The Relationship between Leisure Activity Participation, Language, and Literacy in Adults with Down Syndrome

by

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Abstract

The literature has stated that all adults with Down syndrome (DS) develop the physiological signs of Alzheimer's disease (AD), but that the behavioural changes may not occur until many years later. While there has been a fair bit of literature on the benefits of leisure in reducing the risk, or delaying the development, of AD in adults without DS, this literature is almost non-existent for the DS population. The purpose of the present study was two-fold. First, this study investigated the differences in cognition, language, and literacy skills, and leisure activity participation in younger and older adults with DS. Second, this study examined leisure activity participation as a predictor of cognitive, language, and literacy abilities. Results showed that older participants (age 46-60) tended to score more poorly on measures of cognition, language, and literacy than younger participants (age 20-45). These age-related differences may, in part, be due to AD. Leisure activity participation was also found to vary with age, such that older adults engaged in fewer physical, cognitive, and social leisure activities and worked more hours than the younger adults. Differences in leisure activity participation may be due to AD or to the participant's place of residence, where participants living in a group home tended to work more and were involved in less leisure than participants living with their parents. Finally, leisure activity participation was not found to predict cognitive, language and literacy scores, with the exception of watching television, which negatively predicted oral expression scores. While true of all adults, adults with DS should be encouraged to dedicate more time to positive leisure activities at all ages, and more specifically to cognitive leisure activities, and dedicate less time to television watching, to help delay the onset of declines associated with AD.

List of Abbreviations Used

AAI	Academics Attainment Index
AAMD	American Association for Mental Deficiency
AD	Alzheimer's disease
AE	Age-equivalent
ADHD	Attention deficit hyperactivity disorder
ANOVA	Analysis of variance
BEMS	Batterie pour l'Évaluation de la Morpho-Syntaxe
BPVT	British Picture Vocabulary Test
CRT	Cued Recall Test
dB	Decibel
DC-LD	Diagnostic Criteria for Psychiatric Disorders for use with Adults with Learning Disabilities
DS	Down syndrome
DSDS	Dementia Scale for Down syndrome
DV	Dependent variable
HLM	Hierarchical linear modeling
Hz	Hertz
ICD-10	International Classification of Diseases - Tenth Revision
IQ	Intelligence quotient
IV	Independent variable
LAI	Leisure Assessment Inventory
LC	Listening comprehension

LTM	Long-term memory
M	Mean
MA	Mental age
MCI	Mild cognitive impairment
MLU	Mean length utterance
MMSE	Mini-Mental State Examination
MRI	Magnetic Resonance Imaging
OE	Oral expression
OWLS-II	Oral and Written Language Scales, Second Edition
PPVT	Peabody Picture Vocabulary Test
RC	Reading comprehension
SB4	Stanford-Binet, Fourth Edition
SB5	Stanford-Binet, Fifth Edition
SD	Standard deviation
SE	Standard error
SPSS	Statistical Package for the Social Sciences
SRT	Selective Reminding Test
STM	Short-term memory
TACL-R	Test for Auditory Comprehension of Language - Revised
TROG	Test for Reception of Grammar
WISC-R	Weschler Intelligence Scale for Children - Revised

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Chapter 1 - Introduction

Research on individuals with Down syndrome (DS) has examined their language development and the deficits caused by the early onset of Alzheimer's disease (AD). Few studies have examined methods of promoting language growth and preserving language abilities. This study investigated the differences in cognition, language, and literacy skills, and leisure activity participation in younger and older adults with DS as well as the relationships between these three factors. In the present chapter, the literature on DS, with a particular focus on the production and comprehension of language and literacy skills, is reviewed. The literature on Alzheimer's disease and DS and other factors that affect language and leisure in both the typical and DS population is examined.

Down Syndrome

Down syndrome is a genetic anomaly, which results from a complete or partial third copy of the 21st chromosome. Individuals affected by DS typically have a short stature, broad hands, epicanthal folds, and low muscle tone (hypotonia). Many have health difficulties such as congenital heart disease (Roberts, Price, & Malkin, 2007). Individuals with DS also tend to have microcephalic brains; the hippocampus, the prefrontal cortex, and the cerebellum are the most affected areas (Roberts et al., 2007). Approximately two-thirds of individuals with DS have a hearing loss; mild bilateral conductive hearing losses are the most common type. Otitis media, which can cause fluctuating conductive hearing loss due to fluid in the middle ear, is often the cause of conductive hearing loss in this population (Roberts et al., 2007). Individuals with DS are at high risk for behavioural and psychological problems such as attention deficit/hyperactivity disorder, depression (Roberts, et al., 2007), and non-compliant

behaviour (Rosner, Hodapp, Fidler, Sagun, & Dykens, 2004). On the other hand, they tend to be charming, social, friendly and engaging (Rosner, et al., 2004).

Another characteristic of this population is that all adults with DS above the age of 30–40 display the physiological symptoms of AD (Devenny, Krinsky-McHale, Sersen, & Silverman, 2000; Malamud, 1972; Menéndez, 2005; Rondal & Comblain, 2002; Wisniewski, Wisniewski, & Wen, 1985). Research has shown that the triplicated chromosome codes for the overproduction of amyloid protein. When found in excess, this amyloid produces plaques and neurofibrillary tangles in the brain, a key physiological feature of AD. These issues will be discussed in more detail in the section entitled "Alzheimer's Disease and Down Syndrome".

Cognitive and language abilities of individuals with DS

Behavioral Phenotype

Individuals with DS often exhibit a characteristic pattern of strengths and weaknesses of cognitive, literacy and language abilities, referred to as a behavioral phenotype (Chapman & Kay-Raining Bird, 2011). One of the distinguishing features of DS is an intellectual disability, varying from mild to severe (Chapman, Schwartz, & Bird, 1998; Chapman, Hesketh, & Kistler, 2002; Roberts, et al., 2007), corresponding to an intelligence quotient (IQ) that is generally in the moderately disabled range (Rosner, et al., 2004). Individuals with DS tend to show a relative strength in visual memory skills and weakness in auditory verbal memory (Hodapp & Fidler, 1999; Dykens & Hodapp, 2001; Sellinger, Hodapp, & Dykens, 2006).

Language and Literacy Phenotype

Language and literacy abilities vary considerably across individuals in this population. Evidence suggests that language development in individuals with DS is not deviant, but delayed (Chapman, 1997; Fowler, 1990). This means that these individuals learn language following the typical language acquisition sequence, but are delayed in reaching various milestones. In general, language abilities are delayed relative to non-verbal cognitive abilities. Individuals with DS show a relative strength in language comprehension compared to language production (Chapman et al., 1998; Chapman et al., 2002). Within each process (comprehension and production), vocabulary tends to be stronger than morphosyntax (Abbeduto et al., 2001; Chapman, Schwartz, & Kay-Raining Bird, 1991).

Kay-Raining Bird and Chapman (2011) conducted a review of the literature on literacy abilities of children and adults with DS. They reported that real word reading abilities of children with DS in elementary school were a strength and were often found to be stronger than oral language and cognitive skills. Kay-Raining Bird and Chapman (2011) further reported that, while individuals with DS tended to demonstrate strengths in real word reading, they had difficulties with reading non-words and reading comprehension (see also Roch & Jarrold, 2008). While non-word reading improves with age, for individuals with DS, reading comprehension remains a weakness (Kay-Raining Bird & Chapman, 2011; Moni & Jobling, 2001).

Language Production: Changes across the Life Span

In an early review of the literature, Fowler (1990) concluded that expressive language development plateaued as early as seven years of age at MLUs of around 2.5 –

3. In her review, she noted findings that children with DS as old as 14 have limited syntactic development and that most syntactic learning occurs between four and six years of age, with mental ages ranging from 15 months to 2.5 - 3 years. Fowler (1990) hypothesized that, by the chronological age of seven, a critical period has been reached and specialized language learning abilities are no longer available to children with DS. In 1998, Chapman et al. compared the performance of individuals with DS between five and 20 years of age to non-verbal mental age-matched typically developing children, on conversational and narrative language sample measures. While the average MLU in conversational samples across all ages for participants with DS was consistent with Fowler's (1990) conclusions (MLU $M = 2.45$, $SD = 1.14$), in the narrative samples, participants with DS produced longer MLUs, a greater total number of words, and a greater number of different words than in the conversational samples. Importantly, individuals with DS in the oldest group (16 years 6 months – 20 years 5 months) produced an average MLU of 4.47 (range 2.1 - 7.2), which was significantly higher than the second oldest group (12 years 6 months –16 years 5 months), who produced an average MLU of 3.15 (range 1.7 - 4.2). These findings provided evidence against a syntactic ceiling in expressive language and evidence for continued morphosyntactic growth, at least through adolescence (Chapman, et al., 1998). These findings were supported by a six-year longitudinal study of language comprehension and production in 31 children, adolescents, and young adults with DS between the ages of five and 20 years old at the start of the study, analyzed using hierarchical linear modeling (HLM; Chapman et al., 2002). Expressive language was measured using MLU in 12-minutes of narrative produced by each participant. Chapman et al. (2002) concluded that expressive language

growth in individuals with DS continues through adolescence and is best predicted by syntax comprehension.

Studies of changes in expressive language with age in adults with DS have shown somewhat varied results. Most researchers (Burt et al., 1995; Devenny & Krinsky-McHale, 1998; Rondal & Comblain 1996, 2002; Young & Kramer, 1991) have reported that expressive language ability is relatively stable across age in adults with DS. Rondal and Comblain (2002), for example, examined both expressive and receptive cross-sectional and longitudinal language data in individuals with DS between 14 and 50 years of age. Their cross-sectional study divided 21 participants into three age groups: Adolescents (14 year 5 months - 19 years 6 months), younger adults (23 years 4 months - 30 years 1 month), and older adults (40 years 5 months - 46 years 7 months). Their longitudinal study followed 12 participants between the ages of 37 and 49 for four years. Findings suggested receptive morphosyntax, measured using the *Batterie pour l'Évaluation de la Morpho-Syntaxe* (*BEMS*, Comblain, 1995), expressive morphosyntax, measured using MLU in a picture description task, and vocabulary skills, measured through picture designation, verbal fluency, picture labelling, and a picture description task, did not change across the groups studied cross-sectionally and did not decline for individuals in the longitudinal study. Burt et al. (1995) followed 34 adults with DS between 22 and 56 years of age over a period of three years. They conducted a neuropsychological evaluation, measuring general reasoning, which provided a measure of IQ, memory, expressive and receptive language, fine motor and perceptual-motor abilities, and adaptive behaviour/daily living skills, and a physical evaluation of participants at yearly intervals. Expressive language was measured using the vocabulary,

picture description, and word fluency subtests of the *Stanford-Binet - Third revision* (Terman & Merrill, 1972). Word fluency was also assessed using the category fluency subtest of the *McCarthy Scales of Children's Abilities* (McCarthy, 1972). Repeated measures analyses of variance (ANOVA) were conducted on each of these measures to assess changes in scores over time. The independent variables of interest were age at the start of the study, IQ at the start of the study, and gender. Their findings suggested that age did not have a significant effect on these measures, and more specifically, expressive language scores did not change over time. However, IQ at the start of the study was found to have a significant effect on expressive language scores. When controlling for IQ at the start of the study, Burt et al. (1995) reported a significant effect of time and a significant interaction between time and IQ on expressive language scores. Correlational analyses confirmed a correlation between expressive language scores and IQ at the start of the study. Young & Kramer (1991) measured expressive language in a study of 60 adults with DS between the ages of 22 and 67. Expressive language was assessed using the expressive section of the *Sequenced Inventory of Communication Development* (Hedrick et al., 1984). Their findings suggest that while increasing age predicted declines in certain abilities, such as self-help skills, it did not predict expressive language abilities. Using a cross-sectional design, Devenny & Krinsky-McHale (1998) studied age differences in verbal and non-verbal ability on the *Wechsler Intelligence Scale for Children-Revised* (*WISC-R*, Wechsler, 1981) for 88 adults with DS and 56 adults with an intellectual disability other than DS. Participants were all older than 35, and were divided into two age groups (younger than 45 years and 45 years of age and older). Devenny & Krinsky-McHale's (1998) study found that older adults, either with DS or with other

intellectual disabilities, performed lower than the younger group on non-verbal ability, although there were no age differences in verbal ability for either group. Adults with DS; however, showed evidence of lower performance approximately two decades before the adults with other intellectual disabilities. According to the authors, this pattern of lower non-verbal ability with preserved verbal ability follows the natural aging pattern (Devenny & Krinsky-McHale, 1998). Cooper and Collacott (1995) examined expressive language ability cross-sectionally in 345 adults with DS between the ages of 17 and 76 using a subdomain of the *Adaptive Behavior Scale* (*AAMD*; Nihra, Foster, Shellhaas, & Leland, 1974). Five groups of ten-year age bands were studied (i.e. 20–29; 30–39; 40–49; 50–59; 60+). The four older age bands were compared to the participants from the first age band (i.e., 20–29). Group comparisons suggested a slow, yet continuous decline in expressive language scores for participants 30–39 and older; however, the decline only became statistically significant ($p < .01$) after 60 years of age. In a correlational study of adults with DS between the ages of 19 and 58, Iacono et al. (2010) reported that changes in expressive vocabulary, measured using narrative language sample, were not found, but expressive syntax, measured using MLU in 50 utterances, decreased significantly with age. In a review of the literature on language and cognition in adults with DS, Orange and Zanon (2005) concluded that language production remained fairly stable throughout adulthood or declined marginally with age. Declines were typically characterized by shorter sentences, errors in auxiliary verbs, fractured word order, and simplification of grammar. Advancing age and dementia of the Alzheimer's type were the two factors deemed to be associated with declines in productive language ability.

In summary, the available research suggests that the expressive language ability of individuals with DS increases until about 20 years of age (Chapman et al., 1998). At this point, it seems to plateau (Burt, 1995; Devenny & Krinsky-McHale, 1998; Rondal & Comblain, 1996, 2002). Some studies show declines with age in non-verbal (Devenny & Krinsky-McHale, 1998; Young & Kramer, 1991) or self-help (Young & Kramer, 1991) skills. Declines in expressive language are reported less, and tend to be quite gradual with significant differences present between younger and older adults with DS only beginning at approximately 60 years of age (Cooper & Collacott, 1995). Iacono et al. (2010) argue declines in expressive syntax may begin earlier. In the present study, expressive language was tested. Performance was used to assess age differences in expressive abilities between younger and older adults with DS.

Language Comprehension: Changes across the Life Span

While most studies of language production suggest a plateauing of both expressive vocabulary and morphosyntax beginning in early adulthood, a different pattern emerges in studies examining language comprehension.

In addition to expressive language, Cooper & Collacott (1995) also assessed receptive language, measured using the *Adaptive Behavior Scale* of the *AAMD*. They reported that language comprehension was lower for participants over the age of 40. The following studies examined the subsets of receptive language, syntactic comprehension and vocabulary comprehension, as separate measures rather than as a single measure.

In the longitudinal study by Chapman et al. (2002) on participants with DS between the ages of five and 20 at study start, syntactic comprehension was measured using the *Test for Auditory Comprehension of Language – Revised* (*TACL-R*, Carrow-

Woolfolk, 1985). Results of the HLM analysis showed that participants who began the study at younger ages demonstrated greater syntactic comprehension growth across the six years of the study than those who began participating at older ages. In the best fit model, the predicted growth curve for syntactic comprehension for participants who entered the study at 17.5 years of age was a decline in ability. Laws and Gunn (2004) also studied syntax comprehension longitudinally, in children, adolescents, and young adults with DS between five and 19 years of age at the onset of the study, over a five year period. Syntactic comprehension was measured using the *Test for Reception of Grammar* (*TROG*, Bishop, 1983). Similar to the findings of Chapman et al. (2002), Laws and Gunn (2004) found a negative correlation between chronological age and syntax comprehension. When examining a scatterplot demonstrating the relationship between syntax comprehension (*TROG* scores) and chronological age, Laws and Gunn (2004) reported that syntax comprehension increased through to late adolescence, although increases became less pronounced after 14 years of age. By the age of 17, some of the participants demonstrated a decline in their syntax comprehension scores, although the more frequent pattern was a slowing in the acquisition rate of syntactic comprehension over time. The slowing could not be accounted for by having reached the test's ceiling. Laws and Gunn (2004) suggested this slowing of acquisition was indicative of a plateauing of syntax comprehension skills. This slowing/plateauing of syntactic comprehension growth was best evidenced by their most able participant, who had good reading skill, clear speech, and good hearing. This participant made gains equivalent to 2.75 years on a non-verbal measure of cognition (*Triangles subtest*; *Kaufman Assessment Battery for Children*; Kaufman & Kaufman, 1983), but no language gains were made

between 14 and 19 years of age. In keeping with the previously described studies (Chapman et al., 2002; Laws & Gunn, 2004), the cross-sectional study conducted by Rondal and Comblain (2002) found that receptive morphosyntax was not significantly different in adolescents, young adults, and older adults. Their longitudinal study also did not show significant changes in receptive morphosyntax between the ages of 37 and 49, also indicating a plateauing of receptive language skills.

In contrast to receptive syntax, Laws and Gunn (2004) reported continuous growth for all participants of all ages in vocabulary comprehension over the course of their study, as measured by the *British Picture Vocabulary Scale* (*BPVS*, Dunn, Dunn, Whetton, & Pintilie, 1982), although these gains in vocabulary comprehension were not closely related to chronological age. In another longitudinal study, Carr (2003) examined vocabulary comprehension in adults with DS at two intervals, once at 30 years of age and again at 35 years of age. Individuals showed stable scores in vocabulary comprehension over the period studied. Hawkins, Eklund, James, and Foose (2003) examined receptive vocabulary performance over a ten-year period in adults with DS in their 30s, 40s, 50s, and 60s at study onset using the *Picture Vocabulary* subtest of the *Woodcock-Johnson Early Developmental Battery* (Woodcock & Mather, 1989). They reported increasing receptive vocabulary performance up to 60 years of age, after which performance plateaued. The rate of increase prior to the age of 60 went down with age. Participants who received a diagnosis of dementia were excluded from this study.

Nelson, Orme, Osann, & Lott (2001) studied the relationship between neural plaques and neurofibrillary tangles on behaviour, dementia, pragmatics, cognition, and lexical comprehension in adults with DS. These assessments were conducted at two

separate intervals, one year apart, for 26 adults with DS. The mean age for this sample at the first testing was 40.03 (*SD* = 11.18). At each assessment, participants received an MRI interpreted by two different radiologists, to determine the presence of plaques and tangles in the brain. Participants were also given a neurological exam by an experienced neurologist. The researchers administered the *Dementia Scale for Down Syndrome* to the participants and their primary caregiver. Participants were given the *Peabody Picture Vocabulary Test - III* (*PPVT-III*, Dunn & Dunn, 1981) to assess their vocabulary comprehension. Caregivers were given the *Neuropsychology Behavior and Affect Profile* (*NBAP*, Nelson et al., 1994; Nelson et al., 1989) to assess the participant's indifference, inappropriate behaviour, depression, mania, and pragnosia (pragmatic language dysfunction). Findings showed that the receptive vocabulary skills of some individuals decreased over the year studied while that of others increased. Decreases in receptive vocabulary were related to abnormal MRIs, neurological findings such as enlargement of the ventricles or succal atrophy, and the presence of pathological reflexes such as grasping, sucking, jaw jerk, palmomental reflex, or glabellar reflex. Nelson et al. (2001) hypothesized these symptoms may indicate early signs of AD. In their review of the literature, Orange and Zanon (2005) reported that age-related declines in language comprehension were characterized by a reduced ability to attend to auditory stimuli, poor word discrimination, poor comprehension of spoken language, and reduced ability to follow verbal directions. The review suggested that language comprehension declined more rapidly and more significantly than language production. Advancing age and dementia of the Alzheimer's type were found, in some studies, to play a role in declining language comprehension abilities. However, Prasher (1996) suggested that, when studies

control for declines in visual and auditory perception, expressive and receptive language declines are reported to be affected equally be advancing age.

In conclusion, evidence suggests that syntactic comprehension increases until approximately 17 years of age (Chapman et al., 2002; Laws & Gunn, 2004), and then appears to plateau through early and middle adulthood or even decline for individuals with DS (Rondal & Comblain, 2002). Patterns of vocabulary change in adults with DS are less consistent, but it appears that, in the absence of the signs and symptoms of AD (Nelson et al., 2001) (and maybe sensory impairments; Prasher, 1996), vocabulary comprehension increases until 60 years of age (Hawkins, et al., 2003). One study by Cooper and Collacott (1995) suggests that language comprehension, in general, declines after 40 years of age in adults with DS. In the present study, language comprehension was assessed, to describe the differences in comprehension skills between younger and older adults with DS.

Literacy: Changes across the Life Span

Changes in literacy with age have also been studied in individuals with DS. Turner and Alborz (2003) studied 79 individuals with DS from eight to 24 years of age who were part of an 18 year longitudinal study. Reading, writing, and numeracy skills were assessed using the *Academics Attainment Index* (*AAI*; Sloper, Cunningham, Turner, & Knussen, 1990), a parent/tutor-report measure. Results from this study suggested a plateau in reading, writing, and numeracy skills by 16 years of age. Moni and Jobling (2001) argued that individuals with DS between the ages of 17 and 20 still had the ability to learn new literacy skills, but that this would not occur without continued instruction. A three-year longitudinal study by Moni and Jobling (2001) examined reading rate,

accuracy, and reading comprehension in adults with DS aged 17 to 20 years at the start of the study using the *Woodcock Reading Mastery Test - Revised* (Woodcock, 1987) and the *Neale Analysis of Reading Ability - Revised* (Neale, 1988). Results from their study suggested that literacy gains in adolescence and adulthood were modest and were greatest for reading rate and accuracy and smallest for reading comprehension. Shepperdson (1994) conducted a longitudinal study comparing reading and numeracy skills in adolescents and adults born in the 1960s. Reading was measured using the *Reynell Language Scales* (Reynell & Huntley, 1985), the *Schonell Graded Word Reading Test* (administered to the participant's teachers; Schonell, 1972), and the *Gunzburg Progress Assessment Chart Form 1 and 2* (Gunzburg, 1977). Participants were born between 1964 and 1966 and were seen 3 times over a maximum period of 19 years (1972, 1981, and 1990-1991). There were 49 participants ranging from 6 to 8 years of age at the outset of the study. While the less able readers (reading age-equivalence of 6 years 2 months or less) could no longer read by their mid-twenties, the more able readers (age-equivalences > 6 years 2 months) tended to continue making reading gains into their twenties. The greatest reading improvements from adolescence to adulthood were found for participants with a reading age-equivalence greater than 7 years 4 months.

In summary, a small number of studies have reported literacy abilities in adulthood. Findings suggests that most adults with DS who do not receive continued teaching and practice will demonstrate declining or plateauing of their reading abilities in early to mid-adulthood (Moni & Jobling, 2001; Turner & Alborz, 2003). Some individuals with DS with strong reading skills may continue to develop their reading

abilities into their mid-twenties (Shepperdson, 1994). In the present study, assessments tested reading comprehension in younger and older adults with DS.

Normal Aging in Adults without Down Syndrome

The review of language and literacy skills in adults with DS has shown that many of these skills plateau and some even decline with increasing age; it is unclear what causes these patterns of language and literacy change. It is possible they reflect the normal aging process for individuals with DS. However, as Nelson et al. (2001) showed, they may also result from AD. The present section will review cognitive changes associated with normal aging in adults with and without DS.

Glisky (2007) reviewed the literature on changes in cognitive function associated with normal aging in typical adults. She identified multiple declines in cognitive function in aging adults as well as some skills that were maintained in old age. Considerable individual variability was also documented, with changes related to life experiences.

According to Glisky (2007) older adults tend to demonstrate impairments in dividing or switching attention in a task. Older adults may take longer than younger adults in tasks that require selective attention (attending to one stimulus while ignoring another), however their accuracy in these tasks is similar to that of younger adults. Glisky reported that the increase in reaction time may be attributed to a general slowing of information processing with advancing age. The ability to maintain attention on a task for long periods of time is not affected by natural aging.

Glisky also reported that age-related declines in cognition may be associated with declines in executive control. Multiple processes are involved in executive control, including planning, organization, coordination, implementation, and evaluation of new

activities. Executive control is required for allocation of resources (including attention) and the formulation of strategies for the encoding and recall of information, which affect the speed of information processing. Executive control also plays an important role in inhibiting attention to distracting stimuli, which affects the ability to sustain attention, maintain vigilance, and switch/divide attention between tasks. Areas of the brain responsible for executive control are associated with the frontal lobes of the cerebrum. Structural and functional neuroimaging studies have reported a decline in the volume and function of the prefrontal cortex in older adults.

Glisky's (2007) review also showed certain facets of memory changed with age in typical adults. Memory can be divided into three broad categories: short-term memory (STM), long-term memory (LTM), and working memory. Minimal to no changes in STM were associated with normal aging. With regard to long term memory, older adults demonstrated declines in episodic memory (personal experiences) and prospective memory (remembering tasks to be completed) for which there were no external reminder cues (e.g. calendar, fridge notes, etc.). Additionally, older adults also demonstrated impairments in remembering a person's name or a word for a specific context. No significant impairments were found for semantic memory (general knowledge of the world, facts, words, and concepts), procedural memory (memory of skills and procedures). The exception to this was 'high emotion' memories, for which memory for detail was similar in younger and older adults. Working memory was also affected by normal aging.

Glisky (2007) reported that older adults demonstrated declines in perceptual function, primarily in vision and hearing, that were related to declines in cognition. Two

main hypotheses were discussed to explain this association. The first suggests that both cognitive and sensory losses are associated with neural degeneration. The second hypothesizes that attentional resources must be divided amongst perception and cognition. Sensory declines increase perceptual demands, thereby reducing available resources for proper cognitive functioning.

Glisky's (2007) literature review indicated that language was largely not affected by old age. Language processing time may increase, and older individuals may have occasional word-finding difficulties (see also Burke & Shafto, 2004; Shafto, Burke, Stamatakis, Tam, & Tyler, 2007); however, their language skills are sufficiently strong that they may describe the word they are missing and still clearly convey their message. In contrast, older individuals tend to have stronger discourse skills and more vocabulary knowledge than younger adults. Studies such as Harley, Jessiman, and MacAndrew (2011) and Tyler, Shafto, Randall, Wright, and Marsten-Wilson (2010) have reported that language comprehension remains largely unaffected by natural aging. However, age-related declines in word finding (Burke & Shafto, 2004) and also expressive complex syntax (Harley, Jessiman, & MacAndrew, 2011; Kemper & Sumner, 2001; Kemper, Thompson, & Marquis, 2001), were reported. These declines in language production were primarily thought to be associated with age-related declines in working memory (Harley, Jessiman, & MacAndrew, 2011; Kemper & Sumner, 2001; Kemper, Thompson, & Marqui, 2001).

In summary, cognitive declines resulting from aging in typical adults are seen in attentional processes, executive control, certain facets of LTM, working memory, and perception. Language is relatively spared in older age, with increases demonstrated in

discourse skills and vocabulary, but mild declines in processing speed, syntax production, and word-finding abilities, probably related to cognitive declines. Hence, it may be that the declines in the language ability of adults with DS reported in some studies are a result of factors other than normal aging, such as AD.

Alzheimer's Disease

Alzheimer's Disease is the most common cause of dementia in aging adults without DS. Physiologically, AD presents with senile plaques and neurofibrillary tangles in the brain. The senile plaques are caused by an overproduction of amyloid protein resulting from the triplicated 21st chromosome, while neurofibrillary tangles result from a combination of tau protein and ubiquitin protein. In a review of the literature, Mann (2000) outlined the neuropathologic association between DS and AD. In DS, the third copy of chromosome 21 codes for an overproduction of amyloid protein, which leads to increased amyloid deposits in childhood and adolescence. During adolescence and early adulthood, the amyloid deposits develop into senile plaques. Neurofibrillary tangles develop primarily in the area of the hippocampus, the entorhinal cortex, and the amygdala, and by 50 years of age begin to develop in the cerebral cortex, at which point the physiological symptoms of AD in adults with and without DS becomes indistinguishable. In two studies examining the brains of 35 and 100 deceased adults with DS, all individuals over the age of 30 to 35 had developed a high density of neural plaques and neurofibrillary tangles, greater than what would be expected with normal aging (Malamud, 1972; Wisniewski, Wisniewski, & Wen, 1985). The behavioural effects of these plaques (i.e. dementia) can be evident as early as 40 years of age, but usually are not detectable until 60 or 65 years of age (Cooper & Collacott; 1995; Nelson, Orme,

Osann, & Lott, 2001; Wisniewski & Silverman, 1996).While the progression of physiological symptoms of AD in the DS and non-DS populations is similar, the process underlying each is different, as adults without DS do not have a triplicated copy of the 21st chromosome coding for the overproduction of amyloid protein. Also, adults with DS will live 20 years or more with the physiological symptoms of AD, whereas the progression of AD in adults without DS is only seven to 15 years. These plaques and tangles are typically only detected in post mortem autopsies; however, Magnetic Resonance Imaging (MRI) scans may now detect them (Nelson et al., 2001). In the typical adult population, AD is characterized by progressive cognitive impairment, initially affecting episodic and semantic memory, attention and executive abilities, and later, affecting visuospatial and perceptual abilities, and finally, language, literacy, and the ability to plan and execute movements (i.e. praxis) (Hodges, 2006). Cognitively and behaviourally, AD is thought to present similarly in adults with DS, although there are some differences, particularly an earlier age of onset (Stanton & Coatzee, 2004).

As stated, brain changes characteristic of AD develop in virtually all adults with DS. While AD can only be definitively diagnosed post mortem, cognitive symptoms of dementia provide evidence for a potential or probable AD. It is more difficult to diagnose dementia in adults with DS than adults without DS due to the deficits in language and cognition associated with DS itself (Alzheimer's Association, 2012). As a result, no generally accepted definition of dementia resulting from AD exists for the DS population. Measures such as the *Diagnostic Criteria for Psychiatric Disorders for use with Adults with Learning Disabilities* (*DC - LD*; Royal College of Psychiatrists, 2001), the *Dementia Scale for Down Syndrome* (*DSDS,* Gedye, 1995) or the *International Classification of*

Diseases - Tenth Revision (*ICD- 10*; World Health Organization, 2010) are used to guide the diagnostic process.

Devenny et al. (2000) examined patterns of cognitive decline related to dementia in adults with DS during a ten year longitudinal study. They compared 40 healthy individuals with intellectual disabilities to 44 individuals with DS who were healthy or diagnosed with questionable dementia, early-stage dementia, or middle-stage dementia by a physician. The researchers administered the *Dementia Scale for Down Syndrome* to the participants who received an official diagnosis to further classify the stage of decline (early, middle, and late). Additionally, all participants were assessed on memory and cognition using the *Wechsler Intelligence Scale for Children Revised* (*WISC-R*, Wechsler, 1974), an adapted version of the *Cued Recall Test* (*CRT*, Zimmerli & Devenny, 1995), and an adapted version of the *Selective Reminding Test* (*SRT*, Buschke, 1973). Individuals were assessed annually, although the complete *WISC-R* was only administered twice; once upon entry into the study, and once again during the most recent test cycle. A score below 23 on the *CRT* was predictive of dementia, as was a decline by 20% over at least two consecutive years on the *SRT*. Participants who scored less than 23 on the *CRT* and demonstrated a decline of 20% or more on the *SRT* at the time of the second assessment, but had not received an official diagnosis of dementia from a physician, were classified as having 'questionable dementia'. Results of this study showed that individuals with DS did not display any cognitive changes until they reached 50 to 60 years of age. Furthermore, the presence of behavioural symptoms of dementia was not inevitable, as many of the older research participants with DS did not show any cognitive declines over the course of the study. Indeed, these authors found that declines

in language and cognition were more associated with the stage of dementia than participant age. Individuals with early and middle-stage dementia demonstrated declines in the comprehension subtest, which included questions about social situations and common concepts, while the ability to define a word, declined significantly for individuals with DS in middle-stage dementia. A report released by the Nova Scotia Down Syndrome Society (Moran, Hogan, Srsic-Stoehr, Service, & Rowlett, 2013), which reviewed the literature regarding aging and DS, stated that expressive and receptive language declines were noted in the early stage of AD. During this stage, expressive language declines were characterized by word finding difficulties, smaller vocabulary, shorter phrases, and less spontaneous speech, while declines in receptive language were characterized by an increased difficulty understanding. By middle-stage AD, vocabulary and sentence length further declined such that these individuals often communicated using short phrases and single words.

Nelson et al.'s (2001) study, detailed earlier, reported that individuals with DS who, according to MRI findings, had plaques and tangles in their brain demonstrated lower vocabulary comprehension and pragmatic skill than individuals with normal MRIs (no plaques and tangles). In fact, vocabulary comprehension increased over time for the participants with normal MRIs.

In summary, there is evidence to suggest a relationship between language abilities in adults with DS and AD. More specifically, observed declines in word finding abilities, vocabulary size, phrase length, and frequency of spontaneous speech were reported. Increases in comprehension difficulties were also reported. These declines are not consistent with those noted in Glisky's review of changes associated with normal aging,

since she reported that language is relatively preserved in normal aging, and vocabulary knowledge continues to expand with age. It is possible differences in functioning between younger and older participants in the present study might be related to AD and consequent dementia. However, the impact of these factors was not studied directly. In the present study, information about declines in functioning over time and AD diagnoses were collected via a questionnaire completed by a family member or caregiver. The responses of individuals who had reported declines or a diagnosis of AD were examined for differences from the older group, compared to the performance of the younger group.

Other Factors Affecting Language and Literacy

AD and normal aging, of course, are not the only factors that could impact language and literacy skills. Factors such as schooling and disruption caused by life transitions have been shown to affect the language and literacy abilities of individuals with DS (Kay-Raining Bird & Chapman, 2011; Laws & Gunn, 2004). For instance, Laws and Gunn (2004) reported that some individuals who moved from the family home to college or into a residential home showed signs of decline in cognition and language. Although insufficient research has been conducted to establish a definitive relationship between home literacy environment and language and literacy abilities in individuals with DS (Kay-Raining Bird & Chapman, 2011), research on typically developing children suggests that those raised in rich home literacy environments tend to demonstrate greater reading, writing, and academic skills than those living in poor home literacy environments. Medical conditions, such as hypothyroidism or depression, can also affect the language and literacy abilities of adults with DS (Orange & Zanon, 2005). In the present study, information regarding medical history, schooling, and literacy

exposure were collected via a questionnaire. This information was used to better describe the sample studied and to explore individual differences.

Leisure Participation and Cognitive Health

Research suggests that the frequency of physical activity and cognitive and social stimulation, combined into a single measure referred to as positive leisure activities, help reduce the risk of developing AD and help preserve cognitive processes in the general population (National Institute on Aging, 2010). This may also be true of individuals with DS. Those who participate more in positive types of leisure activities may show resilience to the plateaus and declines in language and literacy skills that come with age or AD. While there is evidence that adults with DS engage in leisure activities, no studies have explored the relationship between leisure participation and cognitive, language, and literacy skills in adults with DS or the predictive value of leisure activity for cognition, language, and literacy. The literature on physical, cognitive, and social leisure activity participation and their potential for reducing the risk or delaying the onset of AD and dementia in the typical population is reviewed and conclusions extrapolated to the DS population. Subsequently, the existing literature on leisure participation in adults with DS is reviewed.

Physical Activity, Cognitive Stimulation, Social Interaction, and Dementia in the General Population

Fratiglioni, Paillard-Borg, and Winblad (2004) conducted a systematic review of the literature on the relationship between physical, cognitive, and social lifestyle on cognition, and dementia. They found evidence that learning new skills from cognitive and physical leisure activities might improve cognitive reserves in the brain by increasing the

number of synapses and neurons, and the efficiency of neural transmission. Such changes are hypothesized to increase the brain's resistance to neuropathologies associated with AD. Fratiglioni et al. (2004) found evidence that physical leisure activity could also help maintain the cerebrovascular system by increasing blood flow or reducing the effect of stress, both potential factors in preventing or delaying the development of neuropathologies associated with AD. In reviewing the literature on social lifestyle and dementia, Fratiglioni et al. (2004) found evidence for a protective effect of social networks and marital status against dementia and AD as well. Additionally, positive social interactions tended to lead to positive emotional states, which reduce stress, and thereby, reduce the risk of developing plaques and tangles in the brain.

Stern and Konno (2009) conducted a systematic review of the literature on physical leisure participation and its association to dementia and AD in the general population. They found that most of the research seemed to suggest that leisure activity participation decreased the risk of developing AD or dementia. There was evidence that increased frequency/regularity, diversity, and intensity of participation all reduced the likelihood of developing dementia and AD later in life. Also, these protective effects were higher for certain types of activity. That is, activities such as gardening, travelling, and walking best protected individuals against the risk of developing AD and dementia as compared to activities such as sports like jogging, cycling, or dancing, which either did not protect against the risk of AD or dementia, or protected to a lesser extent. Reasons for such differences were not discussed in the review. Stern and Konno (2009) noted that many activities could be listed under a number of leisure categories. For instance, travelling was classified as both a physical and a social activity. This complicated the

task of drawing conclusions about the effect of physical leisure activity participation on dementia and AD.

Miller et al. (2011) observed the effect of one hour of aerobic activity, twice per week, for a period of six months, on 31 adults with a diagnosis of questionable dementia or mild cognitive impairment (MCI). The diagnosis was given to participants who scored 0.5 on the *Clinical Dementia Rating*, administered by an experienced neurologist at the start of the study. All participants were younger than 55, were physically able to participate in the exercise sessions, and could independently provide consent to participate in the study. Participants were given a neuropsychological battery of tests which included a modified version of the *Mini-Mental State Examination* (Teng & Chui, 1987), the *Trail Making Test A* and *B* (Reitan, 1958), the *Digit Symbol Coding* (Wechsler, 1997), the *Frontal Assessment Battery* (Dubois, Slachevsky, Litvan, & Pillon, 2000), the *Letter Number Sequencing*, (Wechsler, 1997), the *Hopkins Verbal Learning Test-Revised* (Brandt, 1991), *Animal Naming* (Eslinger, Damasia, & Benton, 1984), and the *Boston Naming Test* (Kaplan, Goodglass, & Weintraub, 1983). Participants were also assessed on cardiovascular endurance and on levels of β-amyloid in their blood. Following the six months of aerobic exercise, participants were re-assessed on all measures. Participants displayed declines on the modified *Mini-Mental State Examination*, delayed recall on the *Hopkins Verbal Learning Test-Revised*, the *Trail Making Test B*, and *Animal Naming*. Furthermore, the declines on the *Mini-Mental State Examination* were likely clinically meaningful (a decline of 2.2 points in six months) and were seen in areas typically associated with AD. No declines were seen on the *Boston Naming Test*. These results suggest that aerobic physical activity did not prevent declines associated with progression

from MCI to AD. Miller et al. (2011) reported that these findings were in disagreement with a similar study conducted by Baker et al. (2010). Baker et al. (2010, cited in Miller et al., 2011) evaluated the benefits of a six-month aerobic exercise routine compared to stretching exercises (control group) for 33 participants randomly assigned to one of the two groups. Participants all had an MCI and exercised for 45–60 minutes per day, four days per week. Heart rate reserve was set at 75–85% for the aerobic exercise group and 37.5–42.5% for the control group. Results from their study suggested that aerobic activity improved executive function, but only in women. Cited in Glisky (2007) studies by Kramer et al. (1999), Hawkins, Kramer, & Capaldi (1992), and Colcombe & Kramer (2003) have shown that involvement in cardiovascular fitness may improve the executive control of attention by improving the efficiency and the metabolic resources of the neural processes. As reported earlier, these differences may be attributable to frequency and intensity of participation in aerobic activities, or may be a result of how declines are measured.

In their systematic review Stern and Munn (2010) investigated cognitive leisure participation and its association to dementia in early and middle adulthood in the general population. Examples of cognitive leisure activities included in the studies were: reading, board games, watching television, puzzles, arts and crafts, and engaging in cultural activities (e.g. going to a play, going to the museum). Protective effects against the risk of AD were demonstrated for cognitively stimulating leisure activities. Once again, the benefits of such stimulation were not consistent across all activities. Activities such as reading and board games were highly protective, while activities such as watching television showed either no positive or even negative effects on the risk of developing

AD. In most of the studies reviewed, reading was found to be the most protective activity. Some of the research reviewed suggested that increased frequency of participation in cognitive leisure activities led to greater protection against the risk of developing AD.

These findings were echoed in three longitudinal studies spanning 2.7 to 4 years, which examined the effect of cognitive and physical leisure participation on cognitive decline in individuals who were diagnosed with potential or probable AD (Akbaraly et al., 2009; Helzner, Scarmeas, Cosentino, Portet, & Stern, 2007; Treiber et al., 2011). In these three studies, all participants received comprehensive clinical assessments, which were comprised of a neurological exam, neuropsychological testing, and clinical interview administered by neurologists, psychometric technicians, or trained psychologists. Cognitive leisure activity participation was found to delay the onset of dementia and AD symptoms. In Treiber et al.'s (2011) study, increases in cognitive leisure participation was associated with a slower rate of decline of scores on the *Mini Mental State Examination* (*MMSE*, Folstein, Folstein, & McHugh, 1975). Cognitive leisure activity participation tended to better protect against declines in *MMSE* scores if participants engaged in these during the earlier stages of AD (e.g., during the first year of dementia symptoms). Treiber et al. (2011) also reported that cognitive activity participation was also associated with better functional ability in the later stages of AD (e.g., three years of dementia symptoms). Physical activity participation (Treiber et al., 2011) and social activity participation (Akbaraly et al., 2009; Helzner et al., 2007) were not found to delay the onset of AD symptoms.

Research by Wilson et al. (2000) conducted over a four-year study period followed 410 typical adults without DS (*M* age in years = 75.5, *SD* = 7.3) who lived in

community residences. Participants had all received a clinical diagnosis of AD (obtained as mentioned above) and a score greater than 10 on the *MMSE*. Cognition was assessed using a 17 test battery on items of memory, language, and visuoconstruction. These tests were also divided to measure verbal abilities (three memory and eight language tests) and non-verbal abilities (three memory and three visuoconstruction tests). Information regarding reading frequency and availability of reading materials in the home during adult life, up to five years prior to the potential or probable diagnosis of AD, was provided by an individual who had the most daily contact with the participant. Frequency of reading was qualified as the number of hours spent reading daily and the number of books read per year. Availability of reading materials was qualified by the number of books in the home, whether or not there was a bookcase in the home, and whether or not the participant had a library card. These measures were combined to form a reading activity composite score. Results of the study suggested premorbid reading scores were correlated to baseline cognitive scores and that increases in reading activity were correlated with a faster rate of decline on measures of global cognition and verbal ability, but not with non-verbal ability. Wilson et al. (2000) suggested that increased reading activity was positively associated with cognitive reserve, such that the brain was more resistant to pathology. Due to this increased resistance, the effect of AD was only visible later in the progression of the disease. However, once the symptoms of AD appeared, the cognitive decline was more rapid in the more frequent readers than the decline noted in the less frequent readers.

In summary, there is evidence that physical, cognitive, and social activities in general, and reading in particular, help reduce the risk of developing AD or delay the

progression of the disease in adults without DS (Akbaraly et al., 2009; Helzner, Scarmeas, Cosentino, Portet, & Stern, 2007; Fratiglioni et al., 2004; Stern and Konno, 2009; Stern and Munn, 2010; Treiber et al., 2011).Furthermore, individuals who engage in cognitive leisure activities such as reading, board games, or physical leisure such as walking, and gardening, have a reduced risk of developing the symptoms of AD, while those who watch television with greater frequency are either as likely or more likely to show the symptoms of AD than participants who do not frequently watch television (Stern & Munn, 2010). Additionally, research suggests that individuals who are more engaged in cognitive leisure would have a reduced risk of developing the symptoms of AD than individuals who are more engaged in physical and social leisure activities (Stern & Konno, 2009).

Leisure and DS

The study of leisure participation in individuals with DS is more limited and has focused primarily upon the types of leisure activities they do, rather than the benefits associated with participation. One exception is a study by Shepperdson (1995), which reported that adolescents with DS who received more stimulation in the home tended to have better language abilities than those who did not. Stimulation was classified as high, medium, or low by the researchers depending on the regularity of the participant's involvement in family outings and special events (e.g. club membership), car ownership, and a general measure of stimulation based on a questionnaire of home activities.

Studies cited in Schlein et al. (2005) by Hayden, Lakin, Hill, Bruininks, and Copher (1992) and Hayden, Soulen, Schleien, & Tabourne, (1996) reported that individuals with disabilities who moved from institutions into group homes (community

living) had limited and primarily passive participation in leisure activities, namely watching television, listening to music, and taking car rides. In contrast, more recent studies have shown that individuals with DS tend to participate in a wide variety of leisure activities (Carr, 1995; Carr, 2008; Jobling & Cuskelly, 2002; Sellinger, et al., 2006), the frequency and type of which vary with age (Carr, 2008; Sellinger, et al., 2006). Carr (2008) conducted a longitudinal analysis of leisure participation in adults with DS. At 30, 35, and 40 years of age, the percentage of participants who engaged at least once per week in watching television (85%, 91%, 91%), listening to music (88%, 88%, 91%), doing household chores (91%, 88%, 88%), and cooking (76%, 68%, 69%) remained fairly stable, while the percentage of those reading (79%, 73%, 62%) and participating in one or more sports (68%, 53%, 44%) declined as participants grew older. Fewer individuals visited with friends (alone: 9%, 12%, 6%; accompanied: 3%, 18%, 0%) as individuals with DS got older as well.

Rosner et al. (2004) examined participation in various types of leisure activities for individuals between 4 and 49 years of age with DS, Williams syndrome or Prader-Willi syndrome. Parents were asked to report on the types of sport and non-sport activities in which their children were engaged. The authors found that individuals with DS were more likely to engage in non-instrumental music activities and visual-motor activities such as arts and crafts compared to individuals with Williams syndrome and Prader-Willi syndrome. Sellinger et al. (2006) conducted a similar study on individuals with DS, Williams syndrome, and Prader-Willi syndrome, between the ages of 5 and 54 and obtained similar results. In contrast to previously mentioned studies, Sellinger et al. (2006) reported that as individuals with DS, Williams syndrome, and Prader-Willi aged,

they engaged more frequently in social activities, namely going out with friends and talking with friends on the phone. Adults with DS also tended to engage in fewer visual-spatial activities (arts-and-crafts, and colouring and drawing activities) and physical activities as they aged. These participation differences were not attributable to differences in IQ (Sellinger et al., 2006).

Frequency of participation in leisure activities and the types of activities in which adults with DS engage has changed over the past few decades. In 1988, Putnam, et al. reported that adults with DS between the ages of 15 and 31 were most likely to engage in passive and non-community-based leisure activities such as watching television, listening to the radio, or spending leisure time with the family, namely taking short trips or vacations. They were less likely to engage in the Special Olympics, sports, hobbies, or join local clubs. Parents who were interviewed for this study generally reported that insufficient leisure opportunities were being offered to their adult children, as well as insufficient support to participate in the opportunities available at the time. In recent years, individuals with DS have reported greater involvement in team and individual sports, and were more likely to complete further education (Carr, 2008).

Jobling and Cuskelly (2002) conducted a study on 173 adults with DS ranging from 18 to 45 years old, in Queensland, Australia. They sent questionnaires to families asking about employment, leisure activities, post-school courses, reading, and religious observance. For leisure activities, questions focused on frequency of participation (hours/week), the type of activities, transportation to and from these activities, what supports were needed to participate, and the participant's choices regarding participation. They reported that 65% of their sample was employed. Watching television was a

common leisure activity with 20% watching less than 10 hours a week, 52% watching 10 to 21 hours a week, and 28% watching over 21 hours a week. Sixty-nine percent of participants participated weekly or monthly in Arts activities, such as music and dance, 66% participated weekly in sports, 32% participated weekly in craft activities, 49% participated daily or weekly in reading activities, and 56% took post-school study classes. In further analyses, Jobling and Cuskelly (2002) separated their sample into two age groups, younger (19-22) and older (23-42). Results suggested that the younger group was more likely to take post-secondary classes, typically literacy for more inclusive employment, and performing arts classes. Activity preferences and employment opportunities were similar for both age groups. Johnson (2000, cited in Kay-Raining Bird & Chapman, 2011) reported that individuals with DS who were more literate had access to more recreational opportunities and were more frequently employed. In her 1995 study, Carr reported that 93% of her sample of 35 adults, who were 21 years of age, listened to music for leisure once per week, 90% watched television once per week, 78% read once per week, and 61% were involved in at least one sport once per week. As these studies show, while there are changes in the frequency of participation in leisure activities across different age groups, the type of activity in which individuals with DS engage tends to remain consistent. Listening to music, watching television, reading, and participating in at least one sport are the most common leisure activities reported.

In summary, recent research has suggested that adults with DS engage in a variety of leisure activities, most frequently watching television, listening to music, reading, sports, and arts and crafts (Carr, 1995, 2008; Sellinger, et al., 2006; Rosner, 2004). Can individuals with DS expect the same benefits from participating in leisure activities as

individuals in the general population? The literature on the benefits of leisure participation in adolescents and adults with DS is scarce. It is possible that patterns seen in aging adults in the general population could be extrapolated to adults with DS. It is also possible that leisure positively influences individuals with DS. The present study assessed age differences in participation in physical, cognitive (including reading), and social leisure activities, watching television, and working for younger and older participants. Additionally, individual scores for older participants, with a special focus on older participants diagnosed with AD, were compared to the younger participant group mean. Leisure was also assessed as a potential predictor of cognition, and language and literacy abilities. Leisure participation was measured as a function of frequency (number of hours per week) and diversity (number of different leisure activities) in younger and older adults.

Present study

The research reviewed on adults with DS has suggested that language ability develops through adolescence and then stabilizes or plateaus from early adulthood through 50 to 60 years of age (Cooper & Collacott, 1995; Rondall & Comblain, 2002), after which language begins to decline. Some studies suggest that some aspects of language continue to develop through adulthood (Hawkins, Eklund, James, & Foose, 2003; Nelson et al., 2001; Rondal & Comblain, 2002; Turner & Alborz, 2003), others are reported to decline (Iacono et al., 2001). There are multiple factors that could account for this decline, including AD, sensory changes, the degree of stimulation in the environment, and important life transitions or medical concerns. While research exists

regarding the protective effects of leisure activity participation against AD in typical adults, no such research is available for adults with DS.

The present study examined cross-sectionally the differences in cognitive, language and literacy skills between younger and older adults with DS. These differences were also examined by comparing individual scores for the older participants in the study, and more specifically the two older participants with a diagnosis of AD, to the group mean for the younger participants. Additionally, the present study examined leisure as a predictor of cognition, language, and literacy skills. Younger (20 - 45) and older (46 - 60) adults with DS were recruited.

Research questions.

This research addressed two questions: 1) Are there differences between younger and older adults with DS in: cognitive skills; language skills; literacy skills; frequency of leisure activity; or type of leisure activity? 2) Does the frequency or type of leisure activity predict cognitive, language, or literacy skills in adults with DS?

For the first question, it was hypothesized that cognition, language, and literacy scores would be similar for the two age groups studied, but lower in the participants who were near 60 years of age or who were diagnosed with AD. With regard to leisure participation, it was hypothesized the frequency of leisure activity would be lower in older adults, but that the type of activities in which they participated would be similar in the younger and older adults with DS. For the second question, it was hypothesized that individuals who engaged more frequently in positive leisure activities, such as physical leisure, cognitive leisure, and social leisure, and specifically in reading, would show higher cognition, language, and literacy skills, than those who engaged less frequently in

these activities. It was also hypothesized that participants who watched television with greater frequency would have lower language and literacy scores than those who watched television with lesser frequency.

While no direct measure of AD or dementia was used in this study, if Alzheimer's disease plays a role in language deterioration, one would expect lower language function for individuals in the older group where symptoms of AD are more likely to be present (Cooper & Collacott, 1995; Orange & Zanon, 2005; Prasher, 1996) or for individuals with diagnoses of dementia identified through caregiver reports. However, if leisure activities play a protective role, language and literacy skills would be lower in those who were less engaged in leisure activities, perhaps especially in the older group.

Chapter 2 - Methods

Participants

In this study, 25 participants aged 20 to 60 years old (M = 32.41, SD = 11.93) were recruited. Participants were in one of two age groups, younger (20 - 45, n = 20) and older (46 - 60, n = 5). Of these, 14 were males (M age in years = 32.13, SD = 11.09) and 11 were females (M age in years = 32.77, SD = 13.46). The composition of the sample is outlined in Table 1. Participants were recruited from Down syndrome associations and various organizations (e.g. Nova Scotia Down Syndrome Society) as well as family support groups, community services, Special Olympics, assisted living/group homes and personal acquaintances. Given the small number of potential participants available in a particular area, participants were recruited in Nova Scotia (n = 15), Prince Edward Island (n = 3), and Ontario (n = 7), to increase the sample size.

In order to be included in the study, participants needed to have DS and be between the ages of 20 and 65, and have no uncorrected vision or hearing problems. Their primary language had to be English, but both monolingual and bilingual individuals were included.

To recruit participants, the primary investigator contacted a total of 30 organizations across Nova Scotia, Prince Edward Island, and Ontario. The recruitment numbers from various organizations are provided in Table 2. Organizations were contacted via e-mail or by phone. The presidents or directors of those organizations who showed interest were sent a letter of recruitment to forward to their members describing the study, its purpose, and the investigator's contact information. The ethics approval that was obtained from Dalhousie University was sufficient for the organizations, homes, and

community services that were contacted, so no additional ethics approval was required. Consent to conduct the tests was obtained either directly from the participants or from their legal guardian. The location of the assessment varied depending on the preference of the participant and the family. For those living in a group home (n = 8), the assessment took place in a quiet room in the home. For those living at home in the Halifax area (n = 5) the assessment was done, as per the participant's preference, either in the home (n = 2), or in a quiet room reserved for such interviews and assessments in Dalhousie University's School of Human Communication Disorders (n = 3). For those living at home outside the Halifax area, the assessment was done in the participant's home (n = 12).

All participants passed a hearing screening (described in Materials section) with one exception. This was a young female participant with a hearing aid (participant #205, age = 22) who was not tested using the audiometer. The participant and her mother confirmed that with the hearing aid, the participant had no difficulty hearing conversational speech. The hearing aid was worn during the testing session.

A short questionnaire (see Appendix A) was administered to collect background information. The first few questions recorded the participants' age, their gender and other demographic information, as well as information to determine their eligibility for the study. The next set of questions recorded educational and housing history (i.e. what year/grade they left school), did they study in an integrated or segregated setting, etc. The third section recorded information about the participants' literacy preferences (e.g. reading enjoyment and frequency, preferred reading materials, source for new reading material). Finally, a fourth section had questions directed at the family member/caregiver

regarding the confirmation of diagnosis of DS and the possible diagnosis of AD. Parents completed the leisure and background questionnaires for 15 participants. Since some participants lived in group homes, parents were not always available to complete the questionnaire. In such instances, a group home worker or director who was familiar with the participant's history completed the forms (n = 8). As a result, information regarding participant education or medical history was not always available (n = 6). In two instances, the participants completed the questionnaire on their own, with support from the principle investigator, and in one instance, the participant completed the questionnaire with the help of her aunt and cousin.

Of the 25 participants studied, 19 were reported to have Trisomy 21 and one was reported to have Mosaic DS (participant #201, age = 22). The type of DS for the remaining five participants was not available. Two of the participants were reported to have been diagnosed with dementia by a family doctor, one female (participant #104, age = 60) and one male (participant #105, age = 55), and a caretaker for both of these participants reported declines in self-help and language skills. Declines in mobility were also reported for the female participant. One additional female participant (participant #211, age = 48) was reported to be showing declines in self-help skills, language skills, and mobility although this person had not received a diagnosis of dementia. All participants spoke English as their first, and preferred language. Two participants were bilingual, one spoke English and Spanish, and the other spoke English and French.

In terms of living arrangements, sixteen participants had been living in their parents' home for a period of time ranging from 20 to 37 years (M = 25.67, SD = 4.50),

eight had been living in a group home for 1 to 26 years (M = 15.25, SD = 12.74)[1], and one had been living independently in an apartment with weekly supervision and assistance from an aide for the past six years. Prior to their current living situations, all participants resided at home, with the exception of one, who resided in a school residence for ten years. With regard to the highest level of education attained, information was only available for 20 participants, all in the young adult group. Eleven participants graduated from high school, one stopped after grade 11 and another after grade 8. Six participants pursued education beyond high school; three attended college, and another three took continuing education courses. Nineteen participants reported on the type of schooling they received. At the elementary school level, of all the 19 participants who reported attending an integrated educational setting, four were segregated, fourteen received mainstream education, and one received partial inclusion. At the high school level, three were segregated, ten were mainstreamed, and six received partial inclusion. Only one participant attended classes for special needs children rather than attending an integrated educational setting. Sex, current place of residence, and degree of inclusion at the grade school and high school level by age group are presented in Table 3.

Participants were also asked to report on medical history. This information was available for all participants. Sixteen participants were taking medication. The most common was Synthroid for hypothyroidism (n = 13). Other reasons for receiving medication included depression (n = 2), high cholesterol (n = 2), reflux (n = 3), birth control and menstrual difficulties (n = 3), lung conditions such as asthma (n = 4), and five participants were medicated for a variety of other difficulties, namely ADHD, blood

[1] Only four participants provided the amount of years spent in a group home, hence the mean has been calculated using only these four values.

pressure, hyperuricemia, rashes, allergies, boils, sleeping medication, and arthritis. Some participants reported having vision problems (n = 13), hearing problems in either one or both ears (n = 6), diabetes (n = 2), asthma (n = 3), cardiac problems (n = 2), celiac (n = 1), seizures (n = 1), perceptual difficulties (n = 1), recovering from overexposure to the sun (n = 1), a stroke (n = 1) or autism (n = 1). The latter two health concerns were of specific interest. An older participant previously had a stroke (in addition to a diagnosis of dementia, participant #104, age = 60) and a younger participant was diagnosed with autism (participant # 202, age = 24). The type of stroke from which participant #104 suffered is unknown. Based on the primary investigators informal observations, participant #104 did not demonstrate any evidence of hemiplegia, aphasia, or dysarthria. Since autism and stroke may affect the language abilities of the participants, the means for each of these participants was compared to the group mean for all other participants to determine whether their scores fell below the norm (Appendix B). While their scores fell below the mean on some measures, these participants were included in the study.

When asked if reading was an activity they enjoyed, 19 reported 'Yes' and six reported 'No'. Of the 19 who enjoyed reading, seven reported reading 'a lot' and 11 reported reading 'some'. One participant did not rate how often he read. A list of options was then provided whereby participants could indicate their favourite reading materials. The majority reported reading two or more options on the list (n = 14). Some only read from magazines (n = 3), newspapers (n = 1), or 'Other' (e.g., picture books) (n = 1). None of the participants answered 'nothing'. Most participants received new reading materials

at least once per month (n = 15) from various sources (e.g. bookstores, library, friends, etc.).

Materials

A background information questionnaire, described above, as well as measures of cognition, expressive and receptive language, literacy, and leisure activity participation were administered.

Cognition measure.

Mental age (MA) was measured using the average of two subtests of the *Stanford-Binet 5* (*SB5*, Roid, 2003): *Vocabulary*, the verbal routing test which measured word knowledge and the *Object-Series/Matrices* subtest, the non-verbal routing test which measured non-verbal fluid reasoning. Since the *SB5* has only been released recently, it has not yet been used in research with the DS population; however, subtests of the *SB4* have been used frequently with this population (Abbeduto et al., 2001; Chapman, 2006; Chapman et al., 1991; Chapman et al., 2002). The *SB* is a well known and frequently used test. The *SB5* has strong validity and reliability (Bain & Allin, 2005; Kush, 2005).

At the simpler levels of the *Vocabulary scale*, participants were asked to label items such as body parts, toys, and pictures. As the participant progressed through the subtest, the participant was then asked to define words. This subtest provided a raw score for verbal cognition. The *Object-Series/Matrices* subtest began by asking the participant to match objects. At the next level of difficulty, the participant completed repetitive and non-repetitive series. The final level of the subtest was similar to the classic matrix reasoning tests, namely the participant filled in the element that completed the pattern in a 2x2, 3x3, or 4x4 matrix. This subtest provided a raw score for non-verbal cognition.

The raw verbal and non-verbal cognition scores were summed to provide a total raw score for cognition. This total raw score was then converted into an abbreviated mental age value. The scoring of the verbal and non-verbal routing tests, as well as the calculation of abbreviated mental age followed the procedure outlined in the scoring manual.

Language and literacy measures.

The *Oral and Written Language Scale – Second Edition, Form A* (*OWLS-II*; Carrow-Woolfolk, 2011) was administered to evaluate *listening comprehension* (*LC*), *oral expression* (*OE*), and *reading comprehension* (*RC*). Each of the three subtests assessed grammar and vocabulary, and to some extent pragmatics (e.g. how to politely request a ball or join a group). The *OWLS-II* has only been released recently, however the *OWLS* has been previously used with the DS population (Abbeduto et al., 2001). The *OWLS* has strong validity and reliability.

During the administration of the *LC* measure, the test administrator presented a verbal stimulus. The participant examined four colour pictures presented on an easel and pointed to the appropriate one, or said the number of the picture. For the *OE* measure, there were two different types of question. In the first type, the examiner described a picture and asked a question about it, and the examinee answered the question. In the second, the examiner began a description, and the examinee ended it. All answers to the *OE* measure were verbal. To score each item, a list of right and wrong answers or scoring rubrics were provided. For the *RC* measure, the participant was asked to read a written prompt. From a field of four, the participant was asked to read and then point to or say the number of the correct picture that best represented the written sentence. Examples of

questions for all three language measures at tested ages are found in Appendix C. Raw scores and age-equivalent scores were calculated for each of the three subtests using procedures outlined in the manual.

Leisure activities questionnaire.

To evaluate the frequency and type of leisure activity participation, the activities in the *Leisure Assessment Inventory* (*LAI*; Hawkins, Ardovino, Rogers, Foose, & Olsen, 2002) were adapted (See Appendix D). The original *LAI* asked participants to choose from 53 listed activities, the ones in which they participated. Caregivers or participants were asked to circle 'Yes' if the participant was involved in the activity and 'No' if the participant was not. If 'Yes', they were asked to state the number of hours per month the participant dedicated to this activity. The administration of this measure was modified following a pilot study. The following modifications were made.

1. Two activities, namely relaxing/day dreaming and listening to the radio/cds/tapes, were removed from the original questionnaire.

2. The remaining activities were combined into 18 activity categories: 1) Work for pay, 2) Volunteer work/helping others, 3) Do household activities, 4) Shop, 5) Go to church/temple, 6) Go to events, 7) Visit with friends or family, 8) Read or be read to, 9) Do puzzles, 10) Do hobbies, 11) Take classes or lessons, 12) Watch television, 13) Exercise, 14) Do group sports, 15) Play games, 16) Miscellaneous leisure activities, 17) Travel or camp, and 18) Others not mentioned[2].

3. Participants/ caregivers were asked whether or not the participant engaged in each category of activities rather than each activity. If they responded 'yes' for a category, participants or caregivers were asked to circle all activities in the category in which the

[2] See Appendix E for activities included in each category.

participant engaged, and add any additional activities not on the list. Next, participants or caregivers were asked to state how many hours they had engaged in the category of activities, as a whole, in the last week. They were then asked if this number was representative of weekly participation throughout the year. If 'yes', they proceeded to the next activity category. If 'no', they were asked to be specific regarding the time period associated with these activities (e.g. hockey three hours per week from November to June, Volleyball two hours per week from September to February, etc.). From the responses provided on the leisure questionnaire, three measures of leisure activity were calculated:

1. Frequency of participation: The categories of activities were assigned a category type: physical, cognitive, social, watching television or working. The distribution of categories by activity type is provided in Appendix D. Frequency of participation was recorded as the number of hours in a week reported for each activity type.

2. Diversity of activities: The total number of different leisure activities listed for all categories reported to be completed in a year was tallied. For instance, if a participant reported playing golf, soccer, hockey, and basketball, these would count as four different leisure activities, despite all being a type of physical activity.

3. Total frequency of positive participation: The sum of hours per week participants spent participating in physical, cognitive, and social leisure activities, combined. Positive participation excluded the amount of hours spent working for pay and watching television.

Hearing.

A portable audiometer was used to screen hearing. Hearing was tested at 45dB for 500Hz, 1kHz, and 2kHz tones. To pass, the participant was required to respond correctly at all three frequencies, in both ears.

Procedure

The data were collected individually. Participants were first screened with the portable audiometer to determine their eligibility to participate in the study. Next, participants were administered the verbal and non-verbal subtests of the *SB5* in individually randomized order. The three subtests of the *OWLS-II* (the *LC*, *OE*, and *RC* subtests) were administered next in individually randomized order. As the language and literacy measures identified a start point based on a participant's age, the mental age calculated from the *SB5* was used to determine the starting point for the assessment. Basal rules were followed to determine the appropriateness of the starting point (seven correct in a row).

If a caregiver completed the background and leisure questionnaires, they filled them out while the participant completed the cognition, language, and literacy measures. At the end of the session, the investigator reviewed the answers with the participant and the caregiver or director, to ensure the reliability of the answers and to clarify certain answers. On two occasions, when the caregiver was absent or unwilling to complete the leisure measure and the background questionnaire, these were administered to the participant after the cognition, language, and literacy measures. When the background questionnaire was given to the participant, administration followed an interview format. Answers were recorded by the researcher. Total testing took between one and two hours

and was completed in one session, with a short break and snack provided at the halfway point.

Table 1.

Mean age (M) and standard deviation (SD) of the younger and older participants.

	Males		Females	
	Younger	Older	Younger	Older
n	12	2	8	3
M	28.38	54.58	25.30	52.70
SD	6.20	.69	3.60	6.42

Table 2.

Distribution of participants by location of recruitment.

Location of Recruitment	Number of Participants
DS associations/organizations and family support groups	9
Community Services	7
Special Olympics	2
Assisted Living/Group Homes	2
Personal Acquaintances	5
Total	25

Table 3.

Distribution of participants by age, gender, current place of residence, and degree of inclusion in grade school and high school.

	n	Sex (n)	Current place of residence (n)	Inclusion in grade school (n)	Inclusion in high school (n)
Younger	20	Male: 12	With parents: 16	Mainstream: 14	Mainstream: 10
		Female: 8	Group home: 3	Segregated: 4	Segregation: 3
			Apartment: 1	Partial Inclusion: 1	Partial Inclusion: 6
Older	5	Male: 2	With parents: 0	Mainstream: n/a*	Mainstream: n/a
		Female: 3	Group home: 5	Segregated: n/a	Segregation: n/a
			Independently: 0	Partial Inclusion: n/a	Partial Inclusion: n/a

*n/a: not available

Chapter 3 - Results

The study had two components. The first was descriptive and cross-sectional in nature, examining age-group differences in cognition, language and literacy skills, and leisure participation in younger (20-45) and older (46-60) adults. The second was correlational in nature, and used regression analyses to examine whether leisure activities predicted cognition, language or literacy skills. An alpha level of .05 was used for all analyses.

Cognition, Language, and Literacy in Adults as a Function of Age

Table 4 provides descriptive statistics for younger and older participant raw scores and mental ages on measures of verbal and non-verbal cognition, as well as age-equivalent scores for language and literacy measures (LC, OE, and RC). Differences in these cognitive, language and literacy measures were analyzed in two ways. Due to the small number of participants in the older group, age-equivalent scores for each of the five older participants were compared to the group mean and standard deviation for the younger group on each measure. More specifically, older group participants' individual scores were compared to see if they fell within the mean and standard deviation of the younger group on the MA, the LC age-equivalent score, the OE age-equivalent score, and the RC age-equivalent score. Individual scores for the older group as well as the younger group mean and standard deviation for all four measures are found in Table 6. Figures 1-4 display the individual scores for the younger and older participants on the measures of MA, LC age-equivalent scores, OE age-equivalent scores, and RC age-equivalent scores, respectively. It is important to note that older participant #1 was diagnosed with AD and had previously had a stroke, older participant #2 was also diagnosed with AD, and while

older participant #3 did not receive a formal diagnosis of AD/dementia, the group home director had noted declines in motor skills, self-help skills, and language skills, symptoms often considered when diagnosing dementia. For all measures, all older participants scored below the mean of the younger group and some scored more than one standard deviation below the mean of the younger group. Specifically, for MA, older participant #2 scored more than one SD below the younger mean. On the measures of LC age-equivalent scores and OE age-equivalent scores, older participants #1 and #2 scored more than one standard deviation below the younger mean. Finally, on the measure of RC age-equivalent scores, the scores for older participants #2 and #3 fell more than one standard deviation below the younger mean. Both younger and older participants tended to score most highly on the measure of RC.

These results suggest that older individuals tend to have cognitive, language and reading scores that fall on the lower end of the younger adult distribution. Those that scored more than one standard deviation below the younger group mean were either officially diagnosed with AD (older #1 and #2) or were demonstrating some of the early symptoms of dementia (older #3). Regardless of age, RC seems to be a relative strength for the participants in this study.

The data were analyzed statistically using a Two-Way age-group (younger, older) by measure (cognition, LC, OE, and RC) mixed ANOVA, age was the between-subjects independent variable (IV) and measure was the within-subjects IV. Mental age (MA)/age-equivalent scores from the *SB-5* and the *OWLS-II* were used as the dependent variables (DV). The results of the between-subjects analysis showed a significant effect of age, $F(1, 23) = 5.619$, $p = .027$, $\eta_p^2 = .196$. While there is no standard method of

interpretation for partial eta squared, the MRC Cognition and Brain Sciences Unit (2013) recommends squaring Cohen's (1988) values for eta squared, such that a small effect size for partial eta squared is greater than 0.010, a medium effect size is greater than .090, and a large effect size is greater than 0.250. Using this interpretation, age had a medium effect size, accounting for 19.6% of the variance. In this case, younger participants, $M = 4.739$, $SE = .251$, had significantly higher age-equivalent scores than older participants, $M = 3.407$, $SE = .503$, regardless of measure. The multivariate Pillai's Trace was reported for within-subject effects as it controlled for possible correlations between variables. The multivariate Pillai's Trace showed a significant effect of measure, $F(3, 21) = 14.954$, $p < .010$, $\eta_p^2 = .681$. The effect size of measure was large, accounting for 68.1% of the variance. Pairwise comparisons of estimated marginal means revealed that RC age-equivalent scores, $M = 5.219$, $SE = .261$, were significantly higher than MA, $M = 3.576$, $SE = .259$, LC age-equivalent scores, $M = 3.782$, $SE = .355$, and OE age-equivalent scores, $M = 3.714$, $SE = .414$. None of the other pairwise comparisons were significant. SPSS controlled for the multiple comparisons using a Bonferroni correction. The estimated marginal means and standard errors for all four measures are presented in Table 7, and the results of all possible pairwise comparisons are found in Table 8.The interaction between measure and age was not significant, $F(3, 21) = .715$, $p = .554$, $\eta_p^2 = .093$, but had a medium effect size, accounting for 9.3% of the variance. Results of this Two-Way Repeated Measures ANOVA are displayed graphically in Figure 5.

These results support the findings of the individual data analysis. Older participants tended to score more poorly on measures of cognition, language, and literacy than younger participants. Also, participant scores differed significantly based on the

measure that was used. More specifically, participants, regardless of age, tended to score most highly on measures of RC. The effect of AD was not separated from the effect of age in the statistical analysis.

Age differences and Leisure Activity

Table 5 provides descriptive statistics for frequency of leisure activity participation in physical leisure, cognitive leisure, social leisure, watching television, working for pay, and total positive leisure activities (sum of hours spent in physical, cognitive, and social leisure activities), as well as for the diversity of leisure activities in which younger and older participants engaged (total number of different leisure activities).

Age-group differences in leisure activity participation were analyzed using several measures. First, frequency of leisure participation (in hours per week) was examined for each of the five leisure activities (physical, cognitive, social, watching television, and working) individually. Next, frequency of leisure participation was examined using the positive leisure participation measure, defined as the sum of hours per week reported spent in physical, cognitive, and social leisure activities. Given the focus the literature has placed on the importance of reading in language development, an analysis of age-related differences in frequency of reading (in hours per week) was also done. Finally, age-related differences in leisure participation were assessed using the diversity measure, defined as the number of different activities in which the participants engaged. Analyses of each of these measures is reported below.

As with cognition, language, and literacy, group differences in frequency of leisure activity were explored in two ways. First, individual data from participants in the

older category were compared to the group mean and standard deviation of participants in the younger category. Second group differences were statistically analyzed.

Variability in the Frequency of Leisure Participation as a Function of Age.

Table 9 shows the individual data for the five older group participants and the mean and standard deviation for the younger group for the number of hours per week spent in each of the five leisure activities (physical leisure, cognitive leisure, social leisure, watching television, and working). For physical leisure activities, all participants in the older group scored below the mean and three scored more than one standard deviation below the mean (older #1, #3, and #5). In contrast, looking at cognitive leisure activity participation, two participants (older #1 and #4) scored below the mean, but none scored below one standard deviation of the mean. With regard to social leisure activity participation, all older participants scored below the younger group mean, two scored more than one standard deviation below the mean (older #1 and #2). Looking at number of hours spent watching television, older participant #1 and #4 scored below the mean and older participant #2 scored one standard deviation below the younger group mean. Finally, looking at the number of hours spent working, all older adults scored above the younger group mean and older participants #3, #4, and #5 scored more than one standard deviation above the younger group mean.

This analysis of individual data suggests that age-related group differences may vary as a function of activity type, such that older adults may be more likely to spend their time working for pay than the younger group and less likely to engage in physical and social leisure activities. Additionally, in many cases, the participants scoring one standard deviation below the younger group mean were the participants diagnosed with

AD (older #1 and #2). With regard to hours spent working, while all older participants scored above the younger group mean, only those who were not officially diagnosed with AD had a mean that fell one standard deviation above the younger group mean. Dementia/AD may contribute to some of the activity specific age-related changes.

A Two-Way mixed ANOVA was conducted with age (younger, older) as the between-subjects IV, activity type (physical, cognitive, social, watching TV, working) as the within-subjects IV, and frequency of participation as the DV, defined as the number of hours per week spent in a given activity type. Results of the mulitvariate Pillai's Trace showed a significant effect of activity type, $F(4, 20) = 16.349$, $p < 0.01$, $\eta_p^2 = 0.766$. No significant effect of age, $F(1, 23) = .214$, $p = .648$, $\eta_p^2 = .009$ and no significant interaction between age and activity type, $F(4, 20) = 2.020$, $p = .130$, $\eta_p^2 = .288$, were obtained. Using the previously mentioned interpretation, activity type had a large effect size, accounting for 76.6% of variance, age had a very small effect size, accounting for 0.9% of the variance, and activity type had a large effect size, accounting for 28.8% of the variance. Pairwise comparisons based on estimated marginal means were conducted to further analyze the main effect of activity type. SPSS controlled for the multiple comparisons, using the Bonferroni correction. These comparisons revealed that, regardless of age, participants spent significantly more time, measured in hours per week, involved in cognitive leisure activities, $M = 24.457$, $SE = 4.528$, social leisure activities, $M = 14.107$, $SE = 2.658$, and working, $M = 23.419$, $SE = 3.369$, than in physical leisure activities, $M = 5.872$, $SD = 1.022$. No other pairwise comparisons were significant, although the difference between watching television, $M = 15.775$, $SD = 3.165$, and physical leisure approached significance ($p = .081$), whereby participants tended to watch

television more frequently than engaging in physical leisure. The estimated marginal means and standard errors for all five activity types are available in Table 10, and the results of all pairwise comparisons are found in Table 11.

This statistical analysis revealed that most participants, regardless of age, engaged least frequently in physical leisure activities. This was not obvious in the individual data analysis because the leisure activity types were not compared directly. Consistent with the findings of the individual analysis, there was no main effect of age on number of hours spent in leisure activities.

Interestingly, while the statistical analysis did not reveal an interaction between activity type and age, the large effect size suggests that there may be activity type specific age-related differences in leisure activity participation that would be detectable with a larger sample size, namely that older participants are more likely to work and less likely to engage in physical or social leisure activities. The statistical analysis could not separate age-related changes from dementia-related changes; such a separation was suggested in the individual analysis.

Variability in the Total Positive Leisure Participation as a Function of Age.

Based on the review of the literature, engaging in physical, cognitive, and social leisure activities was found to have positive effects on language and cognition (Fratiglioni et al., 2004; Miller et al., 2011; National Institute on Aging, 2010; Stern & Konno, 2009; Stern & Munn, 2010; Treiber et al., 2011). As such, total positive leisure participation, defined as the sum of hours spent engaging in physical, cognitive, and social leisure activities, was analyzed as a function of age. First, individual datum from the five older participants was compared to the younger group mean and standard

deviation. Results of this analysis showed that all older adults engaged in fewer hours of positive leisure participation than the younger group mean, two of which (older #1 and #4) fell more than one standard deviation below the group mean (see Table 9). As mentioned previously, older participant #1 was diagnosed with AD and suffered a stroke; older #4 suffered from depression, for which he was receiving medication.

An independent-samples t-test was conducted with age as the independent variable and positive leisure participation as the dependent variable. Levene's test was not passed for this analysis, $F(1, 23)$ 5.552, $p = .027$. Assuming unequal variances, the results of this independent t-test found a significant main effect of age with a medium-large Cohen's effect size, $t(16.741) = 2.187$, $p = .043$, $d = .715$. The younger participants ($M = 52.596$, $SD = 25.729$) engaged significantly more often in positive leisure activities than the older participants ($M = 36.274$, $SD = 10.628$).

Variability in Frequency of Reading as a Function of Age.

Given the importance of reading in the language development literature, differences in the frequency of reading with age were also assessed. First, individual data were assessed and compared the number of hours per week the five older participants spent reading compared to the mean and standard deviation of the younger group. These analyses did not reveal any clear age-related differences, with two participants (older #3 and #5) scoring more than one standard deviation above the younger group mean, older #1 and #2 scoring below the younger group mean, but within one standard deviation, and older #4 scoring one standard deviation below the younger group mean.

Second, these data were analysed using an independent samples t-test with age as the IV and frequency of reading (in hours per week) as the DV. Levene's test was not

passed for this analysis, $F(1, 23) = 91.736$, $p < .01$. With equal variances not assumed, there was no significant effect of age on frequency of reading, $t(4.155) = -1.077$, $p = .340$, $d = 0.998$, although Cohen's effect size was large.

While the statistical analysis supported the findings of the individual data, the large effect size suggested that a relationship may become evident with a larger sample size.

Diversity of Leisure Activities as a Function of Age.

Diversity of leisure activity participation, defined as the total number of different leisure activities in which participants engaged, was also examined. The number of different leisure activities (diversity) in which each of the five older participants engaged was compared to the group mean and standard deviation for the younger group (see Table 9). Results of this analysis revealed that three out of the five participants in the older group (older #3, #4, and #5) scored one standard deviation below the mean for the younger group. Older #1 and #2 scored slightly above and within one standard deviation of the mean.

Next, an independent-samples t-test was conducted with age as IV and the diversity of leisure activities as the DV. Levene's test was passed for this analysis, $F(1, 23) = 0.04$, $p = .949$. Results of this independent t-test found that the effect of age was not significant, although Cohen's effect size was medium-large, $t(23) = .443$, $p = .162$, $d = .722$.

While more difficult to interpret, the analysis of the individual data suggested that older participants tended to engage in fewer leisure activities than younger participants.

While the statistical analysis did not reveal a significant effect of age, the effect size was medium-large, which suggested that a larger sample may reveal a significant effect.

Influence of place of residence on cognition, language, literacy, and leisure

An examination of leisure activity participation individual data for older participants suggested that older participants #1 and #2 often diverged from that of Participants # 3-5. One interpretation that has been considered already is that age differences reflect the presence of AD in older participants #1 and #2. Interestingly, however, older participants #1 and #2 were recruited from the same group home, and older participants #3, #4, and #5 were recruited from another. Consequently, it may be the case that differences in leisure activity participation between the older participants are attributable to differences in schedules and programs at the different group homes, rather than to the presence of AD. It would, therefore, be possible that living in a group home would also influence differences in leisure activity participation with participants living at home, all of whom were younger participants. Furthermore, there is literature to suggest that participants who live in a group home have poorer cognition and language scores than those who live with their parents (Laws & Gunn, 2004).

Descriptive statistics were examined to determine whether cognition, language, literacy, and leisure scores varied by place of residence. Older participants #1 and #2 were excluded from these analyses such that the effect of AD did not influence the possible effect of place of residence. Place of residence was grouped into the following categories: participants who lived in their parent's home (younger $n = 16$), in a group home (younger $n = 3$, older $n = 3$), or independently (younger $n = 1$).

Table 12 provides the means and standard deviations for cognition, language, and literacy age-equivalent scores for participants who lived in their parent's home or a group home; individual data are provided for the participant who lived independently.

To statistically test whether groups differed on any measure as a function of place of residence, a Two-Way Repeated Measures ANOVA was conducted with place of residence (parents' home and group home) as the between-subjects IV and measure (cognition, LC, OE, and RC) as the within-subjects IV. MA/age-equivalent scores from the *SB-5* and the *OWLS-II* were used as the DV. Since the participant living independently had similar scores to those living with their parents on all measures, she was included in the parents' home group. Since the effect of measure has already been reported in the "Cognition, Language, and Literacy in Adults as a Function of Age" section, only the main effect of place of residence and the interaction effect will be reported here. Analyses revealed no significant effect of place of residence, $F(1, 21) = 2.317$, $p = .143$, $\eta_p^2 = .099$. Place of residence had a medium effect size, accounting for 9.9% of the variance. The multivariate Pillai's Trace did not reveal a significant interaction between measure and place of residence, $F(3, 19) = .471$, $p = .706$, $\eta_p^2 = .069$, and this interaction had a small effect size, accounting for 6.9% of the variance. This analysis suggests that participants living in a group home did not have significantly poorer cognition, language, and literacy scores than participants living with their parents.

Table 13 provides the descriptive statistics for physical leisure, cognitive leisure, and social leisure activity participation, watching television, working, positive leisure

participation, reading, and diversity of leisure activities. Perusal of these statistics suggests that groups may differ on several leisure measures.

A Two-Way Repeated Measures ANOVA was then conducted with place of residence (parents' home and group home) as the between-subjects IV and activity type (physical leisure, cognitive leisure, social leisure, watching television, and working) as the within-subjects IV. Frequency of participation (in hours per week in a given activity type) was the DV. The participant who lived independently fell within or above one standard deviation of the means for participants living with their parents on all measures and was included in the group of participants living in their parents' home. Since the main effect of activity type was already discussed in the section " Variability in the Frequency of Leisure Participation as a Function of Age" only the results of the main effect of place of residence and the interaction effect will be discussed here. No significant effect of place of residence was found, $F(1, 21) = .034$, $p = .856$, $\eta_p^2 = .002$. Place of residence had a small effect size, only accounting for 0.2% of the variance. The interaction between activity type and place of residence approached significance, $F(4, 18) = 2.612$, $p = .070$, $\eta_p^2 = .367$, with a large effect size, accounting for 36.7% of the variance. See Figure 6 for a graphical representation of this interaction. Post-hoc independent sample t-tests were run to examine the specific effect of place of residence(IV) on frequency of participation in all five activity types (physical, cognitive, and social leisure, watching television, and working; DV). Using the Bonferroni correction, the p-value was set to .01 for all five t-test. Levene's test was passed for all five analyses ($p > .06$). These analyses suggested that the effect of place of residence approached significance on physical leisure participation, $t(21) = 2.212$, $p = .038$, $d = 1.050$, with a large effect size. Participants

living in a group home, $M = 4.408$, $SE = 1.576$, tended to engage in fewer physical leisure activities than those living with their parents, $M = 8.8165$, $SE = 1.042$. The effect of place of residence also approached significance for number of hours spent working, $t(21) = -2.572$, p .018, $d = 1.221$, with a large effect size. Participants living in a group home, $M = 30.500$, $SE = 4.500$, tended to work more hours than those living in their parents' home, $M = 14.0453$, $SE = 3.433$. Place of residence did not have a significant effect on frequency of cognitive leisure participation, $t(21) = 1.468$, $p = .157$, $d = 0.697$, frequency of social leisure participation, $t(21) = .585$, $p = .565$, $d = .278$, and number of hours spent watching television, $t(21) = -.211$, $p = .835$, $d = 0.100$. Place of residence had a medium effect size for cognitive leisure participation, but a small effect size for social leisure participation and hours spent watching television.

Next, an independent samples t-test with place of residence as the IV and diversity, defined as the number of different activities in which participants engaged, as the DV was run. Levene's test was passed for this test, $F(1, 21) = .3.695$, $p = .068$. Results of the t-test revealed a significant effect of place of residence on diversity of leisure participation, $t(21) = 3.929$, $p = .001$, $d = 1.866$, with a large effect size. Participants living in their parents' home engaged in a greater diversity of leisure activities, $M = 25.59$, $SE = 1.743$, than participants living in a group home, $M = 13.50$, $SE = 1.360$.

Finally, an independent samples t-test was run with place of residence as the IV and frequency (hours per week) of reading as the DV. Levene's test was not passed for this analysis, $F(1, 21) = 46.399$, $p < .01$. Assuming unequal variances, place of residence

did not have a significant effect of frequency of reading, $t(5.270) = -.682$, $p = .524$, $d = .519$, although place of residence had a medium effect size.

It appears that place of residence only affects certain aspects of leisure participation, namely frequency of physical leisure, frequency of work, and diversity of leisure participation. While important to consider, these findings are difficult to interpret in light of the overlap in participants with the earlier presented age-related differences, as all the participants living at home or independently were in the younger group and all the older participants resided in group homes. Only three younger participants lived in a group home.

Correlations between Leisure Participation and Cognition, Language, and Literacy

The relationships between measures of age, cognition, language, literacy, and leisure were examined using Pearson Product Moment correlations. All participants were included in the analyses. First, correlations were examined between age and the raw measures of cognition, language, and literacy. Age was significantly and negatively correlated with raw verbal cognition scores, $r = -.425$, $p = .034$, raw non-verbal cognition scores, $r = -.419$, $p = .037$, and total raw cognition scores ($r = -.491$, $p = .013$). Age was also negatively and significantly correlated with LC, $r = -.383$, $p = .059$, OE, $r = -.468$, $p = .018$, and RC, $r = -.419$, $p = .037$. These correlations show that all measures of cognition, language and reading tend to be lower with increasing age.

The two measures of cognition were significantly and positively correlated to each other, p's $< .03$. Given this, in the linear regression analyses reported below, the total raw cognition score was used as a predicted variable, rather than the verbal and non-verbal subtest raw scores separately. LC, OE, and RC, while significantly correlated to

one another, were analyzed in separate linear regressions to be consistent with previous analyses in the literature and because they measured different aspects of ability.

Linear Regressions

The second part of the study examined whether the frequency or type of leisure activity predicted cognitive, language or literacy skills in adults with DS. That is, linear regressions were run to better understand which factors could account for variation in cognitive, language and literacy scores in adults with DS. Raw scores from the total cognition measure of the *SB5*, and the LC, OE, and the RC measures of the *OWLS-II* were used as the predicted variables. Recommendations vary as to the number of predictor variables that can be used in a regression analyses. Harris (1985, cited in Wilson Van Voorhis & Morgan, 2007), for example, suggests using the number of predictors plus 50 to determine the appropriate number of participants in a multiple regression. Stevens (2009, cited in the Division of Statistics and Science Computation FAQ, University of Texas at Austin, 2013) recommends using no more than one predictor variable for every 15 participants in a regression analysis. Neter et al. (1996, cited in Quinn & Keough, 2002) suggest using no more than one predictor variable for every six to ten participants in a regression analysis. Given these recommendations and the preliminary nature of the current study, we chose to follow Neter et al. and include no more than four predictor variables in any regression analysis.

To determine which leisure predictor variables should be used in the regression analyses, correlations were conducted between the number of hours spent in physical leisure, cognitive leisure, social leisure, watching television, and working, diversity of leisure activity participation, and number of hours spent reading. The relationship

between physical leisure and diversity of leisure activity participation was positive and approached significance, $r = .393$, $p = .052$. Cognitive leisure was also significantly and positively correlated with diversity, $r = .643$, $p = .001$. Number of hours spent working was significantly and negatively correlated with physical leisure, $r = -.500$, $p = .011$, social leisure, $r = -.652$, $p < .001$, and diversity, $r = -.457$, $p = .022$ and the negative correlation between working and cognitive leisure approached significance, $r = -.360$, $p = .077$. Number of hours spent watching television and reading were not significantly correlated with any other leisure measure. While cognitive, social and physical leisure activities were not significantly correlated, they were all positively related. These correlations are shown in Table 14.

To select leisure predictors for the linear regressions, the following guidelines were followed: 1) variables that were positively correlated to each other were combined and entered as a single predictor and 2) variables that were uncorrelated or negatively correlated to the other leisure variables were included individually. Given the positive correlations between physical, cognitive, and social leisure, and the literature suggesting that all three have a positive protective effect on AD, the positive leisure participation measure was selected as one predictor. Watching television was selected as a predictor variable as it was negatively correlated with all measures of cognition, language, and literacy. Because of the negative and significant correlations between working and physical, cognitive, and social leisure frequency measures, working was entered as predictor. Reading and television watching were not correlated significantly with any other measure of leisure and were therefore additional candidates as predictors. However, since four predictors were considered the maximum number to enter, we chose to conduct

a first set of analyses with the following predictors: age, positive leisure participation, watching television, and working. Later analyses will enter reading as a predictor variable.

The first linear regression examined predictors of total raw cognition. This model approached significance, and combined, the variables accounted for 35.5% of the variance, $F(4, 20) = 2.755$, $p = .057$, $R^2 = .355$, only age made a significant contribution, accounting for 14.3% of the variance, $\beta = -.412$, $p = .042$.

The second linear regression examined raw LC scores with all four predictors entered in the model. No variables significantly predicted LC scores, although combined, they accounted for 24.3% of the variance, $F(4, 20) = 1.604$, $p = .212$, $R^2 = .243$.

The third of these linear regressions examined OE. All four predictors combined accounted for 68.4% of the variance, $F(4, 20) = 4.387$, $p = .010$, $R^2 = .684$. Age made a significant contribution, accounting for 21.7% of the variance, $\beta = -.407$, $p = .029$. Hours spent watching television also contributed negatively and significantly, accounting for 20.1% of the variance, $\beta = -.377$, $p = .036$.

The fourth and last linear regression examined raw RC the variables combined, accounted for 32.8% of the variance, $F(4, 20) = 2.442$, $p = .080$, $R^2 = .328$. Only age made a contribution which approached significance, accounting for 12.7% of the variance, $\beta = -.343$, $p = .092$.

Thus far, evidence suggests that age was the best overall predictor of cognition, language, and literacy abilities having a significant and negative effect on all variables except LC. Hours spent watching television contributed negatively to differences in OE

scores. Neither positive leisure participation nor hours spent working predicted cognition, language, or literacy scores significantly.

Linear Regressions with Reading as a Predictor

To examine whether reading frequency predicted cognition, language or literacy abilities over and above the other identified predictors, linear regressions using the significant predictors in the last analyses, age and watching television, and reading using a forced entry method (in the identified order) were completed.

While frequency of reading did not contribute significantly to the models for cognition, language, and literacy, when reading was included as a predictor, the LC model approached significance and explained 26.2% of the variance, $F(3, 21)$ 2.482, $p = .089$, $R^2 = .262$. Only age contributed significantly, accounting for 22.3% of the variance, $\beta = -.441$, $p = .032$. See Table 15 for results of the four linear regressions with age, watching television, and reading as predictor values. See Table 16 for the standardized coefficients and significance of the predictor variables.

In summary, the four regression analyses which included positive leisure participation and working as predictors rather than frequency of reading accounted for a greater proportion of the variance in the cognition and OE models. In all cases, however, age was the best predictor of cognition, language, and literacy abilities. Watching television did contribute to variance in OE scores. Both age and watching television negatively predicted cognition, language, and literacy abilities.

Table 4.
Range, mean (M) and standard deviation (SD) for raw scores and age-equivalences on measures of verbal and nonverbal cognition, listening comprehension (LC), oral expression (OE), and reading comprehension (RC), divided by age group.

	Younger	Older	Total
n	20	5	25
Verbal Cognition Raw Score	*Range* = 12 -28	*Range* = 5 - 18	*Range* = 5 - 28
	M = 18.40	*M* = 14.40	*M* = 17.60
	SD = 4.71	*SD* = 5.37	*SD* = 5.00
Non-verbal Cognition Raw Score	*Range* = 6 - 17	*Range* = 5 - 9	*Range* = 5 - 17
	M = 10.20	*M* = 7.20	*M* = 9.60
	SD = 3.17	*SD* = 1.64	*SD* = 3.15
Raw Total Cognition	*Range* = 21.00 - 43.00	*Range* = 11.00 - 26.00	*Range* = 11.00 - 43.00
	M = 28.00	*M* = 21.60	*M* = 27.20
	SD = 6.64	*SD* = 6.11	*SD* = 7.02
Mental Age	*Range* = 3.03 - 6.11	*Range* = 2.00 - 4.01	*Range* = 2.00 - 6.11
	M = 4.10	*M* = 3.05	*M* = 3.89
	SD = 1.09	*SD* = 0.71	*SD* = 1.10
Raw LC	*Range* = 8 - 85	*Range* = 8 - 37	*Range* = 8 - 85
	M = 42	*M* = 23.00	*M* = 38.20
	SD = 19.34	*SD* = 13.55	*SD* = 19.67
LC Age-Equivalent	*Range* = 2.08 - 8.10	*Range* = 2.08 - 4.06	*Range* = 2.08 - 8.10
	M = 4.50	*M* = 3.07	*M* = 4.21
	SD = 1.50	*SD* = 0.98	*SD* = 1.51

	Younger	Older	Total
n	20	5	25
Raw OE	*Range* = 10 - 61	*Range* = 1 - 32	*Range* = 1 - 61
	M = 31.25	*M* = 13.20	*M* = 27.64
	SD = 17.43	*SD* = 11.71	*SD* = 17.82
OE Age-Equivalent	*Range* = 2.09 - 8.03	*Range* = 2.07 - 4.00	*Range* = 2.07 - 8.03
	M = 4.58	*M* = 2.84	*M* = 4.24
	SD = 1.78	*SD* = 0.80	*SD* = 1.77
Raw RC	*Range* = 3 - 66	*Range* = 0 - 10	*Range* = 0 - 66
	M = 20.70	*M* = 5.80	*M* = 17.72
	SD = 16.47	*SD* = 4.92	*SD* = 15.99
RC Age-Equivalent	*Range* = 4.10 - 9.07	*Range* = 4.02 - 5.09	*Range* = 4.02 - 9.07
	M = 5.77	*M* = 4.67	*M* = 5.55
	SD = 1.12	*SD* = 0.58	*SD* = 1.12

Table 5.
Mean (M) number of hours and range of hours spent in physical, cognitive, and social leisure activities, watching television, working for pay, total positive leisure, and diversity of leisure participation and the standard deviation (SD) for each category, divided by age group.

	Younger	Older	Total
n	20	5	25
Physical leisure (hours)	*Range* = 1.45 - 16.00	*Range* = 2.00 - 5.07	*Range* = 1.45 - 16.00
	M = 8.37	*M* = 3.38	*M* = 7.37
	SD = 4.47	*SD* = 1.18	*SD* = 4.49
Cognitive leisure (hours)	*Range* = 2.32 - 71.65	*Range* = 10.00 - 36.00	*Range* = 2.32 - 71.65
	M = 24.91	*M* = 24.00	*M* = 24.73
	SD = 19.34	*SD* = 10.51	*SD* = 17.73
Social leisure (hours)	*Range* = .46 - 39.69	*Range* = 3.00 - 13.27	*Range* = .46 - 39.69
	M = 19.32	*M* = 8.90	*M* = 17.23
	SD = 11.54	*SD* = 4.15	*SD* = 11.24
Watching television (hours)	*Range* = 1.00 - 45.00	*Range* = 3.50 - 20.00	*Range* = 1.00 - 45.00
	M = 18.05	*M* = 13.5	*M* = 17.14
	SD = 13.55	*SD* = 7.02	*SD* = 12.53
Working for pay (hours)	*Range* = .00 - 35.00	*Range* = 25.00 - 35.00	*Range* = .00 - 35.00
	M = 15.84	*M* = 31.00	*M* = 18.87
	SD = 14.61	*SD* = 5.48	*SD* = 14.57
Total Positive Leisure	*Range* = 9.17 - 98.08	*Range* = 23.38 - 45.27	*Range* = 9.17 - 95.08
	M = 52.60	*M* = 36.27	*M* = 49.33
	SD = 25.73	*SD* = 10.63	*SD* =24.23

	Younger	Older	Total
n	20	5	25
Diversity	*Range* = 11 - 41 *M* = 23.90 *SD* = 7.94	*Range* = 12 - 28 *M* = 18.20 *SD* = 7.69	*Range* = 11 - 41 *M* = 22.76 *SD* = 8.07

Table 6.

Means and standard deviations of younger group and individual scores of older participants on mental age (MA) and age-equivalent scores on listening comprehension (LC),oral expression (OE), and reading comprehension (RC).

	Younger Mean	Std. Dev.	Older #1*	Older #2**	Older #3	Older #4	Older #5
MA	4.10	1.09	3.04	2.00	4.01	3.11	3.09
LC AE	4.50	1.50	2.08	2.10	4.06	4.04	3.05
OE AE	4.58	1.78	2.11	2.07	4.00	3.03	3.01
RC AE	5.77	1.11	5.08	4.05	4.02	5.09	5.09

* Older participant #1 had a stroke and received a diagnosis of AD.

** Older participant #2 received a diagnosis of AD.

Table 7.

Mean and standard error of mental age or age-equivalent scores in the measures of cognition, listening comprehension, oral expression, and reading comprehension.

Measure	Measure Type	Mean	Standard Error
1	Mental Age	3.576	.259
2	Listening Comprehension	3.782	.355
3	Oral Expression	3.714	.414
4	Reading Comprehension	5.219	.261

Table 8.

Pairwise comparison based on estimated marginal means examining differences in mental age/age-equivalent scores according to measure type.

(I) Measure	(J) Measure	Mean difference (I - J)	Standard Error	Significance
1	2	-.206	.244	1.000
	3	-.139	.251	1.000
	4	-1.644*	.241	.000
2	1	.206	.244	1.000
	3	.067	.320	1.000
	4	-1.438*	.315	.001
3	1	.139	.251	1.000
	2	-.067	.320	1.000
	4	-1.505*	.290	.000
4	1	1.644*	.241	.000
	2	1.438*	.351	.001
	3	1.505*	.290	.000

* The mean difference is significant at the . 05 level.

Table 9.

Mean and standard deviation of frequency of leisure activity participation (in hours) in physical leisure, cognitive leisure, social leisure, watching television, and working in the younger group and compared to frequency of participation for the five older adults.

	Younger Mean	Std. Dev.	Older #1*	Older #2**	Older #3	Older #4	Older #5
Physical Leisure	8.37	4.47	2.82	5.07	2.00	4.00	3.00
Cognitive Leisure	24.91	19.34	16.50	36.00	28.50	10.00	29.00
Social Leisure	19.32	11.54	6.75	3.00	12.08	9.38	13.27
Watching Television	18.05	13.55	10.00	3.50	20.00	14.00	20.00
Working	15.84	14.61	25.00	25.00	35.00	35.00	35.00
Total Positive Leisure	52.60	25.73	26.07	44.07	42.58	23.38	45.27
Reading	3.25	2.94	1.00	1.00	20.00	.00	20.00
Diversity	23.90	7.94	25	28	14	12	12

* Older participant #1 had a stroke and received a diagnosis of AD.

** Older participant #2 received a diagnosis of AD.

Table 10.
Mean and standard error of time (in hours) spent participating in each activity type: physical leisure, cognitive leisure, social leisure, watching television, and working.

Activity	Activity Type	Mean	Standard Error
1	Physical Leisure	5.872	1.022
2	Cognitive Leisure	24.457	4.528
3	Social Leisure	14.107	2.658
4	Watching Television	18.775	3.165
5	Working	23.419	3.369

Table 11.
Pairwise comparison based on estimated marginal means examining differences in leisure participation according to activity type.

(I) Activity	(J) Activity	Mean difference (I - J)	Standard Error	Significance
1	2	-18.584*	4.444	.004
	3	-8.234*	2.620	.046
	4	-9.903	3.415	.081
	5	-17.547*	3.875	.002
2	1	18.584*	4.444	.004
	3	10.350	4.880	.449
	4	8.682	5.041	.985
	5	1.037	6.609	1.000
3	1	8.234*	2.620	.046
	2	-10.350	4.880	.449
	4	-1.669	4.166	1.000
	5	9.313	5.377	.967
4	1	9.903	3.415	.081
	2	-8.682	5.041	.985
	3	1.669	4.166	1.000
	5	-7.644	4.390	.950
5	1	17.547*	3.875	.002
	2	-1.037	6.609	1.000
	3	9.313	5.377	.967
	4	7.644	4.390	.950

* The mean difference is significant at the .05 level.

Table 12.

Range, mean (M) and standard deviation (SD) for age-equivalences (AE) on measures of cognition, listening comprehension (LC), oral expression (OE), and reading comprehension (RC), comparing the means for participants living with their parents, in a group home, or independently. The two older participants diagnosed with AD (older #1 and #2) were excluded.

	Parent's Home	Group Home	Independently
n	16	6	1
Mental Age	*Range* = 3.03 - 6.11	*Range* = 3.40 - 4.07	
	M = 4.24	*M* = 3.40	*Score* = 4.03
	SD = 1.16	*SD* = .50	
LC AE	*Range* = 2.08 - 8.10	*Range* = 3.05 - 5.06	
	M = 4.55	*M* = 4.05	*Score* = 4.06
	SD = 1.63	*SD* = .88	
OE AE	*Range* = 2.09 - 8.03	*Range* = 3.01 - 5.01	
	M = 4.66	*M* = 3.52	*Score* = 6.00
	SD = 1.89	*SD* = .83	
RC AE	*Range* = 4.10 - 9.07	*Range* = 4.02 - 6.07	
	M = 5.82	*M* = 5.06	*Score* = 6.07
	SD = 1.22	*SD* = .65	

Table 13.

Range, mean (M) and standard deviation (SD) for frequency of leisure participation (in hours) in physical, cognitive, and social leisure activities, watching television, working, positive leisure, reading, and diversity of leisure, comparing participants who live with their parents, in a group home, or independently. The two older participants diagnosed with AD (older #1 and #2) were excluded.

	Parent's Home	Group Home	Independently
n	16	6	1
Physical leisure (hours)	*Range* = 3.00 - 16.00	*Range* = 1.45 - 12.00	
	M = 9.02	*M* = 4.41	*Score* = 5.50
	SD = 4.35	*SD* = 3.86	
Cognitive leisure (hours)	*Range* = 2.32 - 71.65	*Range* = 5.00 - 29.00	
	M = 28.22	*M* = 15.42	*Score* = 21.67
	SD = 20.13	*SD* = 10.51	
Social leisure (hours)	*Range* = .46 - 36.48	*Range* = 9.38 - 39.69	
	M = 18.13	*M* = 16.00	*Score* = 35.00
	SD = 10.64	*SD* = 11.71	
Watching television (hours)	*Range* = 1.00 - 45.00	*Range* = 10.00 - 40.00	
	M = 17.94	*M* = 19.00	*Score* = 14.00
	SD = 13.81	*SD* = 11.22	
Working for pay (hours)	*Range* = .00 - 35.00	*Range* = 8.00 - 35.00	
	M = 13.99	*M* = 30.50	*Score* = 15.00
	SD = 14.62	*SD* = 11.02	

	Parent's Home	Group Home	Independently
n	16	6	1
Positive Leisure Participation	*Range* = 9.17 - 95.08 *M* = 55.38 *SD* = 27.08	*Range* = 23.38 -50.64 *M* = 35.82 *SD* = 11.68	*Score* = 62.17
Reading	*Range* = .00 - 9.00 *M* = 3.73 *SD* = 2.91	*Range* = .00 - 20.00 *M* = 6.71 *SD* = 10.30	*Score* = 5.00
Diversity	*Range* = 14 - 41 *M* = 25.38 *SD* = 7.36	*Range* = 11 - 20 *M* = 13.50 *SD* = 3.33	*Score* = 29

Table 14.

Bivariate correlations between age, the frequency of participation (in hours) in physical leisure (Phys), cognitive leisure (Cog), social leisure (Soc), watching television (TV), working (Work), the diversity (Div) of leisure activity participation, and reading (Read).

	Age	Phys	Cog	Soc	TV	Work	Div
Age							
Phys	r = -.415						
	p = .039*						
Cog	r = -.106	r = .182					
	p = .612	p = .383					
Soc	r = -.270	r = .361	r = .152				
	p = .192	p = .076	p = .468				
TV	r = -.044	r = -.014	r = .179	r = .041			
	p = .836	p = .946	p = .391	p = .845			
Work	r = .312	r = -.500	r = -.360	r = -.652	r = .025		
	p = .129	p = .011*	p = .077	p = .000**	p = .906		
Div	r = -.265	r = -.393	r = .643	r = .270	r = .091	r = -.457	
	p = .200	p = .052	p = .001**	p = .192	p = .666	p = .022*	
Read	r = .223	r = -.013	r = .298	r = .152	r = .036	r = .015	r=-.111
	p = .284	p = .952	p = .148	p = .469	p = .866	p = .945	p =.598

* Correlation is significant at the .05 level.

** Correlation is significant at the .01 level.

Table 15.

ANOVA statistics, significance and R^2 values for cognition, listening comprehension (LC), oral expression (OE), and reading comprehension (RC) for linear regressions with age, number of hours watching television, and reading as predictor variables.

	F(df)	Significance	R^2
Cognition	F (3,21) = 3.431	p = .036*	.329
LC	F (3, 21) = 2.482	p = .089	.262
OE	F (3, 21) = 5.663	p = .005**	.447
RC	F (3, 21) = 2.488	p = .088	.262

* Correlation is significant at the .05 level.

** Correlation is significant at the .01 level.

Table 16.

Standardized Beta coefficient and significance of contribution of the three predictor variables (age, number of hours spent Watching TV, and number of hours spent reading)in the linear regressions predicting cognition scores, listening comprehension (LC)scores, oral expression (OE) scores, and reading comprehension (RC) scores.

	Predictors	Standardized Beta	Significance
Cognition	Age	β = -.555	p = .006**
	Watching TV	β = -.178	p = .333
	Reading	β = .253	p = .183
LC	Age	β = -.441	p = .032*
	Watching TV	β = -.283	p = .147
	Reading	β = -.207	p = .296
OE	Age	β = -.543	p = .004**
	Watching TV	β = -.421	p = .017*
	Reading	β = .255	p = .142
RC	Age	β = -.446	p = .031*
	Watching TV	β = -.291	p = .136
	Reading	β = .065	p = .739

* Correlation is significant at the .05 level.

** Correlation is significant at the .01 level.

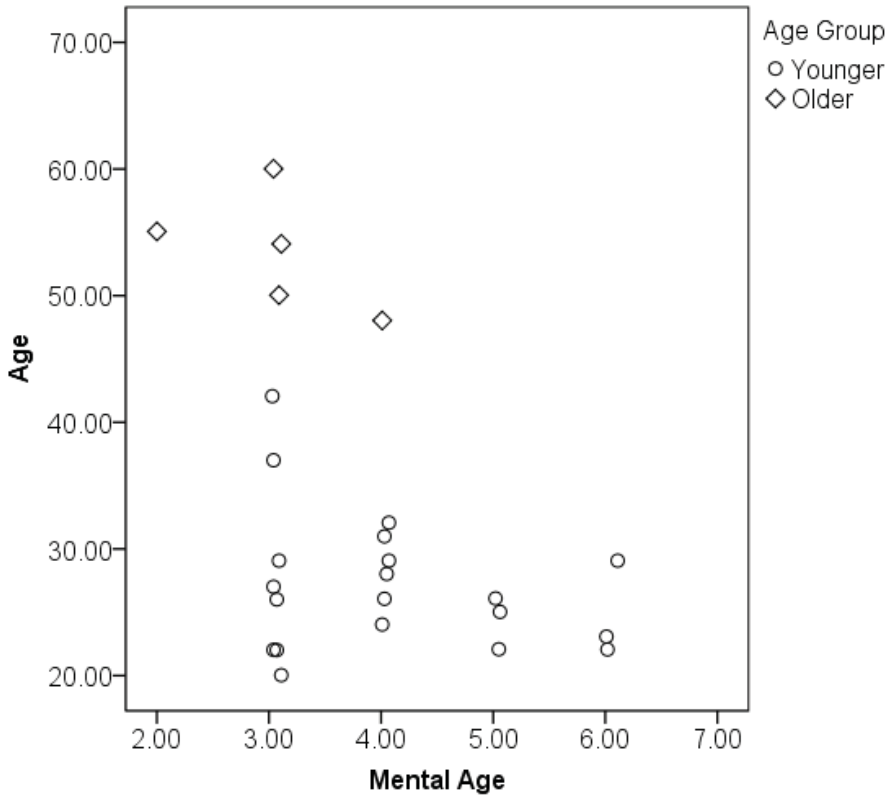

Figure 1. *Scatterplot of participant mental age, sorted by age group. The diamonds represent the older participants, the circles represent the younger participants.*

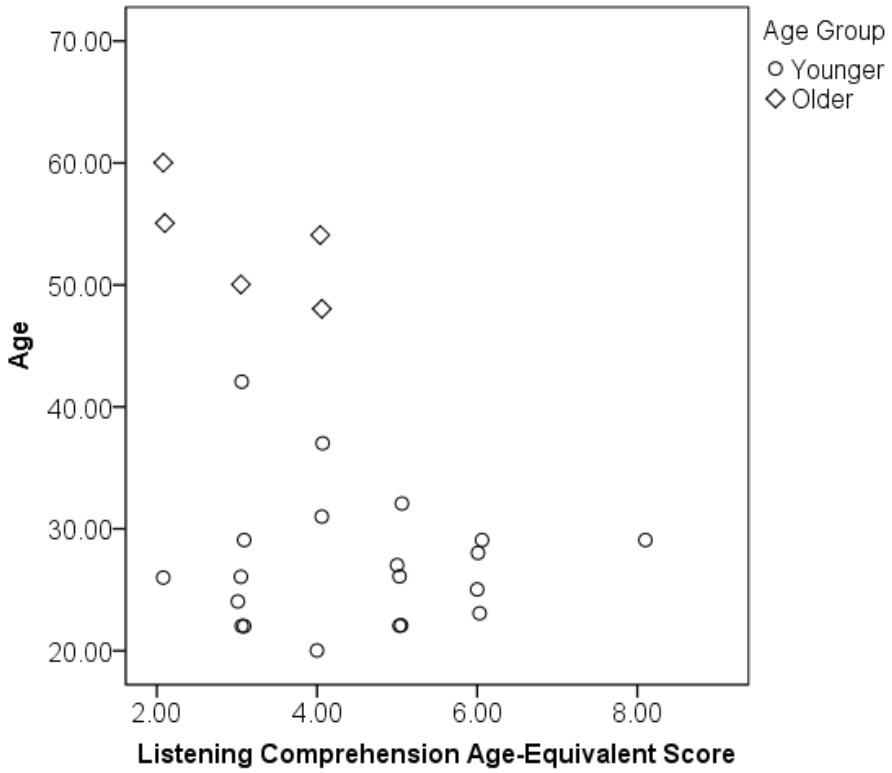

Figure 2. *Scatterplot of participant listening comprehension age-equivalent score by age, sorted by age group. The diamonds represent the older participants, the circles represent the younger participants.*

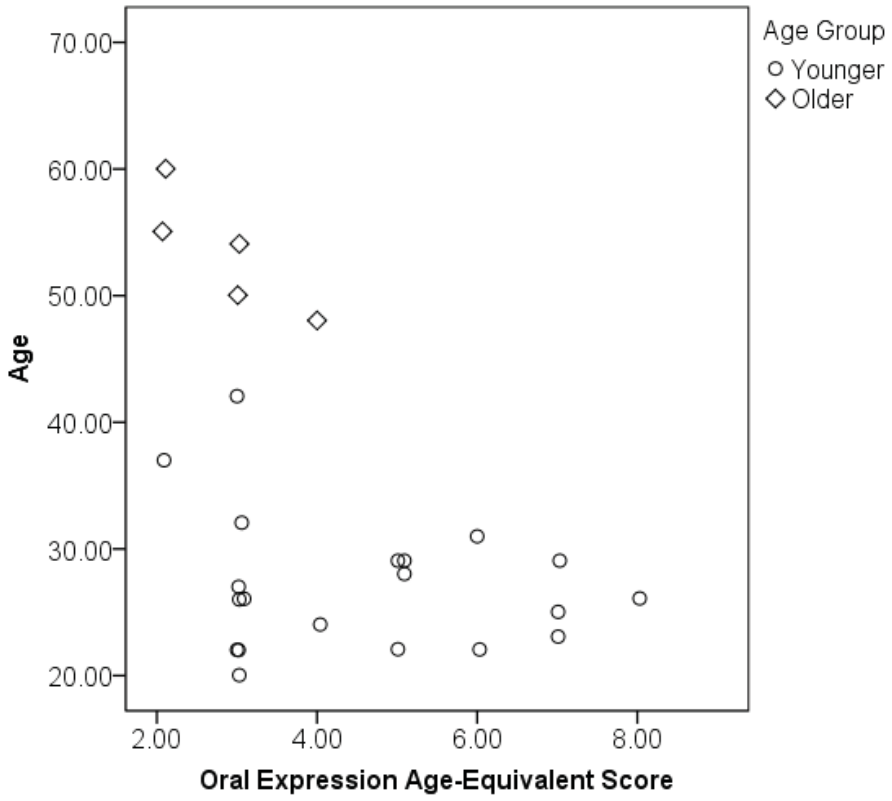

Figure 3. *Scatterplot of participant oral expression age-equivalent score by age, sorted by age group. The diamonds represent the older participants, the circles represent the younger participants.*

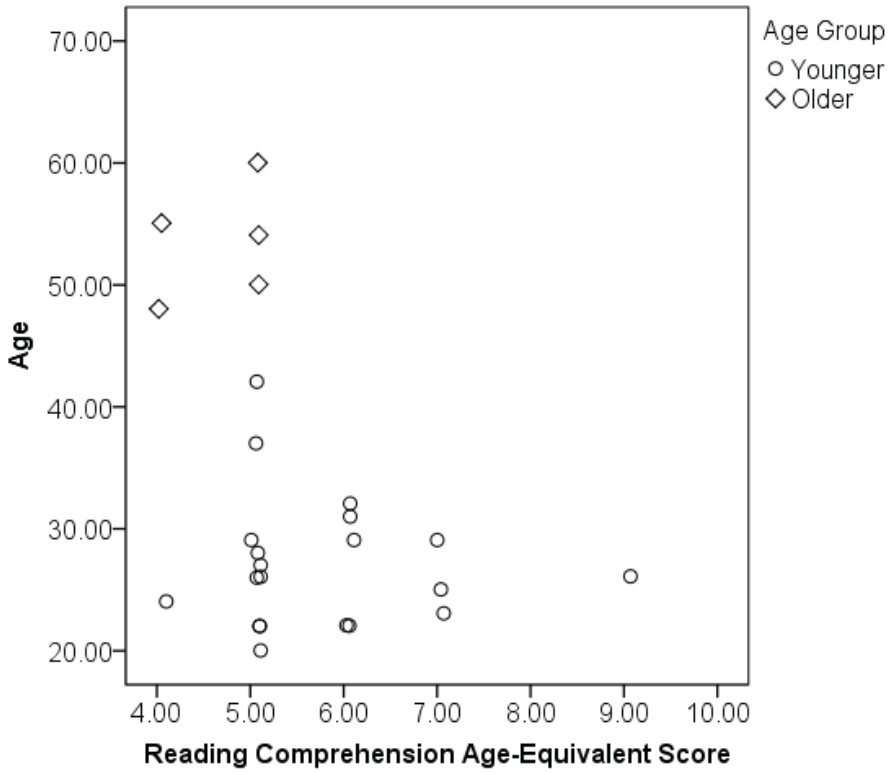

Figure 4. *Scatterplot of participant reading comprehension age-equivalent score by age, sorted by age group. The diamonds represent the older participants, the circles represent the younger participants.*

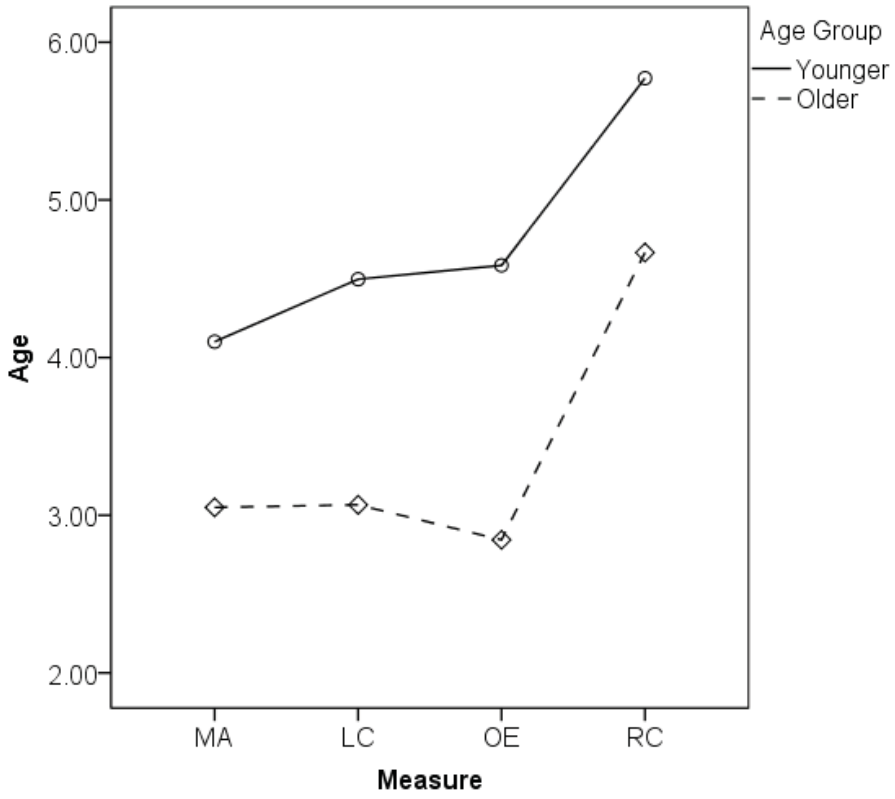

Figure 5. *Line graph displaying the distribution of mental age (MA) and Mean age-equivalent scores on measures of listening comprehension (LC), oral expression (OE), and reading comprehension (RC) for younger and older adults with Down syndrome. The younger adults are represented by the circle markers and the solid line, while the older adults are represented by the diamond markers and the dashed line.*

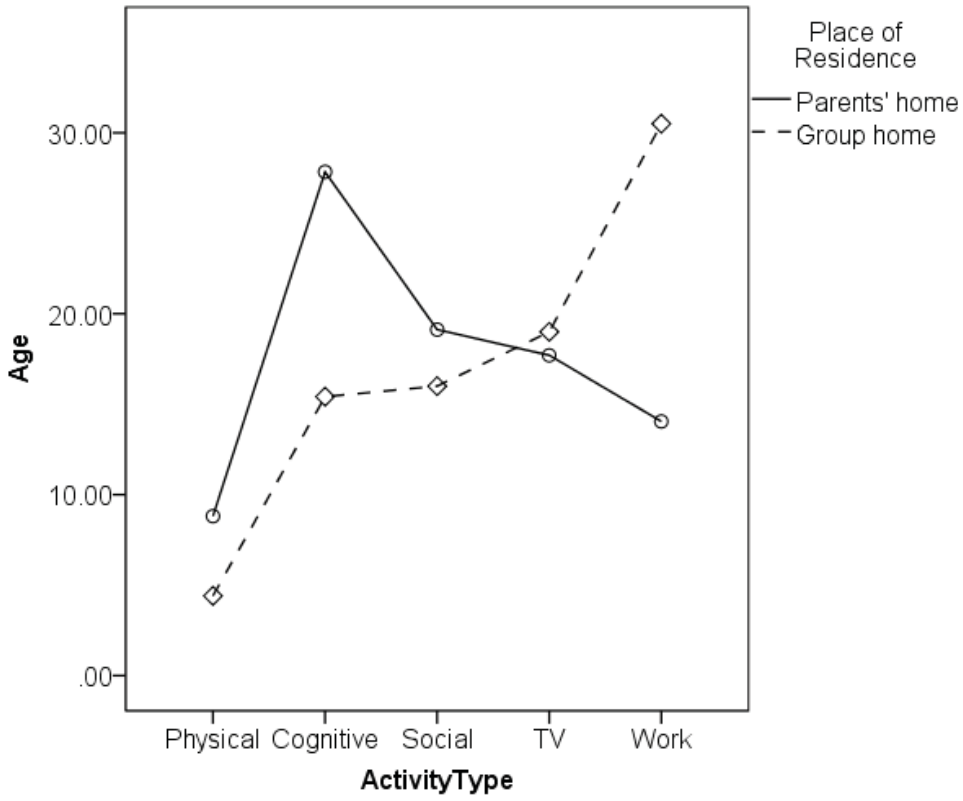

Figure 6. *Line graph displaying the distribution of frequency (in hours per week) of participation in physical leisure, cognitive leisure, social leisure, Watching television (TV), of working for adults with Down syndrome living in their parents' home or in a group home. The adults living in their parents' home are represented by the circle markers and the solid line, while the adults living in a group home are represented by the diamond markers and the dashed line.*

Chapter 4 - Discussion

The purpose of the present study was to examine the differences in cognition, language and literacy skills, and leisure activity participation, in younger and older adults with DS as well as the relationships between these three. More specifically, this study aimed to answer two questions: 1) Are there differences between the younger and older groups of adults with DS in each of the following categories: cognition, language, or literacy skills, or frequency, type or diversity of leisure activity? 2) Is the frequency or type of leisure activity predictive of cognitive development, language development, or literacy skills in adults with DS?

Age Differences in Cognition, Language, Literacy, and Leisure

Cognition, language, reading and age.

It was hypothesized that cognition, language, and reading skills would remain fairly stable for the age groups studied, only beginning to demonstrate differences after 60 years of age or in individuals diagnosed with AD. Findings from this study appear to be consistent with the literature, with age having a significant main effect on raw cognition scores, language scores, and literacy scores, as well as a medium effect size. The results from the individual analysis suggested older adults tended to score more poorly on measures of cognition, language, and reading, but the only participants who fell one standard deviation below the younger group mean were those who were either officially diagnosed with AD (older #1 and #2) or those beginning to show the signs and symptoms of dementia/AD (older #3). The statistical analyses revealed a significant effect of age on cognition, language, and literacy measures. The findings of the individual analysis suggested that these age differences were in fact a result of an AD diagnosis

rather than natural aging processes in older adults with DS. Only one study, by Moss, Tomoeda, and Bayles (2000; cited in Orange & Zanon, 2005) examined the relationship between reading comprehension and age in adults with DS (average age of 41). Moss et al. reported that reading comprehension, measured as a subset of receptive language, was inversely related to age. The majority of the literature, however, does not support age-related differences in cognitive and language abilities until approximately 60 years of age (Burt, 1995; Cooper & Collacott, 1995; Devenny & Krinsky-McHale, 1998; Rondal & Comblain, 1996, 2002). It does, however, support cognition, language, and literacy differences associated with a diagnosis of AD (Devenny et al., 2000; Orange & Zanon, 2005), which is what the results thus far are suggesting. The linear regressions showed that the effects of age significantly and negatively predicted cognitive, language, and literacy scores. Taken together, the findings of this study suggest that older adults with DS have lower cognitive, language, and literacy abilities than younger adults and that the majority of these differences may be attributed to the presence of AD in three of the five older individuals studied. Future studies will need to differentiate AD and normal aging in the DS population more adequately and with a larger sample size in order to disambiguate these factors.

Another potential explanation for some of the age group differences observed is the place of residence of the participants. Participants lived in two primary settings: parents' homes or group homes, with one person living independently. Laws and Gunn (2004) suggested in their study that adults with DS who moved from their parents' home to a group home showed signs of decline in their language abilities, although this was not always the case, as one participant who moved did show small improvements in his

language abilities. Small sample sizes prevented Laws and Gunn (2004) from formally investigating this trend. In the present study, of the eight participants living in a group home, five of them were older participants and three had diagnosed or suspected AD. When analyses of place of residence were conducted, excluding the participants with AD, no significant effects were obtained. These analyses, then, are inconsistent with Laws and Gunn's (2004) suggestion. The effect sizes, however, suggested that with a larger sample size, a difference in favor of the parental home placement might be obtained. It is possible that the findings of the present study were not consistent with Laws and Gunn's (2004) because their study was longitudinal in nature, allowing for the detection of change over time, while the present study was cross-sectional and did not permit for this kind of analysis. Additionally, participants moving into group homes and residential homes in Laws and Gunn's (2004) study were much younger (19-24 years of age) and transitioning out of school, while participants in the present study were in their late 20s, 30s, and 40s and had been out of school for many years. Moving away from the specialist language teaching the participants were receiving in school might explain some of the language declines seen in the Laws and Gunn (2004) study.

Younger participants in this study were better readers than older participants, perhaps a reflection of a greater emphasis placed on learning to read in school in more recent times. Better readers are probably more likely to read independently and enjoy reading. As well, statistical analyses also revealed a strength in reading comprehension which is not consistent with the literature (Kay-Raining Bird & Chapman, 2011; Moni & Jobling, 2001). While the review of Kay-Raining Bird and Chapman (2011) demonstrated that, especially in early childhood, real word reading is a strength for

children with DS, reading comprehension has been consistently found to be a weakness for individuals with DS, including adults (Kay-Raining Bird & Chapman, 2011; Roch & Jarrold, 2008). Even in programs aimed at helping adults with DS develop their reading abilities, the greatest gains were made in reading speed and accuracy, the fewest gains were made in reading comprehension (Moni & Jobling, 2001). The apparent strength in reading comprehension in the present study may, in part, be due to the measure used. Participants cannot achieve an age-equivalent score lower than 4 years 2 months, which skews the results upward and potentially overestimates the participants' abilities relative to other age-equivalent scores. The lowest possible mental age was "2 years or less" on the *SB5*, the lowest age-equivalent score for LC was 2 years 3 months, and the lowest age-equivalent score for OE was 2 years 6 months. Further, a review of the individual data for RC scores revealed that five participants showed minimal RC abilities: one person achieved a score of zero (age-equivalent 4 years 2 months), another pointed to the same option (number two) for every question, which suggested that his raw score of seven (age-equivalent 5 years 7 months) may be invalid, one participant obtained a score of one (age-equivalent 4 years 5 months), another a score of three (age equivalent 4 years 10 months), and another a score of four (age-equivalent 5 years 1 month). The high age-equivalent scores of those who performed poorly is well above age-equivalent scores achieved on the LC and OE measures. In contrast, a good majority (16 out of 25 participants; 64%) scored above a raw score of 10 (age equivalent 5 years 9 months), indicating at least a word-level RC ability. Although raw scores are difficult to compare, comparison of cognition, LC, OE, and RC raw score means and standard deviations (see Table 4) reveal that RC raw scores tend to fall below the mean for all three other

measures, and fall one standard deviation below the mean for cognition and LC scores. The analysis of raw scores supports the notion that RC age-equivalent scores are likely inflated, especially for the less able readers.

Leisure activity and age.

It was hypothesized that the frequency of leisure activity would be lower in older adults. Some of the findings from this study appear to be consistent with this hypothesis, namely that age had a significant main effect on positive leisure participation with a large effect size. Age did not, however, have a significant effect on frequency of reading or in the diversity of leisure activity participation, as was initially hypothesized.

With respect to positive leisure, older adults with DS engaged significantly less frequently in these activities, which were defined as the sum of hours per week spent in physical, cognitive, and social leisure activities. These activities were considered positive leisure activities because studies by Fratiglioni et al. (2004), Stern and Konno (2009), and Stern and Munn (2010) have suggested that involvement in physical, cognitive, and social leisure activities is associated with a reduction in the risk of developing AD. This may suggest that older participants are more likely to demonstrate the declines associated with AD earlier than the participants involved more frequently in positive leisure activities. These age-related declines in positive leisure participation are consistent with a study by Carr (2008), who reported a decline in physical and social leisure activities with age, beginning as early as 35-40 years of age. There were too few participants in the present study to determine whether the age difference in leisure activity participation occurred earlier, during the timeframe proposed by Carr (2008).

Evidence for the age differences in positive leisure activities did not appear to be as attributable to the presence of AD as it was for the age differences noted in cognition, language, and literacy. Individual analysis of participation in physical, cognitive, and social leisure, separately, demonstrated that older #1, who was diagnosed with AD and had a stroke, consistently scored one standard deviation below the younger group mean for all three leisure activities, and older #2, who was also diagnosed with AD, scored one standard deviation below the younger group mean in social leisure; however, older #3 and #5, who were not diagnosed with AD, scored one standard deviation below the younger group mean in physical leisure. Individual analysis of frequency of participation in positive leisure as a whole reveals that older participant #1 and #4 fell one standard deviation below the younger group mean. Thus, it appears unlikely that the age differences in positive leisure participation are attributable solely to a diagnosis of AD, since participants without a diagnosis of AD were equally as likely to score below the younger group mean on all measures of leisure.

Another potential explanation for the differences in positive leisure activity participation may be that all older participants lived in a group home, while most younger participants lived with their parents. Additional analyses were completed investigating the possibility of differences in leisure participation for adults with DS living with their parents or in a group home, excluding participants with a confirmed diagnosis of AD. These analyses suggested that the interaction between place of residence and leisure activity participation approached significance. Post hoc analyses suggested that adults living in a group home tended to engage in fewer physical leisure activities than those

living in the parental home. These analyses can only suggest future directions for research, however, as age and living environment cannot be disambiguated.

Regardless of age, participants tended to engage in fewer hours of physical leisure than in any other activity type. While older studies reported infrequent participation in physical leisure (Putnam, 1988), more recent studies examining leisure participation in adults with DS between 19 and 45 years of age have stated that adults with DS now engage more frequently in physical leisure activities (Carr, 1995; Carr, 2008; Jobling & Cuskelly, 2002). Research examining leisure activity participation in adults with DS appears to be fairly consistent, with 60-70% of adults with DS engaging in sports at least once per week. These studies, however, have not reported the number of hours per week these participants dedicated to these activities. The present study specifically examined the number of hours spent in each activity type, and included sports and exercise, such as walking or going to the gym, in the measure of physical leisure. In the present study, 100% of participants were engaged in at least one physical leisure activity per week and were involved in an average of 7 hours of physical leisure per week (SD = 4.49).

Studies have shown that adults with DS are at a higher risk for obesity (Carr, 2008). Physical activity has been shown to have a protective value on some aspects of health and to support cognitive activity. Stern and Konno (2009) reported that the frequency/regularity, diversity, and intensity of leisure participation may moderate the benefits of physical leisure participation. Interestingly, the activities that were found to best protect against the risk of developing AD were activities such as walking, gardening, or travelling, as opposed to activities such as jogging or cycling. Kramer et al. (1999), Hawkins, Kramer, & Capaldi (1992), and Colcombe & Kramer (2003), cited in Glisky

(2007), and Baker et al. (2010), cited in Miller et al. (2011), have reported that engagement in cardiovascular and aerobic exercises were associated with improvements in executive function. While it is unclear how protective the amount of physical leisure activity in which the participants in the present study are engaged in is, it is clear that it is a positive finding that they all do some form of physical activity weekly.

Adults living in a group home also tended to work more frequently than those living with their parents. Analyses of age differences further indicated that older adults spent more hours working than younger adults, although the type of work in which the participants engaged was not specified. Finally, correlations revealed a negative correlation between positive leisure activity participation (physical, cognitive, and social leisure) and working indicating that the more hours a participant worked, the less time they had to engage in other, positive leisure activities. Given the benefits of engaging in positive leisure, focus should be placed on providing more positive leisure opportunities, regardless of home environment.

Television watching was another leisure activity investigated. The frequency of watching television was not significantly correlated with age and ANOVA revealed no age differences in frequency of television watching, meaning that younger and older participants tended to watch television equally often. Further, watching television was not correlated with participation in any other leisure activity, meaning that those who reported watching television more often reported being involved in positive leisure or working as often as those who watched television less. It would appear then that watching television did not prohibit engaging in positive leisure activities, as working seemed to do. On average, participants in the present study watched approximately 17

hours of television per week (*SD* = 12.53), although the frequency of television watching varied from one hour per week to 45 hours per week. This is fairly consistent with a study by Jobling and Cuskelly (2002), which reported that, of 173 participants with DS between 18 and 45 years of age, 20% watched less than 10 hours of television per week, 52% watched between 10 and 21 hours, and 28% watched over 21 hours of television per week. Surveys conducted by the Television Bureau of Canada in 2012 found that adults without DS between the ages of 18 and 49 reported watching an average of 19.3 hours of television per week, while the Bureau of Broadcast Measurement reported an average of 23.2 hours of television watching per week (cited in Oliveira, 2013). This suggests that the number of hours participants watched television fell within the Canadian average. Individual analyses did not suggest that the participants with AD watched more television than the other participants (younger and older). Of the leisure measures investigated, watching television was the only significant predictor in the regression analyses conducted. It negatively predicted OE scores over and above the effect of age, but did not significantly explain the variance for measures of cognition, LC, or RC. The literature has suggested that individuals without DS who watch more television are at higher risk of developing AD and have poorer language abilities, than those who watch less television. The direction of causality is difficult to determine in the current study. It is possible that those with poorer oral expression choose television as a leisure activity more because they have difficulty with expressive language. Alternatively, it is possible that watching television has a negative effect on language skills because it takes time away from more interactive activities. Longitudinal research is required to ascertain the direction of causality between television watching and oral language. Since there were no correlations

between number of hours spent watching television and participation in other leisure activities, it would appear that watching television is not prohibiting other leisure activities. Research in adults with DS has highlighted that increased television watching may be associated with an increased risk of developing AD. The current findings suggest that adults with DS may benefit from watching fewer hours of television per week.

It was expected that frequency of reading would be lower in older adults. This was not supported. Reading frequency did not differ for the two age groups. Nor did reading frequency correlate significantly with age or reading ability. This is curious, as younger participants tended to be better readers than older participants. The lack of an age difference in reading frequency seems to be inconsistent with those of Carr (2008) who reported that reading at least once a week declined with age, starting around 35 to 40 years of age. One reason for the apparent difference in findings may be a lack of power in the present study. Indeed, in the present study, while not significant, the age main effect had a large effect size, suggesting that an effect of age may be detected with a larger sample size. Differences in the measures used across studies could account for the disparity in findings as well. While Carr (2008) defined reading frequency as whether or not participants read at least once per week, the present study examined the number of hours per week participants 'Read or were Read to', a more sensitive measure but one which may mask self-reading frequency. Studies have reported that reading can help reduce the risk of developing AD in adults without DS (Stern & Munn, 2010). Wilson et al. (2000) followed 410 adults without DS with a mean age of 75.5 years at study start, for four years. Wilson and colleagues (2000) reported that the premorbid reading score was correlated to baseline cognitive scores and that participants who read more

frequently showed a faster rate of decline in cognition and verbal abilities. Studies cited in Wilson et al. (2000) conducted by Alexander, Furey, Grady, et al. (1997), Cummings, Vinters, Cole, and Khachaturian (1998), and Stern and colleagues (1992, 1995, 1999), also found that individuals with higher premorbid cognitive function tended to demonstrate faster decline with AD than those with poorer premorbid cognitive function. It may be that the more frequent readers with greater cognitive ability had "farther to fall". Other studies cited in Wilson et al.'s study (Cummings, Vinters, Cole, & Khachaturian, 1998; Katzman, 1995; Mortimer, 1997; Satz, 2000) hypothesized that activities that improved cognition, such as leisure or social involvement, increased cognitive reserve, making the brain more resistant to mild physiologic changes associated with AD. The cognitive reserve hypothesis is consistent with findings from the review conducted by Fratiglioni et al. (2004) discussed earlier (see "Physical Activity, Cognitive Stimulation, Social Interaction, and Dementia in the General Population"). In line with these studies, Wilson and colleagues hypothesized that reading, and greater premorbid cognitive ability, may delay the onset of the clinical symptoms of AD, but that once the symptoms of AD begin to appear, cognitive and linguistic decline is more rapid than in less frequent readers and individuals with lower premorbid cognitive activity. Therefore, it may be important to ensure that reading is encouraged in adults with DS from an early age.

Diversity (total number of different leisure) also did not differ with age, as was originally hypothesized. Statistical analysis of age differences in diversity, however, revealed a large effect size, suggesting that an effect of age may be present after all, but that the sample size is too small to reveal it. Analyses examining the effect of place of

residence on diversity of leisure activity participation revealed that adults living in a group home engaged in a lower diversity of leisure activities than those living in their parents' home.

Linear Regressions

The lack of predictive value of positive leisure, working, and reading, is surprising since it was expected that positive leisure activity frequency and reading would positively predict cognitive and language measures. For example, the literature suggests that increased participation in physical, cognitive, and social leisure or stimulation (reading, working) is associated with greater language abilities (Shepperdson, 1995) and a lower risk of developing AD (Stern & Konno, 2009; Stern and Munn, 2010). The reviews by Stern and Konno (2009) and Stern and Munn (2010) often focused upon specific activities (e.g., walking, dancing, reading, and gardening) rather than classes of activity as was done in the present study. It may be that the positive leisure participation measure was not sufficiently specific to detect the protective effect of certain activities, although this would not explain the lack of effect of reading or working on cognition, language, and literacy scores. Since, the present participant sample is largely composed of younger adults, leisure participation, including positive leisure, reading, and working, may not show the effect as would be obtained with a group that had a larger number of older adults with DS. With regards to working specifically, it is possible that the type of work is important—these participants may not be engaged in very stimulating work leading to work not having the positive predictive value seen in the literature.

Limitations and Future Studies

The findings of this study can be generalized to adults with DS between the ages of 20 and 60 years of age living with their parents or in group home settings, although the small number of older participants makes the generalization to the higher end of the age spectrum studied more tenuous.

It is important to acknowledge several limitations of the study.

First, the sample size was small and the group sizes unbalanced. On more than one occasion, statistical analyses showed no main effect of age, but the large effect sizes suggested otherwise. Thus, it is important to view the present study as exploratory in nature. Future studies should not only have a larger sample size, but should also consider a more balanced design between younger and older participants.

Another limitation of this study was the dichotomy in place of residence whereby most younger adults lived with their parents and all older adults lived in a group home. Future studies should attempt to recruit the participants from more diverse backgrounds (e.g., older participants living in nursing homes, in assisted living, living independently, still living with their parents, etc.) or perhaps include place of residence as an IV in the study.

Additionally, many of the organizations from which participants were recruited encouraged involvement in the community and in leisure activities. For instance, the group homes were associated with activity centres or day programs, the Special Olympics targeted sports involvement, and the Down syndrome associations, organizations, and societies offered social groups, camps, and art groups to encourage their members to be involved in the community. Thus, the sample may over represent the degree to which

adults with DS participate in leisure activities. Future studies should recruit broadly, to provide greater representativeness in the sample.

Following this thread, while the present study addressed potential implications of a diagnosis of AD on cognition, language, literacy, and leisure, AD was not included as an IV. Future studies should recruit older adults with and without AD as separate groups to better account for the effect of AD on cognition, language, literacy, and leisure participation. Due to the presence of intellectual disability in all adults with DS, it is more difficult to diagnose AD in the DS population than in adults without DS. As recommended by the Alzheimer's Association, a baseline of cognitive, linguistic, and literacy abilities should be obtained prior to 30 years of age, before the physiological symptoms of AD are likely to appear. A potential or probable diagnosis of AD in adults with DS may be achieved by administering neuropsychological batteries at regular intervals and comparing retests to an individual's baseline scores obtained in early adulthood. A dementia measure should also be administered at regular intervals. The administration of both the dementia measure and neuropsychological battery would allow researchers to contrast changes in cognition, language, and literacy associated with natural aging and changes associated with a potential or probable diagnosis of AD. Researchers may wish to consider the D*iagnostic Criteria for Psychiatric Disorders for use with Adults with Learning Disabilities* (*DC - LD*; Royal College of Psychiatrists, 2001), the *Dementia Scale for Down Syndrome* (*DSDS,* Gedye, 1995) or the *International Classification of Diseases - Tenth Revision* (*ICD- 10*; World Health Organization, 2010), which are dementia measures designed for individuals with DS or learning disabilities. Studies may also wish to consider using MRIs to examine AD pathology.

Research has suggested that hearing impairment may be associated with dementia in the non-DS population (Lin, Metter, O'Brien, Resnick, Zonderman, & Ferrucci, 2011). While the nature of the relationship between hearing loss and dementia is unclear, Lin et al. (2011) hypothesized that hearing loss would increase demands on cognitive reserve, increase social isolation, and reduce the richness of the environment, which in turn, might increase the early expression of dementia of all types. Studies cited in Lin et al. (2011; Boyle, Wilson, Schneider, Bienias, & Bennett, 2008; Pichora-Fuller, Schneider, & Daneman, 1995; Tun, McCoy, & Wingfield, 2009) have suggested that the increased demands placed on the processing of auditory stimuli, due to hearing loss, reduces the cognitive reserve available for other cognitive processes, which may lead to the earlier manifestation of the behavioural symptoms of dementia and AD. Lin et al. (2011) also suggested that hearing loss that interferes with verbal communication often leads to a reduction in social interaction and a reduction in the richness environmental stimuli, both of which have been associated with an increased risk of dementia and AD. In the present study, hearing impairment was not a factor. It was screened for all but one participant who was in her early twenties and wore a hearing aid. The participant who wore a hearing aid and her parent confirmed that, with correction, the participant's hearing was within normal limits. All other participants passed the hearing screening showing they had no more than a mild loss in their better ear. Given the cross-sectional nature of the study and that none of the older participants had a hearing impairment, it seems unlikely that hearing loss was a factor affecting cognitive, language or literacy performance in the present study. In future studies, consideration should be given to monitoring hearing in

study participants over time in order to determine whether the relationship between hearing impairment and dementia also exists in the DS population.

As previously discussed, the reading comprehension measure may have over-estimated the reading ability of the less able readers in the study. Future research may wish to consider assessing literacy as a function of speed and accuracy of reading, as well as reading comprehension, with measures tailored specifically for literacy abilities, as was done by Moni & Jobling (2001).

Finally, the cross-sectional nature of this study revealed age-related differences but could not adequately explore causal relationships. Future studies should consider a longitudinal design, which would provide the ability to detect causal relationships between age, cognition, language, literacy, leisure, and AD.

In the present study, the *OWLS-II*, which provides a general measures of language comprehension and expression was administered. Other studies have used the *OWLS* to assess language ability in the DS population (Abbeduto et al., 2001). The *OWLS-II* does allow syntax and vocabulary to be scored separately, but these domains are not tested separately. Instead, vocabulary and syntax items are interspersed throughout the measure. Once the participant has obtained a score of zero on four consecutive questions, regardless of whether the question assessed syntax or vocabulary, the participant reached ceiling on the subtest, and testing on that measure was stopped. Any relative strength or weakness a participant might have had in syntax or vocabulary might therefore be masked. Future researchers might assess vocabulary and syntax directly, as has been done in many studies examining changes in language in childhood, adolescence, and adulthood

(Chapman et al., 1998; Chapman et al., 2002; Fowler, 1990; Hawkins et al., 2003; Iacono et al., 2010; Laws & Gunn, 2004; Nelson et al., 2001). Measures such as narrative language samples, the *PPVT*, and the *TROG* should be considered to specifically assess trends in the sub-components of language comprehension and expression. Such analyses may reveal more specific age-related differences, as outline in the literature, as well as potential relationships between the specific language abilities and leisure participation.

As for the leisure measure, the *Leisure Assessment Inventory* was modified following feedback from participants and caregivers after the pilot study to facilitate administration (see Materials - Leisure activity questionnaire for more details). Changes to the leisure measure, overall, were positive and adequate for the purposes of the current study. The leisure measure used in this study collected specific information regarding leisure activity participation in various categories (e.g., reading, visiting with friends, exercise, hobbies, etc.); however, this information was combined into social, physical and cognitive activities as well as an overall measure of positive leisure activities to allow for statistical analyses. In the regression analyses, the positive leisure measure did not have a significant predictive relationship with the measures of cognition, language or literacy. One possibility is that it may have been too broad to capture the predictive value of leisure participation in specific activities. In order to determine whether physical, cognitive, and social leisure activities are associated with cognition, language, literacy, and AD, future studies should have a larger sample size so that a larger number of measures could be entered into a regression analysis. With a larger 'N', the predictive value of each category of leisure activity (social, cognitive and physical) could be assessed. Should this prove unproductive, then researchers might examine the

relationship at a more specific level (e.g., frequency of participation in hobbies, sports, exercise, etc.) or even types of activities in each activity category (e.g. photography, hockey, choir, etc.).

Future research may also wish to collect greater detail on participation in activities such as reading, watching television, or work. TV watching and work in particular may have both positive and negative aspects to them that may influence cognition and language differently. For example researchers could assess the type of book read, shows watched, or work done and how much time is dedicated to each type. This additional level of detail would allow for the researchers to assess whether an activity as a whole has a positive/negative effect on cognition, language, literacy, and AD, or if only certain aspects of an activity are beneficial/disadvantageous. This may be of particular interest when examining the effect of watching television or work on cognition, language, and literacy.

Following the pilot study, the leisure measure was greatly improved over the initial scale and provided more information than the *LAI* participation scale. Despite the improvements, the accuracy of the reported frequency of leisure activity participation was at times questionable, because participants and/or caregivers struggled to remember how much time was dedicated to some activities. This seemed to occur for one of two reasons. First, some activities such as going to the movies or skiing did not necessarily follow a regular schedule and may not have occurred in the recent past. While participants/caregivers tried to estimate frequency, these estimates may not have been an accurate representation of weekly participation. Second, participants were asked to report weekly hours of participation in each activity category, but they were also asked whether

or not this represented weekly frequency throughout the year. In cases, such as sports, where participation changed seasonally, the accuracy of the weekly estimates might have been affected. Future researchers may wish to consider collecting leisure activity participation over time, perhaps through regular administration of the leisure measure, or by using diaries, although compliance is a problem with such procedures. More regular assessments may allow for increased accuracy in the estimation of weekly hours spent in various leisure activities, while eliminating the need to estimate seasonal trends in leisure participation. It would also provide information regarding the regularity of leisure participation, as well as allow researchers to follow seasonal or yearly changes in leisure participation.

Future research should also consider the distinction between leisure involvement and leisure engagement. Involvement refers to the act of participating in leisure, while engagement refers to an additional level of stimulation and interaction with the leisure activity. A study conducted by Duvall (2011) on 119 adults without DS between 40 and 69 years of age randomly assigned to one of two groups: a Standard Care condition or an Engagement condition. Participants in each group were asked to walk outdoors for 30 minutes, three times per week, for two consecutive weeks. Participants in both groups completed a survey which measured attentional functioning, which is the effectiveness in completing daily tasks that require self-regulation and executive control. The survey also measured feelings of contentment and feelings of frustration. The survey was administered prior to the start of the study, after the two week treatment, and four weeks after treatment. Participants in the Standard Care condition met with researchers to set a walking schedule, while participants in the Engagement condition received "awareness

plans", which were tasks to complete during the walk (e.g., pretend you are an artist who is searching for beauty in everything). For both groups, time spent walking was measured using surveys, walking logs, and accelerometers. While both groups reported increased feelings of contentment, only the Engagement condition reported increases in attentional functioning and decreases in feelings of frustration. Benefits to psychological well-being increased with increased frequency of participation, regardless of treatment condition, although gains were greatest for the Engagement condition. While the present study did not show that positive leisure activities predicted cognition, language, literacy, and leisure, it is possible that such an effect would be observed if level of engagement in leisure activity participation were measured. Future research should examine participant feelings of engagement versus involvement in leisure and compare the effect of each on the participants' cognition, language, and literacy. This may be of particular relevance when examining the relationship between frequency of work and measures of cognition, language, and literacy.

Clinical Implications

This study has a number of clinical implications. First, while the participants' frequency of television was on par with the Canadian average, television watching negatively predicted expressive language in this study and has been associated with increased risk of developing AD (Stern & Munn, 2010). The negative predictive relationship between television watching and expressive language in adults with DS is therefore of concern. It seems important for adults with DS and their caregivers to reflect on the nature and the frequency of their television watching in relation to other leisure activities and to think about how the adults with DS can engage in cognitively stimulating

and engaging leisure activities as often as possible. The more individuals with DS participate in leisure activities that are engaging and stimulating for them, the greater the possible benefits for them (Akbaraly et al., 2009; Duvall, 2011; Treiber et al., 2011). Also, the findings suggest that physical and social activities are done less frequently by older participants and all participants do less physical than other leisure activities. Given the association in the literature between AD symptoms and positive leisure activity participation, it seems important to encourage adults with DS to participate in social and physical leisure activities as they get older. In addition to maintaining participation in positive leisure activities, individuals with DS should be encouraged to play an active and deliberate role in selecting the activities that interest them the most and assisted in incorporating these activities into their schedule. The optimal mix of activity frequency will be an interesting issue to explore in future studies.

With regard to health policies, the government should focus on assessing the support for leisure opportunities for adults with DS of all ages. Particular attention should be paid to having such opportunities available in rural as well as urban centres. Leisure and work opportunities for individuals with DS in group homes and community living should receive attention. Participants, family members, and caregivers are often eager to discuss their experiences and are the best suited to outline areas in which services are lacking.

Chapter 5 - Conclusion

The present study has been the first to examine the relationship between cognition, language, literacy, and leisure in adults with DS. Statistical analyses did not support the original hypothesis that increased participation in positive leisure activities leads to better cognitive, language, and literacy scores. This outcome was unexpected though understandable given the cross-sectional nature of the study. A longitudinal study may be a truer representation of reality and may reveal a significant relationship.

The present study has also been the first to demonstrate a negative relationship between television watching and oral language abilities in the DS population; however, the direction of causality still needs to be established.

Also of note, while the majority of the literature surveyed reported no age-related declines in cognition, language, and literacy before the age of 60, the current study reported that older participants (46 - 60 years of age) were found to have poorer cognitive, language, and literacy abilities than younger adults (20 - 45 years of age) and increasing age was found to negatively predict cognition, language, and literacy scores. older participants also tended to engage in fewer positive leisure activities, such as physical, cognitive, and social leisure, and worked more than younger adults. Whether age differences in cognition, language, literacy, and leisure were a result of natural aging, or of other factors, such as AD, place of residence, or recruitment bias, is unknown; however, these differences are worth investigating further.

As evidenced in studies by Carr (2008) and Jobling and Cuskelly (2002), adults with DS are increasingly becoming active members of the community, engaging in leisure and pursing further education. It is important to understand how these differences

in lifestyle are affecting their cognitive, language, and literacy abilities. Furthermore, as life expectancy for adults with DS continues to increase, more adults with DS will show the declines in cognition, language, and literacy associated with AD. While there has been extensive research attempting to delay the onset of the disease in adults without DS, this literature has been non-existent for the DS population. In essence, further research is required to understand how to better help the DS population, their families, and the organizations that support them.

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Appendix A - Background Questionnaire

Background Questionnaire

Participant ID: _____

Sex: _____

Date of Birth: _____

Testing location: _____

Inclusion Criteria

How old are you?: _____

What languages do you speak? (check all that apply)

- ❑ English
- ❑ French
- ❑ Other, please specify:

  _____

Is English the language you know best? Yes / No

Do you have or have you ever had (check all that apply):

- ❑ Vision Problems
- ❑ Hearing Problems
- ❑ Parkinson's Disease
- ❑ Huntington's Disease
- ❑ Diabetes
- ❑ High Blood Pressure
- ❑ Head Injury
- ❑ Stroke
- ❑ Hypothyroidism
- ❑ Other: _____

We will be providing a snack. Tell us if you have any food allergies we should know about. _____

Educational and Housing History

Do you live at your parents' home / in a group home / other?

If other, please specify

_____

Have you always lived in this type of residence? Yes / No

If no, please identify others you have lived in and how long you lived in each one.

(Check all that apply)

- ❑ Parent's home
- ❑ School residence Length of time _____
- ❑ Group home Length of time _____
- ❑ Nursing home Length of time _____
- ❑ Institution Length of time _____
- ❑ Other _____

How long did you attend school?

Grade school (Grade_____)/ high school (Grade_____)/ college university

If college or university, please explain how long you attended and what you studied

_____

In grade school, did you attend a class for people with special needs or the same class as all the other children?

- ❑ Separate classes
- ❑ Same classes as everyone else

In high school, did you attend a class for people with special needs or the same class as all the other children?

- ❑ Separate classes
- ❑ Same classes as everyone else

Literacy

Do you like to read? Yes / No

How often do you read for fun? Not at all / Some / A lot

What do you usually read (Check all that apply)?

- ❑ Nothing
- ❑ Newspapers
- ❑ Magazines
- ❑ Books
- ❑ Novels
- ❑ Others (please specify):_____

What is the name of a book you really like?

_____

Do you get new things to read at least 1 time per month? Yes / No

Where do you get these?

- ❑ Library
- ❑ Bookstore
- ❑ Friends
- ❑ Other store
- ❑ Other (please specify):_____

Health

Are you taking any medications? What and for what?

_____

For Family:

Is the participant diagnosed with Down syndrome? Yes / No

What type of Down syndrome? Trisomy 21 / Translocation / Mosaic

Was genetic confirmation obtained? Yes / No

Has the participant been diagnosed with dementia?

Yes / No

If yes, which type? _____

when? _____

By whom? _____

Over the past 2 years,

Have you noticed a decline in appetite? Yes / No

Have you noticed a decline in self-help skills? Yes / No

Have you noticed a decline in language ability? Yes / No

Have you noticed a decline in mobility? Yes / No

Is there anything else you would like to draw to the attention of the interviewer?

Yes / No

If so, explain.

_____

_____

Appendix B - Comparison of Participant with Autism and Stroke to Other Participants on Measures of Cognition, Language, and Literacy

Minimum and maximum scores, mean (M) and standard deviation (SD) for raw scores and age-equivalences on measures of verbal and nonverbal cognition, listening comprehension, oral expression, and reading comprehension, comparing one participant with autism to the group mean for all participants and all younger participants.

	Group Mean	Younger Mean	Participant with Autism
Verbal Cognition Raw Score	*Range* = 5 - 28	*Range* = 12 - 28	
	M = 17.54	*M* = 18.37	*Score* = 19.00
	SD = 5.10	*SD* = 4.83	
Non-verbal Cognition Raw Score	*Range* = 5 - 17	*Range* = 6 - 17	
	M = 9.71	*M* = 10.37	*Score* = 7.00
	SD = 3.17	*SD* = 3.17	
Total Cognition Raw Score	*Range* = 11 - 43	*Range* = 21 - 43	
	M = 27.25	*M* = 28.74	*Score* = 26.00
	SD = 7.16	*SD* = 6.79	
Mental Age	*Range* = 2.00 - 6.11	*Range* = 3.03 - 6.11	
	M = 3.89	*M* = 4.11	*Score* = 4.01
	SD = 1.13	*SD* = 1.22	
Listening Comprehension Raw Score	*Range* = 8 - 85	*Range* = 8 - 85	
	M = 39.13	*M* = 43.37	*Score* = 16
	SD = 19.53	*SD* = 18.85	
Listening Comprehension Age-Equivalent	*Range* = 2.08 - 8.10	*Range* = 2.08 - 8.10	
	M = 4.26	*M* = 4.58	*Score* = 3.01
	SD = 1.52	*SD* = 1.50	

	Group Mean	Younger Mean	Participant with Autism
Oral Expression Raw Score	*Range* = 1 - 61	*Range* = 10 - 61	
	M = 27.63	*M* = 31.42	*Score* = 28.00
	SD = 18.206	*SD* = 17.89	
Oral Expression Age-Equivalent	*Range* = 2.07 - 8.03	*Range* = 2.09 - 8.03	
	M = 4.24	*M* = 4.61	*Score* = 4.04
	SD = 1.81	*SD* = 1.83	
Reading Comprehension Raw Score	*Range* = 0 - 66	*Range* = 4 - 66	
	M = 18.33	*M* = 21.63	*Score* = 3.00
	SD 16.03	*SD* = 16.37	
Reading Comprehension Age-Equivalent	*Range* = 4.02 - 9.07	*Range* = 5.01 - 9.07	
	M = 5.61	*M* = 5.86	*Score* = 4.10
	SD = 1.09	*SD* = 1.07	

Minimum and maximum scores, mean (M) and standard deviation (SD) for raw scores and age-equivalences on measures of verbal and nonverbal cognition, listening comprehension, oral expression, and reading comprehension, comparing one participant with stroke to the group mean for all participants and all older participants.

	Group Mean	Older Mean	Participant with Stroke
Verbal Cognition Raw Score	*Range* = 5 - 28	*Range* = 5 - 18	
	M = 17.63	*M* = 13.75	*Score* = 17.00
	SD = 5.11	*SD* = 5.965	
Non-Verbal Cognition Raw Score	*Range* = 6 - 17	*Range* = 6 - 9	
	M = 9.79	*M* = 7.75	*Score* = 5
	SD = 3.06	*SD* = 1.26	
Total Cognition Raw Score	*Range* = 11 - 43	*Range* = 11 - 26	
	M = 27.42	*M* = 21.50	*Score* =22.00
	SD = 7.08	*SD* = 7.05	
Mental Age	*Range* = 2.00 - 6.11	*Range* = 2.00 - 4.01	
	M = 3.92	*M* = 3.05	*Score* = 3.04
	SD = 1.11	*SD* = .82	
Listening Comprehension Raw Score	*Range* = 8 - 85	*Range* = 11 - 37	
	M = 39.46	*M* = 26.75	*Score* = 8
	SD = 19.04	*SD* = 12.28	
Listening Comprehension Age-Equivalent	*Range* = 2.08 - 8.10	*Range* = 2.10 - 4.06	
	M = 4.30	*M* = 3.31	*Score* = 2.08
	SD = 1.47	*SD* = .94	

	Group Mean	Younger Mean	Participant with Autism
Oral Expression Raw Score	*Range* = 1 - 61	*Range* = 1 - 32	
	M = 28.50	*M* = 14.75	*Score* = 7
	SD = 17.67	*SD* = 12.920	
Oral Expression Age-Equivalent	*Range* = 2.07 - 8.03	*Range* = 2.07 - 4.00	
	M = 4.33	*M* = 3.03	*Score* = 2.11
	SD = 1.75	*SD* = .788	
Reading Comprehension Raw Score	*Range* = 0 - 66	*Range* = 0 - 10	
	M = 18.13	*M* = 5.25	*Score* = 8
	SD 16.21	*SD* = 5.50	
Reading Comprehension Age-Equivalent	*Range* = 4.02 - 9.07	*Range* = 4.02 - 5.09	
	M = 5.57	*M* = 4.56	*Score* = 5.08
	SD = 1.14	*SD* = .609	

Appendix C - Example Questions from the Oral and Written Language Scales - II

Listening Comprehension Example Question

Age 3
Show me the car (from four presented images).
1) Spin-top
2) Car
3) Drum
4) Ball

Age 4-5
Show me who has the most marbles (from four presented images)
1) This child has 2 marbles.
2) This child has 4 marbles.
3) This child has 18 marbles.
4) This child has 5 marbles.

Age 6
Show me the circle in front of the cat (from four presented images).
1) The circle is in front of the cat.
2) The circle is on top of the cat.
3) The circle is under the cat.
4) The circle is behind the cat.

Age 7
The class thought the chameleon was the most interesting thing they had seen on the trip. What did they see? (Select from four presented images).
1) Monkey
2) Zebra
3) Chameleon
4) Crocodile

Age 8
Which toy rotates? (Select from four presented images).
1) Drum
2) Kite
3) Spin-top
4) Cube

Age 9-11
In which picture do the fishbowls have an unequal amount of water?
1) Both bowls are equally full.
2) The fishbowls have an unequal amount of water.

3) Both fishbowls are equally half-full.
4) Both fishbowls are empty.

Age 12-16

Dad said he would divide the pie into equal pieces for the three children. Show me how he cut the pie (from four presented images).
1) The pie is not cut.
2) The pie is cut in five equal pieces.
3) The pie is cut in three equal pieces.
4) The pie is cut in three unequal pieces.

Age 17-21

Although we were cognizant of the dangers that might assail us in the march toward the frontiers of a pioneer life, we steadfastly proceeded, persuading and cajoling our beasts of burden toward the plains that already had been devastated by caravans.
1) The picture represents a line of cars in traffic.
2) The picture represents nomads with their camels in the desert.
3) The picture represents pioneers and their caravans in the plains.
4) The picture represents men and their elephants in the jungle.

Oral Expression Example Questions

Age 3-4

Here is a cat, and here is a _____.

Accepted answers:
Dog
Puppy

Age 5

Here, the boy is jumping. Here, he is _____.

Accepted answers:
Running
Jogging

Age 6-7

In this picture, the cat is lying on the chair. In this picture, the cat is lying _____.

Accepted answers:
Under the chair
Under there
Underneath the chair
Below/beneath the chair
Under

Age 8
The girl thought her orange science book was on the bottom of the pile of books, but it was actually _____.

Accepted answers:
On (the) top
At (the) top
Above/over (the other books)

Age 9-10
In this picture, the baby is kissed by the mother. In this picture, the mother _____.

Accepted answers:
Is kissed by the baby
Is being/getting kissed
Got/gets/was kissed

Age 11-13
Finish this story with one word: Here, she is shaking hands with her favorite singer. Here, she is asking for his _____.

Accepted answers:
Autograph
Signature

Age 14-16
Seth said he had butterflies in his stomach before the big race. How did Seth feel?

Accepted answers:
Nervous
Excited
Anxious
Scared
Nauseous

Age 17-21
Combine these ideas into one sentence without using the word 'and'. You may add other words.

The boy brushes his teeth.
The boy goes to bed.

Accepted answers:
The boy goes to bed after he brushes his teeth.
The boy brushed his teeth before going to bed.

Reading Comprehension Example Questions

Age 5-6
What word goes with this picture?
1) Sob
2) Sat
3) Sun
4) Sip

Age 7
Which picture goes with this sentence? 'Mother is eating the cake.'
1) In this picture, the mother is eating the cake.
2) In this picture, the mother is cutting the cake.
3) In this picture, the mother is baking the cake.
4) In this picture, the mother is carrying the cake.

Age 8
What sentence tells about this picture?
1) Under the chair is the cup and on the table is the cat.
2) The cat is on the table and the cup is under the chair.
3) The cup is on the table and the cat is under the chair.
4) On the table is the cat and under the chair is the cup.

Age 9-10
Finish the sentence with the best word. The machine uses _____, so you must first plug it into an outlet.
1) Smoke
2) Motion
3) Action
4) Electricity

Appendix D - Activity Assessment Inventory

Activity Assessment Inventory

Instructions: a) In the last week (Monday through Sunday), please indicate how many hours you (or if you are reporting for someone else, how many times the participant) spent on the following activities. b) For each activity, please also tell us whether the amount of time you reported stays about the same throughout the year or not. If the frequency changes much at different times of the year, please explain. c) Finally, if there is a list of activities given for a particular item, please circle all the activities that apply.

Example: Do Household activities (Take care of pets, garden, cook, bake, work with tools, clean, other)

(Yes) / No How many hours/week? 14

Is the reported time spent about the same all year? Yes (No)

If not, please explain Garden 2 hrs/day from May through November

1. Work for pay

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

2. Do Volunteer Work, Help Others

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

3. **Do Household activities (Take care of pets, garden, cook, bake, work with tools, clean, laundry, other _____)**

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

4. **Shop**

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

5. **Go to Church or Temple**

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

6. **Go to Events (Concert, museum, sports event, play, movie, show, party, restaurant, other _____)**

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

7. **Visit with Friends or Family (Talk, talk on the telephone, Skype, other _____)**

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

8. Read or Get Read to

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

9. Do Puzzles (e.g. Crosswords, jigsaw puzzles, word searches, sudoku, word jumbles, other _____)

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

10. Do Hobbies (Photography, arts and crafts, ceramics, pottery, paint, draw, sketch, play an instrument, sing, sew, weave, knit, crochet, other _____)

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

11. Take Classes or Lessons

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

12. Watch Television

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

13. Exercise (e.g. Exercise class, jog, run, gym, hike, walk, ride a bike, ride a horse, dance, canoe, kayak, swimming, skiing, skating, other _____)

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

14. Do Group Sports (e.g. Basketball, soccer, golf, baseball, softball, other _____)

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

15. Play games (e.g. Computer games, board games, card games, bowling, ping pong, pool/billiards, darts, bingo, other _____)

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

16. Do Other leisure Activities (Fishing, sailing, picnicking, other _____)

Yes / No How many hours/week? _____

Is the reported time spent about the same all year? Yes No

If not, please explain_____

17. Travel or camp

Yes / No How many times/year? _____

For how long? _____

18. Are there other activities you do that were not mentioned above?

If so, what are they?

_____

How many hours/week?

_____

Is the reported time spent about the same all year? Yes No

If not, please explain

_____

Appendix E - Activities Sorted by Activity Type

1. Physical activities:
    a. Exercise (e.g. Exercise class, jog, run, gym, hike, walk, ride a bike, ride a horse) dance, canoe, kayak, swimming, skiing, skating)
    b. Do Group Sports (e.g. Basketball, soccer, golf, baseball, softball)
    c. Outdoor Activities (Fishing, sailing, picnicking)
2. Cognitive activities:
    a. Household activities (Take care of pets, garden, cook, bake, work with tools, clean, laundry)
    b. Read or Get Read to
    c. Puzzles (e.g. Crosswords, jigsaw puzzles, word searches, sudoku, word jumbles)
    d. Hobbies (Photography, arts and crafts, ceramics, pottery, paint, draw, sketch, play an instrument, sing, sew, weave, knit, crochet)
    e. Take Classes or Lessons
    f. Play games (e.g. Computer games, board games, card games, bowling, ping pong, pool/billiards, darts, bingo)
3. Social activities:
    a. Volunteer Work, Help Others
    b. Shop
    c. Go to Church or Temple
    d. Go to Events (Concert, museum, sports event, play, movie, show, party, restaurant)

    e. Visit with Friends or Family (Talk, talk on the telephone, Skype, chat or email on computer)
    f. Travel or camp
4. Watching television
5. Working for pay