough to remain influential to work routine after controlling for educational attainment.

This finding is also related to prior research showing associations between childhood social status and occupational success (Tinto, 1984). Specifically, it was found that male college students only received occupational status benefits from attending prestigious colleges when they came from lower social status before college. For individuals with an elite social status background, going to a good college was not necessary for high occupational status attainment. These individuals seemed to have enough benefits from their preexisting social status to insure higher occupational status in the work environment. The same may be true for experiences of work routinization in early stages of adulthood. Perhaps there is an interaction between baseline reasoning ability and educational attainment, where work experiences are only benefited from high educational attainment when individuals have low baseline reasoning ability. Although the present study had some variability in both educational attainment and cognitive ability, the Seattle Longitudinal Study participants are generally above average on cognitive function and education

compared to the general population (Schaie, 2005). Thus, this interaction needs to be examined in more diverse samples in the future.

Finally, counter to the hypothesis that women would have higher work routine compared to men, the present study found that women had lower levels of routine over the 14 years examined. This finding differs from previous research which suggests that women typically occupy lower status occupations (Huang et al., 2006, 2007). This result highlights the importance of distinguishing between the concept of occupational status and psychosocial work experiences like work routinization. This unexpected gender finding illustrates the necessity of not equating occupational status with perceived work experiences, especially when work perceptions have been shown to be associated with important domains such as cognitive function (De Frias & Schaie, 2001; Schooler et al., 1999, 2004), health (Gimeno et al., 2004; Ziff, Conrad & Lachman, 1995; Johnson et al., 1996; Kamarck et al., 2004; Vaananen et al., 2003), and well-being (Carmel & Bernstein, 2003; Predna & Lachman, 2001). The unexpected gender finding may also be attributed to gender differences in perception. The stress literature shows that women tend to perceive more stress and exhibit greater physiological stress responses compared to men (Smith & Reise, 1998; Zeidner, 2006). Thus, it is possible that women and men perceive and experience work environments differently. Alternately, it is possible that the women in the present sample are more career driven compared to nationally representative trends, resulting in preferable work conditions and lower reports of routinization in the workplace. Further, while there is little question that work-related gender disparities exist, the disparities may not necessarily relate to the perceived work environment. For example, Warren, Sheridan and Hauser (2002) found that women had significantly lower occupational earnings at career entry, with level differences persisting overtime. However, the disparity in earnings does not necessarily mean that men and women had different experiences at work. It is possible that men and women can be employed in the same occupation and encounter similar work experiences, while also having earnings differences.

Differing Trajectories of 21-Year Change in Work Control, Complexity, and Routinization and Associated Covariates

Trajectories of Work Control

As reported earlier, Nagin mixture models were used to identify subgroups of individuals exhibiting different trajectories of change in work control experiences over 21 years. In contrast to question one, the age range in question two was from 22 to 65 years. For interpretability, high work control in the present study represented low supervisor control, or environments where an individual perceived high personal control over one's own work. Three subgroups were identified, each with specific patterns of change. Roughly 42% of the sample was assigned to Group 1 (low control, stable). Group 2 (average control, quadratic change) also consisted of roughly 42% of the sample. Finally, Group 3 (high control, stable) was comprised of roughly 15% of the total sample. Further, the addition of covariates helped to differentiate and predict group membership.

When comparing the low control, stable (Group 1) and average control, quadratic change (Group 2) groups, the results indicated that individuals who participated in more social engagement activities, including communication and solitary activities, were more likely to be assigned to Group 2 (lower supervision). Thus, more engaged individuals had higher patterns of work control, confirming our hypothesis. The literature suggests that higher social engagement in older adults is a protective factor for cognitive function (Ghisletta et al., 2006; Lovden et al., 2005) which has also been associated with all three psychosocial work domains (Schooler et al., 1999, 2004). Thus it was hypothesized that in addition to cognitive function, social engagement would also be associated with perceived work experiences over time. Surprisingly, cognitive function did not differentiate between group membership, but engagement did. This is an important finding because it makes a direct link between social participation and work experiences, without the moderating effect of cognitive function. The present findings indicate that individuals with more social engagement at the beginning of the study were less likely to

have persistent, high supervision over 21 years. Perhaps higher participation in social activities is indicative of strong social skills and an outgoing personality, which have been linked to promotions and occupational success in previous research (Caspi et al., 1987; Melamed, 1996a, 1996b; Rawls & Rawls, 1968), explaining the patterns of change in Group 2 (average control, quadratic change).

Comparisons between Group 3 (high control, stable) and Group 1 (low control, stable) indicated that older adults and women were more likely to be in Group 3. This suggests that older adults and women are experiencing more perceived control over their work environments compared to younger adults and men. This finding of higher control in women was the opposite of what was hypothesized, (i.e., that men would experience preferential psychosocial work environments compared to women). This finding, similar to the gender effect predicting patterns of work routine in early adulthood for question 1, may relate to gender differences in perception. As mentioned previously, women tend to report differential perceptions of stress and physical symptoms of stress (Smith & Reise, 1998; Zeidner, 2006), indicating gender differences in context perception. Thus, this gender difference may also be present relative to work contexts, such that women, regardless of occupational status, may perceive greater control in their work compared to men. An interesting question to address in the future is whether occupational status is associated with the gender difference in perceived work environment experiences. Regardless of the reason for the gender difference, women's lower supervisor control in the present study may be protective against higher levels of work stress which have been associated with high supervisor control and disease prevalence in previous studies (Johnson et al., 1989; Karasek, 1979; Volkoff et al., 1989). This may be especially important for women, who typically have higher levels of stress compared to men. The hypothesis that younger age would be associated with less stability in work control was not supported by the findings, such that the only significant age difference found between trajectories of work control was between Groups 1 and 3 which were both stable. However, it was expected that older adults would be associated with a trajectory

of higher control (less supervision, Group 3), due to more time in the workforce and previous studies indicating that while younger adults have more gains in occupational status, older adults typically have higher, stable levels (Gelissen & de Graaf, 2006).

Trajectories of Work Complexity

The Nagin mixture models identified four distinct trajectory groups of work complexity in the present sample. Group 1 (average complexity, linear decline), roughly 31% of the sample, began the study at mean level work complexity and experienced gradual linear decline over the 21 years. Group 2 (average complexity, stable) on the other hand, 55% of the sample, showed stable, mean-level complexity over the 21-years. Group 3 (high complexity, stable), roughly 13% of the sample, displayed stable, high level complexity, while Group 4 (high complexity, linear gain; 2% of the sample) started the study at high levels of complexity and experienced moderate, linear gains over time.

The inclusion of theoretically substantiated covariates to the work complexity trajectories aided in the prediction of group membership. Compared to Group 1 (average complexity, linear decline), individuals were more likely to be assigned to Group 2 (average complexity, stable) who had higher subjective health status. Thus, individuals with poorer perceived health had linear declines in work complexity (Group 1). This finding supports the hypothesis that work environments low in complexity would also be associated with poor health status. Because health status was only measured at one occasion, the direction of the association cannot be determined. However, the literature would suggest that high stress work, often associated with high supervisor control and high routine (Borg et al., 2000; Gimeno et al., 2004; Vaananen et al., 2003; Ziff et al., 1995) can have negative health consequences (Barclay et al., 1988; Insel et al., 2006; Roehrs et al., 1995; Scherr et al., 1988). However, while the literature mentions high supervision and routine associated with work stress, complexity is not specified. Thus, the present study adds an important component to the existing findings in that work complexity trajectories are also positively associated with subjective health status. Complexity and control were correlated in the

present study and it is then possible that both may be similarly related to stress at work and health. It is also possible that work environments high in complexity provide better quality health care, which may also be associated with subjective health status differences between Groups 1 and 2. For the aforementioned reasons, future research needs to examine associations among psychosocial work complexity, work stress, and quality of health care to gain a clearer understanding of the association between complexity and health status.

While it was hypothesized that more job and profession changes would be associated with longitudinal instability in psychosocial work experiences, only job changes significantly differentiated membership between Group 3 (high complexity, stable) and Group 1(average complexity, linear decline) over 21 years. Thus, as hypothesized individuals with more job changes were more likely to be members of Group 1 (linear decline) compared to Group 3 which showed high, stable complexity.

Finally, no covariates included in the present study significantly differentiated between Groups 1 (average complexity, linear decline) and 4 (high complexity, linear gain). However, a trend indicated that individuals who experienced high complexity, linear gain (Group 4) tended to have higher subjective health status compared to Group 1. Also remember that Group 4, only 2% of the sample, displayed high levels of work complexity at the first occasion and moderate linear gain over time. Because Group 4 only contained 6 individuals in the current sample, it is likely that the small group size reduced the power for the identification of significant covariates. Future studies need to examine these trajectory groups with a larger sample to have adequate power to ascertain significant covariates in Group 4 (high complexity, linear gain), a small proportion of the total sample.

Trajectories of Work Routine

The Nagin mixture models identified three distinct trajectory types of work routine over 21 years. Group 1 (average routine, linear decline), 41% of the sample, had mean work routine at the first occasion slightly below the total sample, and displayed linear decline over the course of

the study. Group 2 (average routine, stable), roughly 54% of the sample, illustrated stable, mean level routine over time. Group 3 (high routine, 14-year gain), consisting of roughly 5% of the sample, showed high levels of routine across the entire study, with a gain in routine at the third occasion (after 14 years). And while the cubic shape for Group 3 was not significant, it was the best fitting slope resulting in significant group membership and produced the strongest model fit criteria.

Further, the addition of covariates successfully differentiated group membership by meaningful domains. Compared to Group 1 (average routine, linear decline), individuals that experienced average routine, stable (Group 2) had a higher educational attainment. This finding was surprising and counter to the hypothesis that more years of education would be associated with lower work routine. However, there was also a strong trend at the last data point for individuals with higher word fluency to be in Group 1 (average routine, linear decline). In combination, these two findings are counter to the widely accepted argument that cognitive function and educational attainment are positively correlated (Anstey & Christensen, 2000; Katzman, 1993). Perhaps more years of education is associated with Group 2 (average routine, stable) compared to Group 1 (average routine, linear decline) because Group 2 demonstrated stability over time. It is possible that individuals with more education are also more likely to be in careers of their choice, with little impetus for change over time. And although the decline in routine experienced by Group 1 is what was hypothesized to be associated with high educational attainment as well as cognitive function, Group 2 did not have a particularly high level of routinization. Instead, Group 2 experienced stability in level of routine over time, which might be considered less outwardly risky or protective compared to levels of routinization for Groups 1 (average routine, linear decline) and 3 (high routine, 14-year gain).

Lastly, comparisons between Groups 1 (average routine, linear decline) and 3 (high routine, 14-year gain) indicated that individuals with high word fluency function at last data point were more likely to be assigned to Group 1. This finding, which paralleled the trend between

Groups 1 and 2, supported the hypothesis that patterns of low routine and decline in routine would be associated with higher cognitive function, word fluency in the present case. Thus, this finding provides additional support for the argument that psychosocial work domains such as routine are associated with cognitive function in adults (Avolio & Waldman, 1987; Schooler, 1984; Schooler et al., 1999, 2004; De Frias & Schaie, 2001). In addition, the present study extends to the prior literature by associating a specific cognitive domain, word fluency, with change in work routine across adulthood.

Word fluency, associated with verbal memory and verbal ability (Schaie, 2005), is a fluid ability that typically begins to exhibit normative decline after age 60 (Finkle et al., 2003; Schaie, 2005). The present finding indicated that individuals with high verbal fluency at the last data point declined in work routine over time. This association warrants examination in future studies. The present analysis cannot disentangle directionality of the association, but rather provides evidence that trajectories of psychosocial work experiences are positively associated with cognitive function. Thus, the findings suggest that decline in routinization may be associated with gain in word fluency and alternately that being high in verbal fluency is related to decline in work routinization. In either direction, higher level of cognitive functioning is associated with decline in routinization.

Patterns of Cognitive Change among Older Workers and Work Domain Correlates

Verbal Memory

Individual patterns of verbal memory were examined over 14 years in a sample of older adults who were working at the first occasion of measurement. This question aimed to examine the impact of work experiences on older adults' cognitive function, even in those who were fully retired by the end last data point. For verbal memory, a basic fluid ability (Cattell, 1963), the present study found that for a 60-year old, every year older was associated with linear decline in memory. This supports earlier studies that identify age as a major risk factor associated with decline in cognitive function (eg. Finkle et al., 2003). The present study also found that more

variance was accounted for in memory over time when individual level slopes for age were included. This indicates that in addition to variance in verbal memory associated with main effects of age, a significant portion of variance in the rate of memory change was attributed to individual differences. In other words, the rates of memory change over time significantly differed between individuals (interindividual differences in intraindividual change). This supports literature which suggests high interindividual variability in cognitive change (Christensen et al., 1999). Additionally, faster processing speed was related to linear gain in memory performance, supporting the hypothesis that speed would be positively associated with positive cognitive change. Various theorists (Salthouse et al., 1996; Sliwinski & Bushke, 1997) have examined the association between memory performance and age, and found that including processing speed ameliorates the effects of age on memory decline. In the present sample, both age and speed accounted for unique variance in verbal memory over time, suggesting that both need to be included when examining change in fluid abilities.

The remaining significant factors controlled for included gender and educational attainment, such that women outperformed men and more years of education beyond high school was associated with higher memory performance. However, even after age, speed, education and gender were accounted for, an effect for psychosocial work control remained. Specifically, individuals with more perceived personal control over their work environments (low supervision) had significantly stronger memory function on average. Further, work status, either working at the first occasion versus working during multiple occasions, and health status factors were not significantly associated with verbal memory. This suggests that regardless of the length of time employed or one's health status, late life perceptions of high personal work control are predictive of higher memory function in older adults. Similar findings can be found in the literature. For example, Avolio and Waldman (1987) found that occupational status attenuated the impact of age on cognitive function, suggesting that certain work experiences can be protective. The present findings also extend the work of Schooler (Schooler, 1984; Schooler et al., 1999, 2004), such that

the domain of work control was positively associated with change in verbal memory in older adults. While past findings reported associations between control and intellectual flexibility, the present finding provides stronger evidence that psychosocial domains, even experienced late in life, may be protective for cognitive change in older adults. Additionally, because not all participants in the present sample were engaged in work throughout the entire study, this finding suggests that experiences of high personal work control may have a lagged effect on memory past retirement for those individuals who retired during the study. Work status was not significantly associated with memory, suggesting that the protective effect of work control was important for those engaged in continued employment as well as those already retired.

Inductive Reasoning

Individual patterns of inductive reasoning, a high order fluid ability (Cattell, 1963), were examined. Like verbal memory, both age and perceptual speed were associated with inductive reasoning over time. Specifically, compared to a 60-year old, every increased year of age was associated with linear decline in reasoning. However, faster perceptual speed was associated with significantly higher reasoning function in the present sample. Also paralleling verbal memory, there were significant individual differences in the rate of reasoning change with age, suggesting interindividual variability in intraindividual rates of change which supports previous studies (Christensen et al., 1999). The final significant control factor associated with inductive reasoning was educational attainment, where more years of education beyond high school was associated with higher reasoning ability.

Unlike verbal memory, neither gender or work control were significantly associated with inductive reasoning. In fact, no psychosocial work experiences significantly predicted reasoning functioning in older adults. Instead, general work status was associated with reasoning ability, such that individuals who retired after the first occasion had lower reasoning function compared to those who were employed at the second and/or third data points. This suggests that regardless of the type of work environments experienced, any work participation may be protective for

reasoning ability. Further, this finding is not likely due to group differences in health status because neither objective nor subjective health status was significantly associated with reasoning ability in the final model. The protective effect of work engagement can be related to the engagement literature which argues that stimulating contexts and activities are protective for cognitive maintenance in older adults (Bunce & Macready, 2005; Louvden et al., 2005; Salthouse, 1991). The Disuse Hypothesis (Salthouse, 1991) postulates a use-it or lose-it approach to cognitive function, where older adults need stimulation to maintain ability. A life event, such as retirement, may result in declines in social and mental stimulation with associated negative effects on cognitive function. The present study lends support to the disuse hypothesis in that regardless of the type of work experienced, extended work participation predicted better reasoning function.

Verbal Ability

Patterns of verbal ability, a crystallized cognitive ability (Cattell, 1963), were examined over time in a sample of older adults. While both verbal memory and inductive reasoning had negative linear effects of age, verbal ability had a positive linear effect of age and a slight negative quadratic age effect. This supports what is known about crystallized abilities (Cattell, 1963), such that vocabulary typically increases well into late life, and only begins to decline in the very old. The present sample showed overall gains in verbal ability with very modest decline noticeable toward the end of the 14 years. Further, there were also significant differences in individual's rates of verbal ability change beyond the main effects of age, similar to what was found for verbal memory and inductive reasoning.

Levels of verbal ability were also associated with several theory-based controls, including education, perceptual speed, gender, and objective health status. Specifically, higher verbal ability was related to greater educational attainment beyond high school, faster perceptual speed, higher objective health status, and being female. All associations were in the expected directions and supported the hypotheses.

The finding of most interest based on the aims of the present thesis is that similar to the results for inductive reasoning, prolonged employment was associated with higher verbal ability. This remained significant after including age, education, speed, and health status. Combined with the positive association with inductive reasoning, the present finding for verbal ability adds additional support to the engagement literature (Bunce & Macready, 2005; Louvden et al., 2005; Salthouse, 1991), suggesting that work experiences in older adults may be protective for both fluid and crystallized abilities.

Strengths, Limitations, and Future Directions

Strengths

The present thesis made several important contributions to the study of work environment experiences and cognitive function. First, an overarching question is whether cognitive ability drives work experiences, whether work experiences influence cognitive function, or whether the association is entirely reciprocal. The first question of the present study addressed the importance of cognitive function on work environment experiences in young and middle aged adults. The finding that reasoning ability was indeed negatively associated with higher work routinization adds important information to the question of work-cognitive associations in early adulthood. Specifically, individuals are more likely to have novel, changeable work if they have higher baseline inductive reasoning ability, suggesting that early cognitive ability may indeed influence the type of work environment contexts experienced.

The present study was also able to address the work-cognition relation in older adults, by modeling patterns of both fluid and crystallized change in adults with some work participation over 14 years. While the best way to assess the accumulated impact of psychosocial work experiences across adulthood on older adults is to measure individuals from their first entrance in the workforce to beyond retirement, this would involve a long time period and is not pragmatically feasible in more designs. Further, individuals who would remain in a study for that length of time would likely have special selection effects, such that they would be more likely to

be high functioning and healthy compared to the general population. Thus, by examining baseline levels of late life work experiences and associating them with cognitive change in a sample of older adults, the present study contributed to the field by accounting for possible lagged effects of work experience on cognition past retirement. The findings suggested that both inductive reasoning and verbal ability were not influenced by any particular work environment experience, but level of the ability was higher among those who participated in work longer. This is an important contribution because it provides evidence that prolonged work engagement is beneficial for both fluid and crystallized ability in older adults over time. Further, the finding that lower supervisor control predicted strong verbal memory in older adults gives strength to the argument that specific work experiences and cognitive function in late life are associated. If the accumulated effect of work experience could have been tested, it is likely that there would have been significant associations with the other cognitive abilities included in the present study.

Another contribution of the present study was examining individual differences (subgroups) in trajectories of psychosocial work environment over time. The existing research primarily examined occupational status over time (Caspi et al., 1987; Melamed, 1996a, 1996b; Rawls & Rawls, 1968), ignoring the importance of individual's personal experience of work. Additionally, while women typically have lower status occupations (Huang et al., 2007), the women in the present study reported trajectories of higher work control compared to men, highlighting the important differences between occupational status and individual work experiences.

Limitations

While the present study had many strengths and contributions, there were also limitations that must be addressed. First, while the Seattle Longitudinal Study is an exceptional sample due to the inclusion of work domain and cognitive measurement, as well as the longitudinal data, there are several limitations. First, the present sample had very limited racial or ethnic diversity. Thus, future studies need to examine whether the present findings replicate in more diverse

samples before they can be generalizable to the general population. In addition, the SLS sample is highly educated and of a higher socioeconomic status than the general population. Higher SES is associated with higher occupational status and thus the SLS sample is also selective in the work environments experienced. Therefore, the findings in the present study must only be generalized to white, middle class and up Americans.

In addition to some sample limitations, there was also a methodological limitation associated with the Nagin mixture models. While using the Nagin models was highly advantageous with the question of identifying trajectory types and finding associated covariates, the method only allows for covariate comparisons to the first Group. Therefore, the present study was not able to compare Groups 2 and 3 or Groups 2 and 4 of work complexity trajectories, for example.

It is also possible that the measurement of some key factors in the present study was not optimal. Specifically, the Big 5 personality factors were derived from 13 Test of Behavioral Rigidity personality facets in contrast to direct assessment of the 5 personality domains. While the confirmatory factor analysis used to create the 5 personality factors was a good fitting model, none of the factors were significantly associated with patterns of work environment experiences in the present study. It could be that they simply were not important after including the final covariates; alternately, it is possible that direct measurement of the 5 personality factors would allow for better covariate estimation in future research.

Implications and Future Directions

Findings from the present study have important implications for the cognitive and physical health of the aging population, as well as for the issue of delayed retirement. First, the findings from questions one and three in the present study indicate that while early reasoning ability is predictive of lower work rigidity in young and middle aged adults, participation in extended employment may also be beneficial for older adults' cognitive function. It is possible that selection effects in the present study may have influenced the finding that continued

employment was associated with higher cognitive function in older adults. Specifically, by only examining one measure of work experience in late life and no baseline cognitive ability, it's possible that older adults in the present sample who continued to work were those who already possessed some critical level of cognitive function necessary for employment. However, one could also argue that for older adults, continued stimulation by work participation helps to maintain cognitive function, supporting Salthouse's (1991) disuse hypothesis. This extension of work stimulation may also be adding to an individual's cognitive reserve over time. Cognitive reserve is an important component of disentangling accumulated environmental stimulation with cognitive performance (Stern, 2002). Cognitive reserve represents the accumulation of life experiences that can act as a buffer against cognitive decline or neuropathology. The association among an engaged lifestyle, social activity, educational attainment, and work experiences with cognitive function throughout adulthood may operate via this process. The present study supports this theory in that regardless of the individual's occupation, continued employment was a protective factor for both fluid and crystallized abilities in older adults.

Cognitive reserve may also influence cognitive performance in late life relative to the allocation of cognitive resources. It is well documented that processing speed declines with age (Hess, 2005), resulting in diminished resources available to older adults for cognitive processing. There is also evidence that personal goals and motivation affect how an individual allocates cognitive resources, in line with the theory of selection, optimization and compensation (SOC; Baltes, 1997; Hess, 2005). Therefore, cognitive reserve operates to increase cognitive resources available to individuals in late life, such that the allocation of cognitive resources will not be as strained. Accordingly, with adequate cognitive reserve, older adults may exhibit higher levels of cognitive function over several abilities instead of the select few in which they would invest their attention as predicted by SOC.

If the accumulated effect of participation in work is associated with developing cognitive reserve in older adults, there are many important social implications. Maintenance of fluid ability

has been linked to an individual's ability to perform activities of daily living (IADL's; Hogan, 2005). Thus, if continued work participation is a protective factor for inductive reasoning, it may also be associated with the ability to live independently longer. This outcome associated with prolonged employment has individual, industrial, and social benefits. First, older adults benefit by maintaining critical cognitive abilities associated with one's ability to live independently. Further, businesses that will soon be losing large numbers of workers due to the retiring Boomers will gain several benefits by keeping older workers employed longer. Organizations will benefit from the years of experience older workers bring with them, in addition to maintaining enough employees to sustain their daily business operations once the Boomers begin to retire in large numbers. Finally, the social benefits include possible delay in receipt of social security benefits if they delay retirement, which is necessary with the upcoming social security crisis. Finally, if older adults are able to maintain cognitive function and associated IADL's for a longer period of time, there will be less strain to society relative to health care costs associated with older adults' functional independence.

There are several issues that future research should address based on the present study. First, the only psychosocial work environment domain associated with cognitive change in older adults was work control, associated with verbal memory. However, the present study was not able to evaluate the effect of accumulated work environment experiences with cognitive function trajectories. Future research should use the trajectory types identified in the present study, and examine associations between group membership and trajectories of cognitive change. It will also be important for future work to directly measure the Big 5 personality factors, to determine whether the lack of association found in the present study was real or due to measurement error.

Due to the important implications discussed above, future work also needs to examine the association among prolonged employment, cognitive function, and older adult's ability to maintain independent living. If a specific association can be determined between work experiences and activities of daily living, it is possible that policy makers will promote further

legislation to delay retirement. It would also provide older adults considering a delayed retirement more motivation to do so.

In summary, the present thesis aimed to evaluate psychosocial work experiences across adulthood, and the association between those work experiences with cognitive function. Although not all proposed factors were associated with the trajectories of work experiences and cognitive function, the findings provided evidence that individuals' work experiences are associated with specific cognitive abilities beyond general intelligence and intellectual flexibility. Further, the current study found evidence suggesting that delaying retirement may be protective for both fluid and crystallized cognitive function. Work-related implications for independent living and cognitive maintenance were discussed and future research needs to examine these associations directly.

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2007 American Psychological Association 2003
Gerontology Society of America (GSA)
2000 Psi Chi, National Honor Society in Psychology

PROFESSIONAL EXPERIENCE:

2007 Reviewer, Abstract submissions for the 2007 Gerontological Society of America Annual Meeting
2007 Paper Session Chair, *Social Support and Mental Health,* Presented at the Gerontological Society of America Annual Meeting.

TEACHING EXPERIENCE:

2007 Trained new instructor, assist with preparation of new course – HDFS 445, Development and Administration of Human Services Programs
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