# SOCIAL NETWORK AND COGNITIVE FUNCTION IN APPALACHIAN OLDER ADULTS

by

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A THESIS

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## ABSTRACT

The present study examined the association between social network and cognitive function in 268 Appalachian older adults without dementia who had a mean age of 78.5. Cognitive functioning was assessed in two ways using results data from an extensive neuropsychological battery: an overall composite score of all the tests and an overall composite score for tests in specified cognitive domains (working memory, visuospatial ability, semantic memory, and episodic memory). Social networks were measured from structured questions using the Lubben Social Network Scale-6 (LSNS-6). The associations of social network to cognitive function were assessed in two hierarchical linear regression models: Model B controlled for age, education and Geriatric Depression Scores (GDS), whereas Model A did not. Results suggest a significant main effect and positive association with social network and global cognitive function, episodic memory, working memory, semantic memory and visuospatial ability. Therefore, these findings confirm that larger social networks in older adults are associated with better cognitive functioning and this remains true across varied cognitive domains.

## LIST OF ABBREVIATIONS AND SYMBOLS

| | |
|---|---|
| $\alpha$ | In statistical hypothesis testing, the probability of making a Type I error; Cronbach's index of internal consistency |
| $\beta$ | Population values of regression coefficients |
| *F* | Fisher's *F* ratio:  A ratio of two variances |
| *M* | Mean: the sum of a set of measurements divided by the number of measurements in the set |
| *N* | Statistical notation for total sample size |
| *p* | Probability associated with the occurrence under the null hypothesis of a value as extreme as or more extreme than the observed value. |
| *r* | Estimate of the Pearson product-moment correlation coefficient |
| $R^2$ | Multiple correlation squared; measure of strength of association |
| *SD* | Standard deviation |
| *SE* | Standard error |
| $\Delta$ | Increment of change |
| $<$ | Less than |
| $\leq$ | Less than or equal to |
| $=$ | Equal to |

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# INTRODUCTION

Memory loss poses a considerable clinical and public health care burden to older adults. In fact, memory loss is a strong risk factor for and characteristic of dementia, which in 2002 was estimated to affect up to 3.4 million individuals (13.9%) aged 71 and older in the US (Plassman et al., 2007), with 4.6 million new worldwide cases every year (Ferri et al., 2005). This burden is expected to increase substantially because the older adult segment of the US population is the fastest growing demographic (U.S. Census Bureau, 2009). Therefore, there is increased need to elucidate factors that may contribute to memory decline in order to protect this increasing number of older adults. This paper focuses on investigating potential relations between social network and cognitive function.

Cognitive functioning is associated with functional capacity (Buchman, Boyle, Leurgans, Barnes, & Bennett, 2011; McGuire, Ford, & Ajani, 2006) and the ability to maintain independence of daily activities into old age (Steen, Sonn, Hanson, & Steen, 2001), which in turn are related to quality of life (Hellström, Persson, & Hallberg, 2004). A substantial body of research (Petersen et al., 1999; Ritchie, Ledesert, & Touchon, 2000; Unverzaget et al., 2001) indicates that impaired memory is an important health outcome and a potential early warning sign of more severe cognitive impairment. More severe cognitive impairment is further associated with increased risk of institutionalization (Aguero-Torres, von Strauss, Viitanen, Winblad, & Fratiglioni, 2001), dementia (Hogan & Ebly, 2008; Petersen et al., 2001), and mortality (Dewey & Saz, 2001; Smits, Deeg, Kriegsman, & Schmand, 1999).

These statistics are particularly concerning because older adults are the fastest growing US age-group. From the year 2000, the number of individuals over 85 years of age will more than double by 2030, from 4.2 million to 8.7 million (Administration on Aging, 2009).

Therefore, research on the important issues that will affect older adults is critical. Specifically, there is great need for effective strategies aimed at preventing and treating age-associated cognitive decline.

Numerous investigations have identified physical health characteristics as risk factors for cognitive decline. These factors include the presence of depression (Jorm, 2000; Sachs-Ericsson, Joiner, Plant, & Blazer, 2005), diabetes (Xiu et al., 2009; Xiu, Qui, Winblad & Fratiglioni, 2007), and cardiovascular disease (Newman et al., 2005; Whitmer, Sidney, Selby, Johnston, & Yaffe, 2005). Other factors are also associated with increased risk of cognitive decline, such as female sex (Giampaoli, 2000), low education attainment (Albert et al., 1995; Gatz et al., 2007), low annual household income (Lee, Buring, Cook, & Grodstein, 2006), alcohol abuse (Thomas & Rockwood, 2001) and smoking (Stewart, Deary, Fowkes, & Price, 2005). Considerably fewer investigations have sought to determine relations between social network and patterns of cognitive functioning.

It has long been proposed that a low quantity, and sometimes low quality, of social relationships increased risk of death, even after controlling for baseline health (House, Landis, & Umberson, 1988). From the recent research that is available, it appears that greater social resources are positively associated with health benefits (Seeman & Crimmins, 2001). For example, increased social resources are associated with increased longevity (Seeman et al., 1993) and reduced risk of mortality (Bowling & Grundy, 1998; Glass, Mendes de Leon, Marottoli, & Berkman, 1999; Penninx et al., 1997) and dementia (Fratiglioni, Wang, Ericsson, Maytan & Winblad, 2000; Wang, Karp, Winblad, & Fratiglioni, 2002). Likewise, extensive epidemiological research has reported that social resources are protective against factors associated with cognitive decline, such as depression, cardiovascular disease, stroke and hypertension (Rosengren, Lars Wilhelmsen, & Orth-Gomer, 2004; Seeman, Lusignolo, Albert, & Berkman, 2001).

Even with robust evidence linking social engagement to health benefits, the influence of social relationships on cognitive function remains largely unexamined. Berkman, Glass, Brissette, and Seeman (2000) have proposed a conceptual model whereby social networks impose a broader impact on the social environment than other social resources because they provide the possibility for social support and engagement. However, studies that have explored this relation have yielded conflicting results.

Several studies have suggested that social networks are important predictors of cognitive outcomes among older adults. Specifically, a positive relation is proposed to exist between the size of social network and cognitive function. Barnes, Mendes de Leon, Wilson, Bienias and Evans (2004) measured social network size based on the number of children, relatives, and friends seen at least once per month. They found that a higher number of social networks (90th percentile) was correlated with a higher initial level of cognitive function and an attenuated rate of cognitive decline. Similarly, social disengagement (i.e., having few close ties and social activities in the community) resulted in a two-fold increase in risk of cognitive decline compared to the most engaged respondents (those with five or more ties; Bassuk, Glass, & Berkman, 1999). Additionally, Crooks et al. (2008) found that larger social networks have a protective influence on cognitive function among elderly women. Studies further suggest that having more frequent social contacts and preserving social networks prevents cognitive decline and the onset of dementia (Holtzman et al., 2004; Fratiglioni, Paillard-Borg, & Winblad, 2004).

In addition, social isolation variables have been found to be a significant predictor of emotional loneliness in older rural adults (Dungan & Kivett, 1994). Since loneliness is associated with increased risk of developing dementia and a more rapid decline in global cognition and semantic memory (Berkman et al., 2000; Wilson et al., 2007), it may be beneficial to study aspects of social network in a population of older rural adults.

It seems apparent that an active and socially engaged lifestyle confers protection against cognitive decline (Bassuk et al., 1999; Fratiglioni et al., 2004; Holtzman et al., 2004; Zunzunegui, Alvarado, Del Ser & Otero, 2003). However, it is not clear which aspects of social interactions are associated with cognitive function. For example, despite the relation between frequency of emotional support and reduced cognitive decline, Wilson et al. (2007) determined that social network size was not associated with incidence of Alzheimer's disease (AD) or cognitive performance. Similarly, Krueger et al. (2009) found that social network size was not strongly related to global cognition, despite the positive relations between social activity and social support with cognitive function. Therefore, such discrepancies warrant further examination to determine which features of social interaction and stimulation are associated with cognitive function. This study consists of a secondary analysis of data collected from prior research conducted at West Virginia University Center on Aging by principal investigator Wu (2008). The purpose of the original study was to expand on previous findings (Stein, Desrosiers, Donegan, Yepes, & Kryscio, 2007; Wu, Plassman, Crout, & Liang, 2008) elucidating relations between memory and oral health in older adults.

This analysis seeks to extend existing data by examining the relations between social network size and cognitive function. Data from the Wu (2008) study offers several distinct advantages for the analyses. First, it represents a unique sample of community-dwelling men and women.  West Virginia is the only state that lies entirely within Appalachia (Appalachian Regional Commission, 2008), where residents have been labeled a “neglected minority” (Tripp-Reimer & Friedl, 1977).  Furthermore, Appalachian residents are affected with numerous health problems (University of Pittsburgh Center for Rural Health Practice, 2004).  Nearly 45% of West Virginia’s population is rural, compared with only 17% of the United States (United States Department of Agriculture, Economic Research Service, 2008).  Therefore, this subject pool constitutes a doubly underrepresented population in research: rural and older.

Second, although published findings on social network and cognitive function are suggestive, further interpretations of results are often hindered by operational and conceptual limitations.  For instance, there is variability in how social interaction is defined and how adequately it is assessed.  The concept of social network is a multidimensional construct, therefore it has been difficult to quantify.  Furthermore, previous studies have used multiple indices (e.g., social support, social network size and social ties) to measure social networks, so comparing results is difficult.  For this reason, there is a need for further research to establish a universal measure of social networks, to facilitate more robust statistical analysis and cross-study comparisons.  The questionnaire used in the Wu (2008) study emulated that of Crooks et al. (2008), by using the abbreviated Lubben Social Network Scale (LSNS-6; Lubben, 1988), a validated measure of social network.

Third, this data set includes a more comprehensive assessment of cognitive function in contrast to nearly all previous studies, which generally rely on only one measure to identify cognitive functioning.  The cognitive assessments available in the study provide a more complete assessment of major domains of cognitive function such as episodic memory, semantic memory, working memory and visuospatial ability.  Studies that assess multiple domains are important since dementia criteria consists of a loss of memory and cognitive impairment in at least two cognitive domains that cause impaired functioning in daily living (Roman et al., 1993). Memory deficits that occur prior to a diagnosis of AD have been demonstrated in multiple cognitive domains, including verbal ability and reasoning (Jacobs et al., 1995), visuospatial ability (Small, Herlitz, Fratiglioni, Almkvist & Bäckman, 1997) and episodic memory (Grober, Lipton, Hall & Crystal, 2000). Furthermore, the different domains of cognition are distinctly influenced by environmental factors and developmental paths across the life span (Kramer, Bherer, Colcombe, Dong & Greenough, 2004). One study found that "less satisfaction with support" was marginally associated with a decline in episodic memory performance (e.g., delayed, cued, and recognition; Hughes, Andel, Small, Borensein, & Mortimer, 2008). Conversely, Krueger et al. (2009) found that social support was positively related to level of function in working memory and visuospatial ability, but not in episodic or semantic memory. However, little research has examined which specific domains of cognitive function are associated with social networks.

The hypotheses for this retrospective analysis are as follows: Social networks will have a significant ($p < .05$) positive association with cognitive functioning. The analysis also plans to investigate the following exploratory hypotheses: Social networks 1) will not have a significant ($p > .05$) positive association with episodic memory and semantic memory, but 2) will have a significant ($p < .05$) positive association with working memory and visuospatial ability.

The working hypothesis of this analysis is that larger social networks will be associated with higher levels of cognitive functioning, putatively due to increased social interactions that engage aspects of cognitive functioning. Therefore, older rural adults with larger social networks will have better cognitive functioning (higher overall composite score). In the exploratory analyses, by comparing domain composite scores, it is possible to test whether larger social networks vary across cognitive domains.  Similar to the results of Krueger et al. (2009), it is predicted that social networks will have a positive relation to problem solving abilities (e.g., working memory and visuospatial ability), but will not be related to storage of information (e.g., episodic and semantic memory).

# METHODS

The analysis will examine data collected from the "Cognitive Function and Oral Health Among Older Adults Age 70 and Above in West Virginia" research project carried out from 2007 to 2009. The project included five components of data collection: (a) an assessment of cognitive functioning, which was administered by a trained psychometrician utilizing a neuropsychological battery; (b) an oral evaluation, which was undertaken by calibrated researchers using guidelines and procedures from the National Health and Nutrition Examination Survey (NHANES, IV) protocols (National Center for Health Statistics, 2001); (c) a participant interview that included information on sociodemographics, mental health and self-rated oral health; (d) an informant interview (Langa et al., 2005) with a family member or close friend identified by the participant as someone who could provide information regarding the participant's clinical, dental and medical histories; and (e) a list of all medications taken during the previous two weeks. A sixth and optional component was a blood sample, drawn by a registered nurse or a trained phlebotomist. This protocol was approved by the West Virginia University Institutional Review Board.

*Participants*

Data were collected from 268 community-dwelling men and women in West Virginia who were dentate (i.e., at least four natural teeth) and aged 70 and above. Multiple strategies were used to recruit participants, including educational presentations, senior center sign-up and regional data collection sessions. In addition, caretakers and senior center directors and members were presented with a description of the study and were then urged to discuss participation with anyone whom they felt might fit the desired subject profile. Those whom expressed interest, met with or provided contact information to project staff, so they could be given further detailed information about study participation and screened for eligibility.

All potential participants reviewed an informed consent document, describing the procedures and potential risks and discomforts. Such risks included possible gum bleeding in the dental exam and mild frustration during the memory screening. In addition to the general consent, participants were asked to sign a record release authorization form, HIPAA research authorization form, and consent and information form for the collection of human tissue for research. Individuals whom were unable to sign for themselves (e.g., cognitive impairment) had consent forms explained to them and provided assent to the researchers, as well as signatures from their medical power of attorney. All participants were assigned an identification code that was used on all other testing forms to ensure participant confidentiality.

Participants who voluntarily agreed to be in the study completed the protocol described above, which generally ranged from 2 to 3 hours in length. The informant interview was completed on-site if the informant was present or via telephone if not present. A $50 gift certificate was given to eligible participants that started the project, regardless whether or not they choose to complete the study. Participants who agreed to take part in the blood-draw procedure received an additional $10 gift certificate.

*Setting*

Study participants were recruited from 14 counties within West Virginia. Data collection sessions were conducted at 18 sites, including 12 senior centers, three dental or health clinics, two assisted living facilities, and one retirement housing community. It was necessary that the collection site had the appropriate physical environment for data collection, including sufficient space for a portable dental chair and nurses' station. Further, given the sensitive nature of many of the protocol items (e.g., the neuropsychological and dental assessments), environments with maximum privacy and minimal distractions were paramount. Most often, at least three separate private spaces were used for the data collection so that these physical and confidential needs could be met appropriately.

*Measures*

A trained psychometrician (EAD) administered the participant survey and battery of neuropsychological instruments (see Appendix). The dependent measure for this analysis of cognitive functioning was assessed using results data from the neuropsychological battery. This battery was aimed at testing participants' memory, concentration and attention. The neuropsychological battery consisted of the following tests, administered to each participant in the subsequent order: Rey-Osterrieth Complex Figure (Rey-O; Rey, 1941; Osterrieth, 1944), California Verbal Learning Test-2nd Edition Short From (CVLT-II; Delis, Kramer, Kaplan, & Ober, 2000), Trail Making Test A and B (Reitan, 1958), Boston Naming Test-2nd Edition (BNT; Kaplan, Goodglass, & Weintraub, 1983), North American Adult Reading Test (NAART; Blair & Spreen, 1989), Controlled Oral Word Association Test (COWAT; Benton & Hamsher, 1989), and Animal Naming Test (Barr & Brandt, 1996). The independent measure of social networks for this analysis was measured from structured questions asked as a part of the participant survey using the Lubben Social Network Scale-6 (LSNS-6; Lubben, 1988). These two components of testing took between 45 to 90 minutes to administer, depending upon the amount of information participants provided and total time taken on certain tasks. The participant interview was done following the neuropsychological testing, whereas the neuropsychological testing was administered either before or after the dental assessment.

*Assessment of Cognitive Function*

The neuropsychological battery consisted of 7 tests: one measure of episodic memory including Word List Memory, Recall and Recognition as a portion of the CVLT-II; 4 measures of semantic memory including Verbal Fluency (e.g., COWAT and Animal Naming Test), BNT and NAART; one test of working memory including the Rey-O; and one measure of visuospatial ability including Trail Making A and B. Cognitive function was assessed by two means: an overall composite score of all the tests and an overall composite score for tests in specified cognitive domains. A composite measure of global cognition was based upon results of all 7 tests by acquiring the raw scores on each test. As previously described by Wilson et al. (2005), these raw scores were then converted to scaled scores, using the baseline mean and standard deviation (*SD*) in the population. The scaled scores were then averaged and standardized. In addition, it was possible to construct composite scores for episodic memory (1 test), semantic memory (4 tests), working memory (1 test), and visuospatial ability (1 test). Again, raw scores on individual tests were converted to scaled scores, using the baseline mean and standard deviation (*SD*), averaged and standardized to yield the composite scores for each specified cognitive domain.

*Rey-Osterrieth Complex Figure (Rey-O; Rey, 1941; Osterrieth, 1944)*. The Rey-O consists of three subtests: the copy, immediate recall and delayed recall. The test is designed to measure planning, visual memory and perceptual organization (Lezak, Howieson, & Loring, 2004). In the Rey-O copy test, participants are instructed to copy a picture of a complex figure that is displayed before them. As the participant copies the figure, the psychometrician traces on another copy of the image to depict the participant's organizational approach to the task by numbering the line sequence. In the Rey-O immediate recall test, participants must rely on visual memory to reproduce the complex figure without it being displayed in front of them. After a 45-minute delay from completing the original Rey-O copy, participants are again directed to reproduce the complex figure without it being displayed. Raw scores are derived from the accuracy in which the participants draw the complex figures for the three tests. Scores ranged from 0 to 72, with higher scores indicating better performance. Inter-scorer reliability for the Rey-O figure is typically above 0.95 (Lezak et al., 2004), which is high given that the scoring criteria is individually assessed and not precisely defined.

*California Verbal Learning Test-II Short Form (CVLT-II SF; Delis et al., 2000).* CVLT-II is used to measure verbal learning and memory through a multiple-trial list-learning task (Lezak et al., 2004). The CVLT-II Short Form is designed as a measure for clients with severe cognitive dysfunction or as a screening instrument for memory impairment (Delis et al., 2000). The psychometrician reads a list of 9 words and then asks participants to recall as many of the words as they can in any order. This process is repeated for four trials, after which participants complete a 30-second Distractor Task of counting backwards from 100. After 30 seconds, participants are asked to recall as many of the words from the list that they can remember. A long-delay, free recall is done after 10-minutes, as well as three cued recalls in which participants are given categories (e.g., words from the list that are fruits). Finally, participants are given a yes/no recognition task to say “yes” if the word is from the list or “no” if the word is not from the list. Scores were calculated by software, which is corrected for the examinee’s age and sex. Reliability correlations are high, with split-half reliability correlations of scores from Total Trials 1-4 range from .87 to .89, and alternate form reliability ranges from .72 to .79 for various measures (Delis et al., 2000).

*Trail Making Test A and B (Reitan, 1958)*. Trail Making Test A and B measures visuomotor tracking, attention, and perceptual motor speed (Lezak et al., 2004). For Trails A, participants connect a series of numbered circles in order (e.g., 1–2–3–4). For Trails B, participants connect a series of numbered and lettered circles in an alternating sequence (e.g., 1–A–2–B). The time taken to complete the tests is used to determine age-normed scaled scores, with faster completion time indicating better performance. Since time to completion is individually derived, there is no range. Reliability coefficients vary considerably, with most above .60 and in the .80s but several in the .90s (Spreen & Strauss, 1998).

*Boston Naming Test- 2nd Edition Short Form (BNT; Kaplan et al., 1983)*. BNT is a measure of object naming from 15 simple line-drawn pictures. Participants are shown an object and asked, "Can you tell me what this is?" If there is no response or an incorrect response, the psychometrician cues the participant. For example, if the picture is an image of a tree, the psychometrician would cue the participant by saying "It's something that grows outdoors." If there is still no response or an incorrect response, the psychometrician would cue the participant with a phonemic cue, such as "the word starts with the sound____." Participants receive one point if they correctly identify the object without any cues. Therefore, the range of scores is 0 to 15, with lower scores indicating poorer performance. The BNT has exhibited high correlations with other verbal ability tests (e.g., $r$ =.83 with the Gates-MacGinitie Reading Test; Franzen, 1989).

*North American Adult Reading Test (NAART; Blair & Spreen, 1989)*. NAART is a measure used to test and estimate premorbid verbal intellectual ability (Lezak et al., 2004). The version of the NAART given to subjects required an oral reading of 35 words, varying in frequency of use. If pronounced correctly participants receive a point, if pronounced incorrectly participants receive zero points. Therefore, the range of scores is 0 to 35, with lower scores indicating poorer performance. NAART scores have been shown to correlate reasonably well with the established Wechsler Memory Scale (e.g., $r$ = 0.83; Lezak et al., 2004).

*Controlled Oral Word Association Test (COWAT; Benton & Hamsher, 1989).* COWAT is a measure used for assessing verbal fluency and the ease with which a person can think of words that begin with a specific letter. Participants are given a letter of the alphabet and asked to say as many words as possible beginning with that letter in one minute. There are a few rules: participants may not use proper nouns, may not slightly change the end of a word to get another and may only use each word one time. The test is given three times to each participant, using the letters F, A, and S. Since the values derived are individually based, there is no range. A previous study found that when retesting elderly persons after one year, there was a reliability coefficient of .70 for letters other than A and .71 for the total score (Snow et al., 1988).

*Animal Naming.* Animal Naming is a measure used to test verbal fluency, specifically verbal production, semantic memory, and language (Lezak et al., 2004). Participants are required to name as many animals as possible in one minute. Since the value derived here is individually based, there is no range. Animal Naming has strong psychometric properties, including significant overlap with other measures of verbal fluency ($r$ = .76; Williams et al., 2005).

*Assessment of Social Network*

Social network was measured using the abbreviated Lubben Social Network Scale-6 (LSNS-6) as a series of questions asked as a portion of the study's participant survey questionnaire. This measure estimates social isolation in older adults by measuring participant's social network size. There are a total of 6 questions, three referring to family social network and an equivalent set for friendship social network. The LSNS-6 assesses the size of the participant's active social network (e.g., How many relatives/friends do you see or hear from at least once a month?), perceived support network (e.g., "How many relatives/friends do you feel close to such that you could call on them for help?") and perceived confidant network (e.g., "How many relatives/friends do you feel at ease with whom you can talk about private matters?"). Each question is scored on a 0 to 5 scale, with responses as none (0), one (1), two (2), three or four (3), five thru eight (4) or nine or more (5). The social network score is the sum of these 6 questions. Therefore, scores range from 0 to 30 with higher scores indicating larger social networks. In order to establish good internal consistency, a Cronbach's alpha coefficient was calculated for the LSNS-6. There was an overall Cronbach alpha of 0.79, with a 0.83 for the family subscale and 0.69 for the friend subscale. Such results are similar to previous studies which found an overall Cronbach alpha of 0.83 (Lubben, Blozik, & Gillmann, 2006), with a 0.86 for the family subscale and 0.82 for the friend subscale (Lubben, 1988).

*Demographic Variables*

Demographic variables included age (in years), sex (male = 1, female = 2), education (in years), marital status (never married = 1, married = 2, divorced/separated = 3, and widowed = 4), total annual income (under $10,000 = 1, $10,000 to $19,9999 = 2, $20,000 to $29,999 = 3, $30,000 to 39,999 = 4, $40,000 to $49,999 = 5, $50,000 or above = 6), and race (white = 1, nonwhite = 2). Vascular risk factors consisted of diabetes, hypertension, hypercholesterolemia, stroke, cardiac surgery, cancer, and thyroid disease (Black, 1992). If the participant had the condition they received a score of one and a score of zero if they did not. A composite score of vascular risk was acquired by summing of scores from the seven conditions. Therefore, the range of scores was 0 to 7, with high scores contributing to increased vascular risk. Depressive symptoms were assessed from 15 questions taken from the Geriatric Depression Scale (GDS-15; Yesavage et al., 1983). Scores ranged from 0 to 15, with higher scores indicating greater levels of depression.

*Data Fidelity Monitoring Measurements*

Research assistants were trained to conduct neuropsychological assessments and participant interviews under the supervision/guidance of a neuropsychologist. Training occurred over four sessions and included understanding test measures and role-playing (of both the neuropsychological battery and participant interview). Furthermore, weekly supervision meetings were held to discuss problems or questions that may have arisen during data collections.

When more than one recorder was available to obtain data, it was important to have reliability checks to ensure that data were recorded and scored in a similar manner. To accomplish this, one in every three files was randomly selected and scored by both recorders. If scores differed, then a consensus meeting was held with the research team to discuss these differences and to agree upon a consensus score. However, this was only necessary for the first 85 files, because the remaining data were collected and recorded by the same psychometrician (EAD).

In addition to 100% self-checking of data entry, data quality checks were performed for each measure. Approximately 60% of the total number of files (or 160 out of $N$ = 268) were checked for accuracy by comparing the written protocol with the data that had been entered. The number of errors found for each measure was divided by the total number of possible errors, to get the following percentages: Rey-O: 1.36%, CVLT-II: 0.40%, Trails A/B: 2.61%, BNT: 0.31%, and COWAT: 0.81%. There were no errors found in the data entry of the NAART, Animal Naming and LSNS-6. This accounts for errors in the data entry process and scoring, but does not account for any recording errors that may have been made by the examiner or equipment (e.g., stopwatch) during testing.

## Data Analysis

Linear regression analysis was used to evaluate the main hypothesis and examine the association of social network with overall cognitive functioning. The independent variable was participant's calculated social network score and the dependent variable consisted of an overall cognitive functioning score. Exploratory hypotheses were also examined using four linear regression analyses to study whether social network was associated with participants' cognitive functioning across four separate cognitive domains: episodic memory, visuospatial ability, working memory and semantic memory.

Each of these linear regression analyses were repeated controlling for self-reported variables that were potential confounds because they had associations with cognitive function among the cohort. Therefore, the relation between the demographic variables and criterion variables were investigated using Pearson product-moment correlation coefficients. Covariates were chosen based on the number of significant correlations with the criterion variables. Hierarchical linear regression analyses were run with chosen covariates entered together on Step 1 and social network entered on Step 2. This approach allowed the independent contribution of social network to be measured as a predictor of cognitive function.

Therefore, two regression models were used to study the proposed associations of social network with cognitive function. In Model A, social network was entered on the first step of the regression. However in Model B, the covariates were entered on the first step and social network was entered on the second step of the regression. The significance of the association between the variables were tested with an $\alpha = .05$. The planned analysis was approved by the University of Alabama Institutional Review Board.

RESULTS

*Sample Characteristics*

The participants ranged in age from 69 to 94, with a mean age of 78.5. The sample consisted of 174 women and 94 men. The demographic profile of the study participants is presented in Table 1.

Table 1
*Participant Demographics (N = 268)*

| **Variable Name** | **Mean (Range)** | **Percentage** |
|---|---|---|
| Age | 78.5 (69-94) | |
| Female | | 64.9% |
| White | | 95.5% |
| Marital Status: | | |
| Never Married | | 1.5% |
| Married | | 41.9% |
| Divorced/Separated | | 9.7% |
| Widowed | | 46.4% |
| Other | | 0.4% |
| Highest Level of Education: | | |
| Elementary School or Less | | 5.7% |
| Some High School | | 11.0% |
| High School | | 31.1% |
| Some College | | 22.0% |
| College | | 17.8% |
| Graduate Degree or Above | | 12.5% |
| Household Income | | |
| Under $10,000 | | 8.2% |
| $10,000-$19,999 | | 30.3% |
| $20,000-$29,999 | | 18.4% |
| $30,000-$39,999 | | 12.7% |
| $40,000-$49,999 | | 7.0% |
| $50,000 or Above | | 23.4% |
| Health Status | | |
| 0-2 | | 71.9% |
| 3 or Above | | 28.1% |
| GDS | | |
| 0-2 | | 83.9% |
| 3-5 | | 10% |
| 5 or Above | | 6% |

Ninety-five percent of participants reported being Caucasian or White, and 5% reported racial or ethnic minority status. Most of the participants completed high school (83.4%) and were widowed (46.4%) or were currently married (41.9%). The majority of participants (71.9%) endorsed fewer than 3 conditions that contribute to increased vascular risk factors. On the GDS-15, most of the participants (83.9%) endorsed between 0 to 2 depressive symptoms.

Social network size ranged from 4 to 30 ($M$ = 19.45, $SD$ = 5.82), with higher scores indicating larger social networks. Global cognitive function scores ranged from -2.34 to 2.11 ($M$ = -0.0039, $SD$ = .80), with higher scores indicating greater cognitive functioning. Given the number of significant correlations with criterion variables, participants' age, education level and GDS were used as covariates in the following analyses. The correlations of social network and demographic variables with criterion variables are presented in Table 2.

Table 2
*Correlations of Demographic Variables with Criterion Variables*

| | **Age** | **Gender** | **Race** | **Marital Status** | **Ed. Level** | **Income** | **Vascular Risk** | **GDS** |
|---|---|---|---|---|---|---|---|---|
| Cognitive Function | -.23* | .17* | -.08 | .20* | .34* | .32* | -.19* | -.20* |
| Episodic Memory | -.19* | .14* | -.09 | .16* | .22* | .22* | -.05 | -.15* |
| Working Memory | -.08 | .26* | -.12 | .15* | .25* | .24* | -.16* | -.16* |
| Visuospatial Ability | -.25* | .08 | -.04 | .13* | .24* | .20* | -.13 | -.21* |
| Semantic Memory | -.19* | .06 | -.03 | .20* | .39* | .35* | -.23* | -.14* |
| Animal Naming | -.32* | -.04 | -.07 | .21* | -.04 | .09 | -.05 | -.15* |
| COWAT | .05 | .01 | .10 | .05 | .31* | .25* | -.14 | -.13* |
| BNT | -.26* | .08 | -.06 | .15* | .14* | .19* | -.21* | -.08 |
| NAART | .01 | .11 | -.03 | .13* | .70* | .43* | -.25* | -.03 |

* $p < .05$

*Main Hypothesis*

Linear regression analysis was conducted to examine the relation of social network to overall cognitive functioning. There was a significant main effect for social network, which accounts for 10.7% of the variance in overall cognitive function, $F(1,259) = 31.06$, $p < .05$ (Model A; Figure 1).

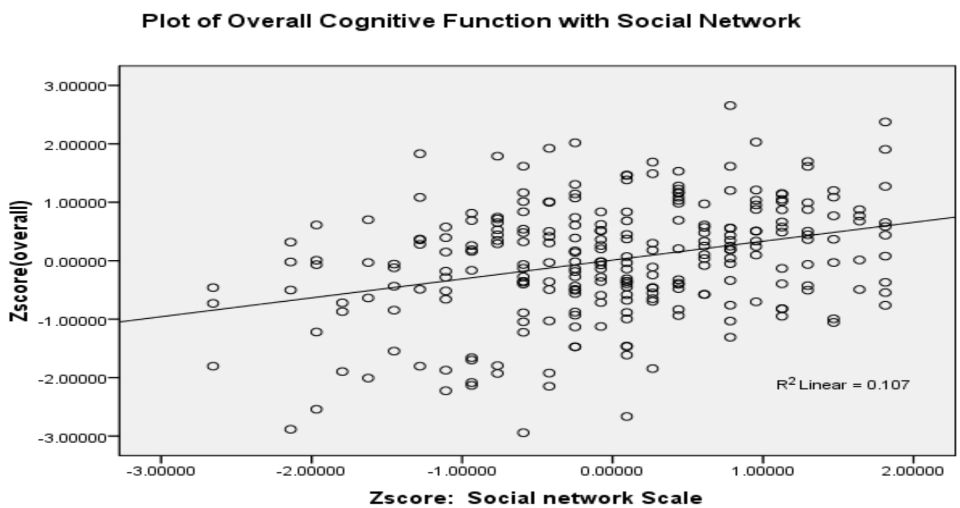


*Figure 1*. Scatterplot and regression line of overall cognitive function with social network. In addition, social network had a positive association with global cognition: β = .327, *SE* = .059, $p < .05$.

Moreover, hierarchical linear regression analysis was conducted to examine social network and overall cognitive function after controlling for the effects of covariates (age, education level and GDS) on Step 1 (Model B). After controlling for covariates, social network had a significant main effect and positive association with global cognition: β = .275, *SE* = .055, $F(4,256) = 23.70$, $p < .05$, 7.2% increment in $R^2$ compared to a model with only covariates. However, in this analysis, the association of social network with global cognition was reduced by about 16%, but remained significant. None of the social network by covariate interactions were significant. The results of these regression analyses are presented in Table 3.

Table 3

*Regression Analyses of Overall Cognitive Domains on Social Network*

| | Model A | | | | Model B | | | |
|---|---|---|---|---|---|---|---|---|
| **Predictor** | $R^2$ | $\Delta R^2$ | $F$ | $\beta$ | $R^2$ | $\Delta R^2$ | $F$ | $\beta$ |
| Covariates | | | | | 0.199 | | 21.24* | |
| Overall Social Network | 0.107 | | 31.06* | .327* | 0.270 | 0.072 | 23.70* | .275* |

* $p < .05$

*Exploratory Analyses*

Four linear regression analyses were conducted to determine whether social network was related to participants' cognitive functioning across four separate cognitive domains: episodic memory, visuospatial ability, working memory and semantic memory (Model A). Social network had a significant main effect and positive association with all four cognitive domains. Social network accounted for 9% of the variance in episodic memory, $F(1,259) = 25.56$, $p < .05$ (Figure 2).

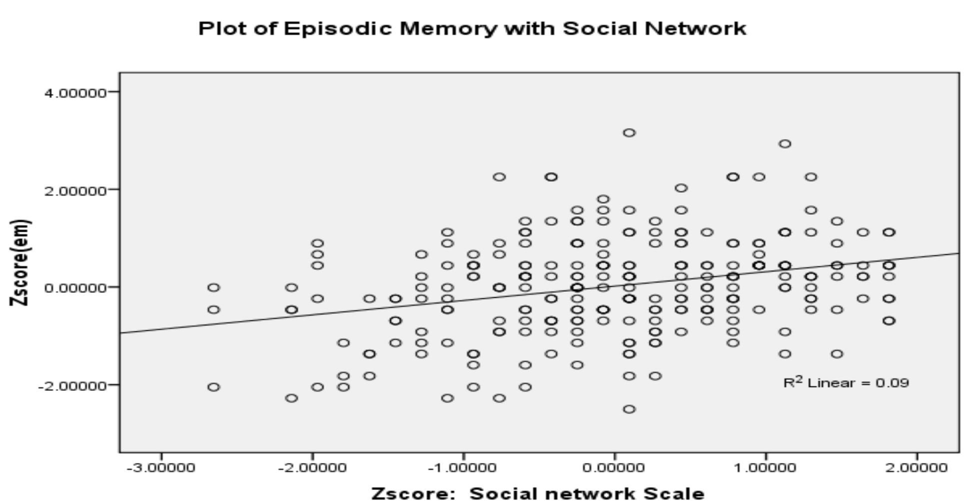


*Figure 2*. Scatterplot and regression line of episodic memory with social network.

In addition, social network had a positive association with episodic memory: β = .300, *SE* = .059, $p < .05$. Similarly, social network explained 8.8% of the variance in visuospatial ability: β = .297, *SE* = .060, $F(1,259) = 24.55$, $p < .05$ (Figure 3).

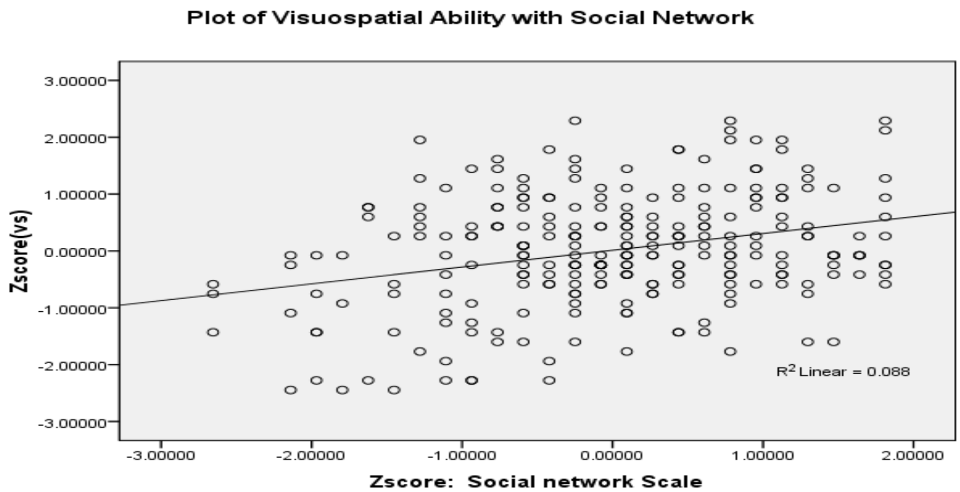


*Figure 3*. Scatterplot and regression line of visuospatial ability with social network.

Results also support a positive association with social network and working memory: β = .211, *SE* = .061, $R^2 = .045$, $F(1,259) = 11.80$, $p < .05$ (Figure 4).

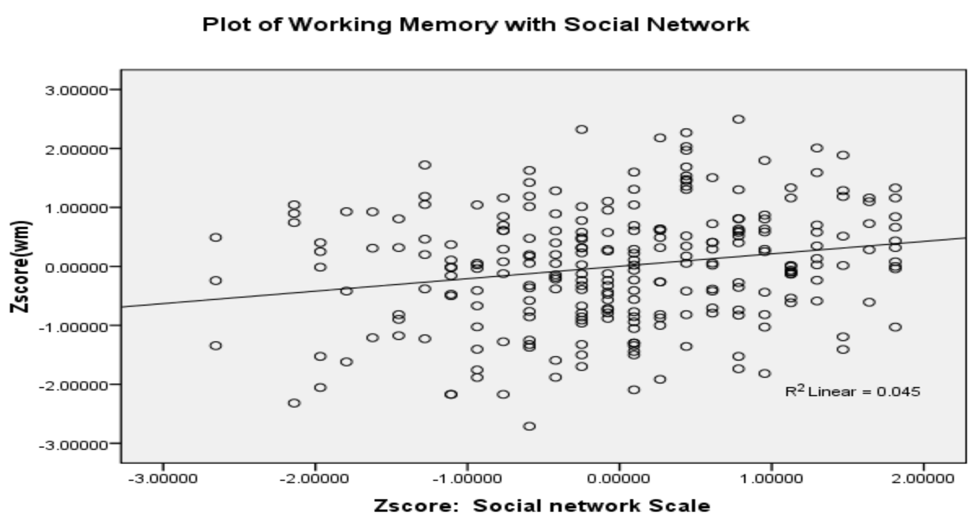


*Figure 4.* Scatterplot and regression line of working memory with social network.

Furthermore, social network had a positive association and explained 5.4% of the variance in semantic memory: β = .232, *SE* = .060, $F(1,259) = 14.80$, $p < .05$ (Figure 5).

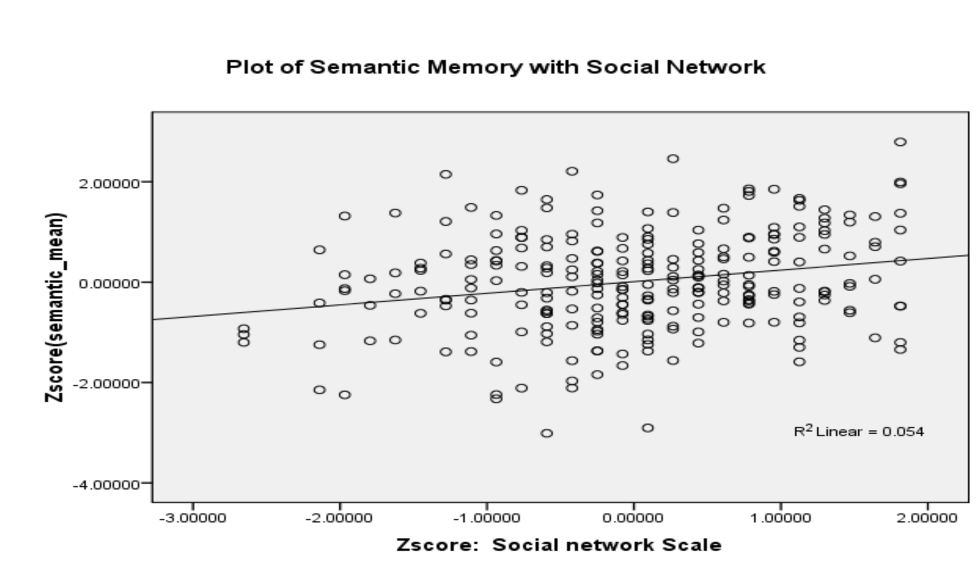


*Figure 5*. Scatterplot and regression line of semantic memory with social network.

To determine whether covariates could account for the relation of social network to different cognitive domains, four hierarchical linear regression analyses were conducted controlling for the effects of covariates (age, education level and GDS) on Step 1 (Model B). After controlling for covariates, results suggest that social network maintained a significant main effect and positive association with each of the four cognitive domains. Results support a positive association with social network and episodic memory: β = .261, *SE* = .059, $\Delta R^2 = .065$, $F(4,256) = 12.36$, $p < .05$. In addition, social network had a positive association with visuospatial ability: β = .239, *SE* = .058, $\Delta R^2 = .054$, $F(4,251) = 15.83$, $p < .05$. Social network explained 3.3% of the variance in working memory, $F(4,250) = 8.83$, $p < .05$. Furthermore, social network had a positive association with working memory: β = .188, *SE* = .061, $p < .05$. Similarly, results support a positive association with social network and semantic memory: β = .190, *SE* = .056, $\Delta R^2 = .034$, $F(4,256) = 19.72$, $p < .05$. However by controlling covariates, the associations of social network with episodic memory was reduced by about 13%, visuospatial ability was reduced by 19.5%, working memory was reduced by about 11% and semantic memory was reduced by about 18%. None of the social network by covariate interactions were significant. The results of these regression analyses are presented in Table 4.

Table 4
*Regression Analyses of Specific Cognitive Domains on Social Network*

| | Model A | | | | Model B | | | |
|---|---|---|---|---|---|---|---|---|
| **Criterion** | $R^2$ | $\Delta R^2$ | $F$ | $\beta$ | $R^2$ | $\Delta R^2$ | $F$ | $\beta$ |
| Episodic Memory | 0.090 | | 25.559* | .300* | 0.162 | 0.065 | 12.363* | .261* |
| Visuospatial Ability | 0.088 | | 24.551* | .297* | 0.201 | 0.054 | 15.834* | .239* |
| Working Memory | 0.045 | | 11.804* | .211* | 0.124 | 0.033 | 8.832* | .188* |
| Semantic Memory | 0.054 | | 14.796* | .232* | 0.236 | 0.034 | 19.716* | .190* |

* $p < .05$

Because semantic memory was the only studied cognitive domain that was comprised of more than one task, an additional exploratory analysis was conducted to determine if social network was related to specific semantic memory tasks but not others. Therefore, four linear regression analyses were conducted in order to study the effects of social network on participants' cognitive functioning across four semantic memory tests (BNT, NAART, Animal Naming, COWAT; Model A). Results suggest that social network had a significant main effect in Animal Naming, COWAT and BNT, but not for NAART. Social network explained 7.7% of the variance in Animal Naming, $F(1,257) = 21.43$, $p < .05$ (Figure 6).

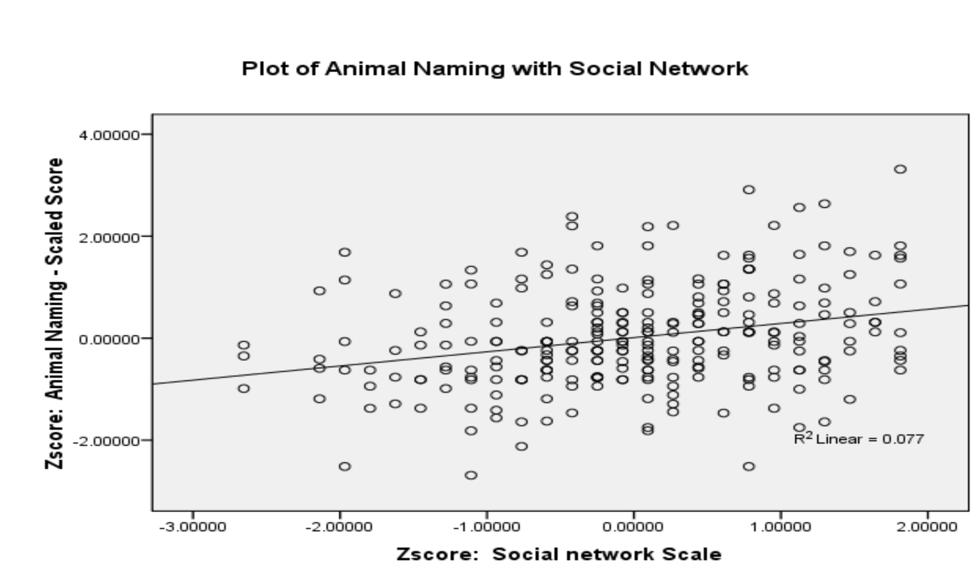


*Figure 6*. Scatterplot and regression line of animal naming with social network.

Furthermore, social network had a positive association with Animal Naming: β = .277, *SE* = .060, $p < .05$. Similarly, social network had a positive association and explained 3.7% of the variance in COWAT: β = .193, *SE* = .062, $F(1,253) = 9.80$, $p < .05$ (Figure 7).

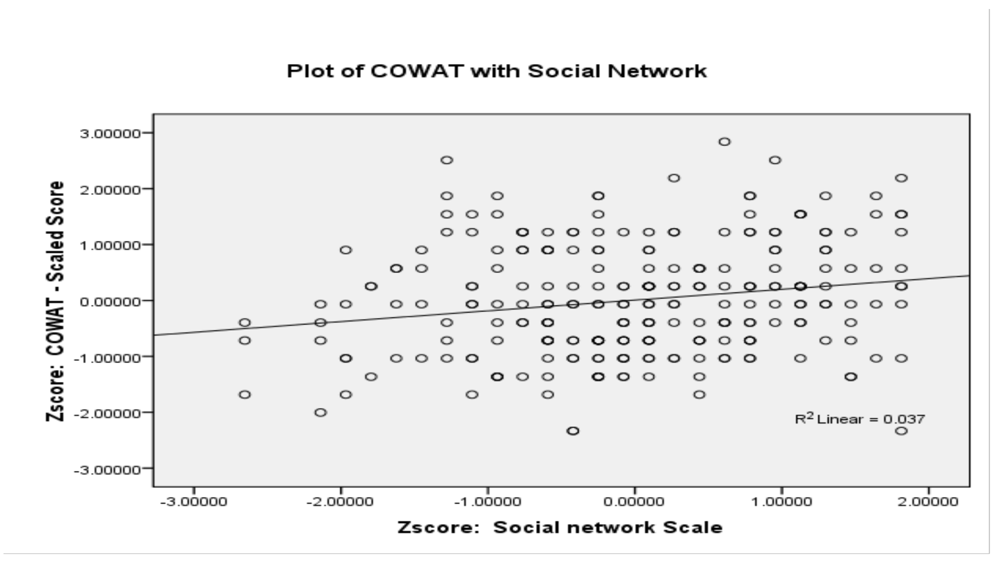


*Figure 7*. Scatterplot and regression line of COWAT with social network.

In addition, social network had a positive association with BNT: β = .185, *SE* = .062, $R^2$ = .034, $F(1,254) = 9.04$, $p < .05$ (Figure 8).

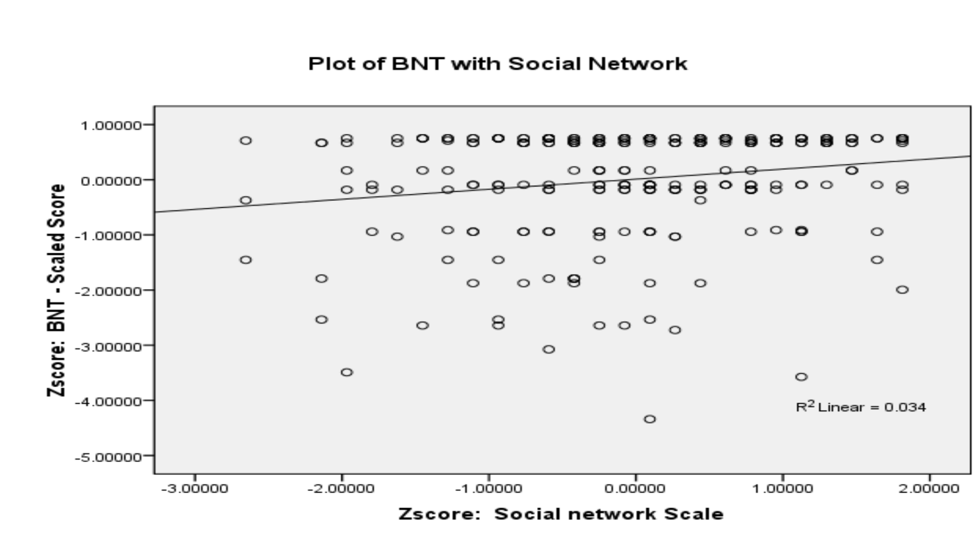


*Figure 8*. Scatterplot and regression line of BNT with social network.

However, social network had an insignificant main effect and an inverse relation with the NAART: β = -.022, *SE* = .063, $R^2$ = .00, *F*(1,249) = .122, *p* = .73 (Figure 9).

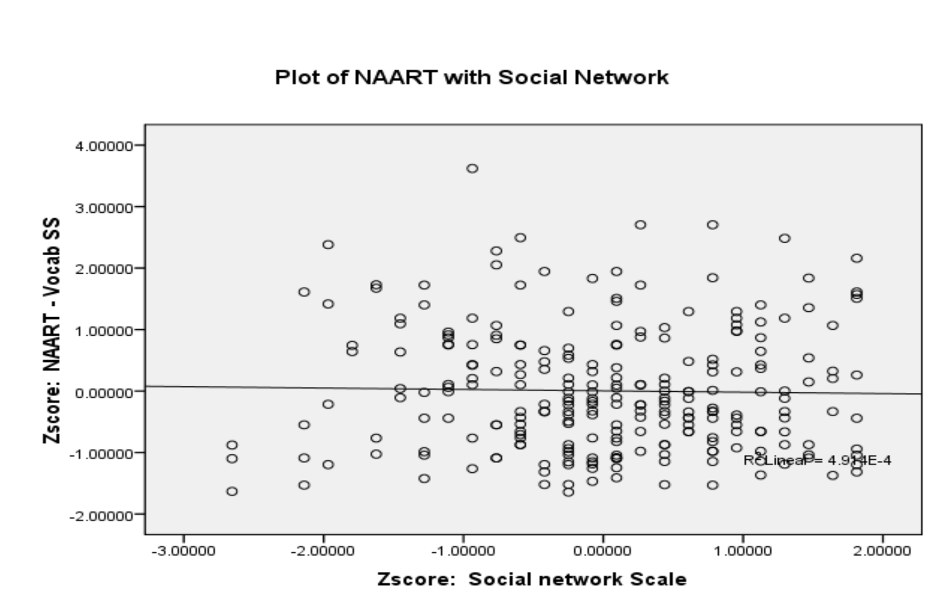


*Figure 9*. Scatterplot and regression line of NAART with social network.

These four linear regression analyses were repeated controlling for the effects of covariates (age, education level and GDS) on Step 1 (Model B). After controlling for covariates, results suggest that social network had a significant main effect for each of the semantic memory tasks.  More specifically, social network had a positive association and explained 4.3% of the variance in Animal Naming:  $\beta = .213$, $SE = .059$, $F(4,254) = 11.51$, $p < .05$.  Similarly, social network explained 3.9% of the variance in COWAT, $F(4,250) = 11.03$, $p < .05$.  Furthermore, social network had a positive association with COWAT: $\beta = .197$, $SE = .060$, $p < .05$.  In addition, results suggest a positive association with social network and BNT: $\beta = .135$, $SE = .061$, $\Delta R^2 = .017$, $F(4,251) = 7.53$, $p < .05$.  Social network explained only 0.1% of the variance in NAART, $F(4,246) = 58.48$, $p < .05$.  However, social network had an insignificant inverse relation with the NAART:  $\beta = -.027$, $SE = .047$, $p = .56$. By controlling for covariates, the association of social network with Animal Naming was reduced by about 22%, NAART was reduced by 18% and BNT was reduced by 27%.  On the contrary, the association of social network with COWAT increased by about 2%.  In addition, there was a significant GDS by social network interaction for BNT, $F(5,250) = 8.731$, $p < .05$.  Specifically, when GDS scores were below 1.98, the size of the social network increased as scores on the BNT increased.  However, when GDS scores were above 1.98, the size of the social network increased as scores on the BNT decreased (Figure 10).


*Figure 10*. Interaction of GDS and Social Network with BNT.

The results of these regression analyses are presented in Table 5.

Table 5

*Regression Analyses of Semantic Memory Tasks on Social Network*

| | Model A | | | | Model B | | | |
|---|---|---|---|---|---|---|---|---|
| **Criterion** | $R^2$ | $\Delta R^2$ | $F$ | $\beta$ | $R^2$ | $\Delta R^2$ | $F$ | $\beta$ |
| Animal Naming | 0.077 | | 21.43* | .277* | 0.153 | 0.043 | 11.508* | .213* |
| COWAT | 0.037 | | 9.80* | .193* | 0.150 | 0.037 | 11.027* | .197* |
| NAART | 0.000 | | 0.12 | -.022 | 0.487 | 0.001 | 58.476* | -.027 |
| BNT | 0.034 | | 9.04* | .185* | 0.107 | 0.017 | 7.533* | .135* |

* $p < .05$

## DISCUSSION

Overall, the results of this investigation demonstrate that social network has a significant main effect and positive association with global cognitive function, as well as specified cognitive domains (episodic memory, working memory, semantic memory and visuospatial ability) in older rural adults. To our knowledge, this is the first study to demonstrate positive associations between social networks across various cognitive domains. These findings are important because they suggest that a socially integrated lifestyle in late life may protect against cognitive decline.

Larger social network, as measured by the LSNS-6, was associated with substantially higher cognitive function. Controlling for age, education level and GDS decreased the association of social network with cognitive function. This reduction suggests that these covariates may partially account for the relation between social network and cognitive function. A significant main effect of social network on cognitive function supports the notion that social resources are an important factor for cognitive health in older adults. Furthermore, the relation between a smaller social network and lower cognitive function in the elderly is consistent with a number of previous findings (Fratiglioni et al., 2004; Holtzman et al., 2004; Barnes et al., 2004; Bassuk et al., 1999). These findings are also in agreement with this study's original hypothesis that larger social networks will be associated with higher levels of cognitive functioning, putatively due to increased social interactions that engage aspects of cognitive functioning.

Exploratory analyses were conducted to examine the associations between social network and function in different domains of cognition. Social network had a significant main effect and positive association with all four cognitive domains: working memory, episodic memory, semantic memory and visuospatial ability. As described above, controlling for age, education level and GDS reduced the association and accounted for a small unique portion of the variance in all four domains of cognition.  Such findings support the proposed hypotheses that social network would have a positive relation with working and visuospatial ability.  However, results contradict the proposed hypotheses that social network would not be associated with episodic and semantic memory.  These hypotheses were predicted based upon the results of Krueger et al. (2009), who found that social support was positively related to level of function in working memory and visuospatial ability, but not with episodic or semantic memory.  This discrepancy warrants further examination to determine which domains of cognitive function can be improved by social network.

An additional exploratory analysis was conducted to determine if social network was related to some specific semantic memory tasks but not others.  Results suggest that social network had a significant main effect and positive association with Animal Naming, COWAT and BNT.  However, social network had a nonsignificant main effect and an inverse relation with the NAART.  By controlling covariates, there was a reduction in the association between social network and Animal Naming, NAART and BNT.  This reduction suggests that these covariates may partially account for the relation between social network and cognitive function.  On the contrary, the association between social network and COWAT increased.  In addition, there was a significant GDS by social network interaction for the BNT.

Many explanations may be offered in attempt to define the associations between social network and cognitive function.  For example, the dependency of our variables may be reversed, in that the cognitive capability of an individual determines their engagement in social activities.  Alternatively, larger social networks may simply indicate a positive lifestyle in general, which could be more highly related to overall mental-health status.  Furthermore, the results suggest that social network is related to depression level, therefore, depressive affect may precede reduced social network. Lastly, Fratiglioni et al., (2004) suggests that social network combines with mental and physical activity to explain lifestyle components that have beneficial effects on cognition. They propose that these lifestyle components share a common pathway that converges within three major hypotheses for dementia and AD: the cognitive reserve hypothesis, the vascular hypothesis, and the stress hypothesis.

The "cognitive reserve" hypothesis posits that individuals possess varying capacity to resist AD symptomology, which could explain the lack of relation between the severity of brain pathology and the clinical manifestation (Katzman, 1993). The hypothesis is that greater positive lifestyle components (social, physical and mental) increase cognitive reserve by making the individual more resilient to neuropathological damage. On the other hand, the vascular hypothesis suggests that the lifestyle components may provide beneficial effects on cardiovascular disease and stroke (Rosengren et al., 2004), which in turn are risk factors for cognitive decline. Since long-term exposure to stress increases the risk of dementia, the stress hypothesis suggests that active lifestyles lend to more opportunities to socially engage which may lead to lower stress. Independent of the mechanism, the hypothesis that social networks may protect against cognitive decline provides additional strategies for prevention and possibly treatment of dementia and AD.

*Study Limitations*

Although the results of the current study are informative, it should be acknowledged that there were several limitations. First, the study design was cross-sectional. Longitudinal studies will be needed to elucidate the direction of the association between social network and cognition. Second, the analyses are based upon a group of participants that were predominantly Caucasian or White (95%). These figures are consistent with the ethnic/racial distribution of the state of West Virginia which consisted of 96.5% of elders aged 65 and above classified as White based on the 2000 Census (Wu, 2003). However, it will be important to determine whether these results are generalizable to a more diverse population of older adults. In addition, the participants were acquired by convenience sampling, which is not typically representative of the entire population. Furthermore, given the nature of the neuropsychological battery, individuals that had severe cognitive impairment were excluded from the testing. Lastly, the original data set had to be manipulated and transformed in order to address the research aims. Therefore, all findings from this study should be interpreted with caution.

*Future Directions*

Thus far, these data provide preliminary evidence that older adults should be encouraged to participate in active social relationships (e.g., by family members, clinicians and care providers). Even though the present study is unable to determine causality between social networks and cognitive function, these data may reveal additional strategies for preventing and treating cognitive decline. This analysis may also validate continued funding for community-based elderly social programs. Future studies should a) continue to examine social network with a validated measure, such as the LSNS-6, b) build upon the research investigating the effects of social network on different cognitive domains by using a comprehensive neuropsychological battery, c) emulate the current study using a larger, more diverse samples of participants, d) conduct longitudinal studies to elucidate the direction of the association between social network and cognitive function, and e) investigate different methods of increasing social network.

*Summary and Conclusions*

This series of retrospective analyses demonstrated that aspects of an individual's social network are positively related to overall and specific domains of cognition. Taken together, our findings offer continued support for the hypothesis that social networks may protect against cognitive decline. In combination with the imminent, substantial growth of the elderly population and the established relations between cognitive impairment and risk of dementia (Hogan et al., 2008; Petersen et al., 2001), institutionalization (Ageuro-Torres et al., 2001), and mortality (Dewey et al., 2001; Smits et al., 1999), this investigation provides further justification for determining the nature of the relations between social engagement and mental health. It is our hope that future studies will generate prognostic and/or therapeutic modalities to improve the mental health of older adults.

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Appendix

Cognitive Function and Oral Health in Older Adults Project

Neuropsychological Screening Battery

Current as of August 7, 2007

_________________ Participant ID

_________________ Date

EAD Other:_____ Examiner

________ am pm Clock time @ beginning

Notes: Put participant ID and full date on ALL forms. Put "Do Not Disturb" signs on door(s).

**INTRODUCTION**
Introduce self by first and last name. Greet participant by name.
**"This part of the study involves different procedures which check your vision, your speech, your thinking, your concentration, and your memory. Some of these you will find easy and others you may find more difficult. No one is able to answer all of these questions or to do all of these tasks perfectly. I believe that you will find these tests interesting, and sometimes challenging.**

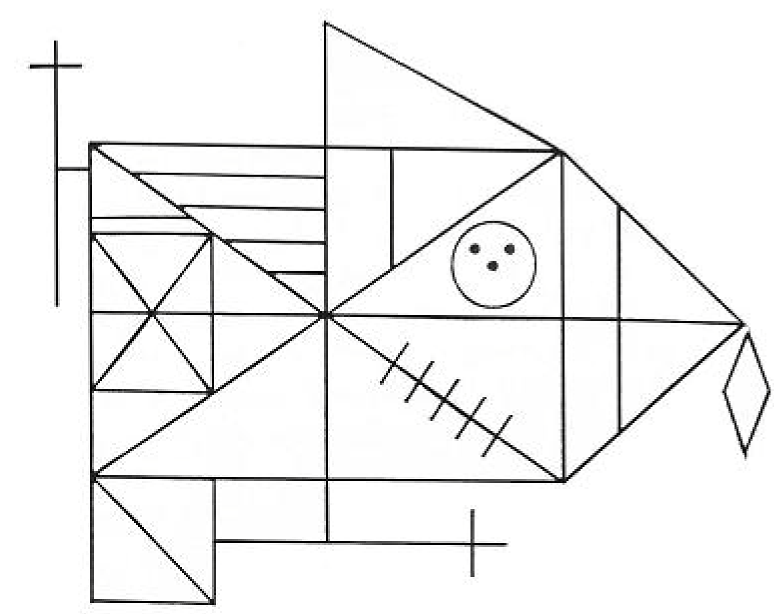
**These tests are standardized, and some of the tasks are timed, so I won't be able to chat at certain times.**

**This part of the study will take about an hour. Please concentrate and give your best effort during the tests, so that we will have an accurate evaluation of your abilities.**

**If you need a break between any of the tests, just let me know. I'm flexible."**

**REY-O COPY**
Present participant with the stimulus and a half sheet of blank paper. Say: **"I would like you to copy this figure on this piece of paper. I want you to make your drawing look as much like the original as possible. It does not have to be perfect, but please do the best you can."**

Allow participant to copy (NOT TRACE) the stimulus figure. Caution the participant to take his/her time if it appears that he/she is going too fast. As the participant is copying the figure, trace on another copy to depict the participant's organizational approach to the task by numbering the line sequence. Participant may erase, but may not rotate figure while copying. Put the participant's ID #, date, and #1 (for Rey-O copy) on the drawing.



________ am pm Current clock time, to begin 45-minute delay

________ am pm Time to begin REY-O 45 minute delay

**REY-O IMMEDIATE RECALL**

Immediately after the participant is finished copying, remove the stimulus and the drawing, and place another blank half sheet in front of him/her. Say:
**"Now I would like you to draw the same figure from your memory. Please draw it here on this paper. Take your time and try to be as accurate as you can."**
Caution the participant to take his/her time if it appears that he/she is going too fast.

Put the participant's ID #, date, and #2 (for Rey-O immediate recall) on the drawing.

**CVLT-II-SF *(USE SEPARATE FORM)***

Administer "List A Immediate Free Recall Trials 1, 2, 3, and 4"
30-Second Distractor Task (30 seconds)
Short-Delay Free Recall

________ am pm Current clock time

________ am pm Time to continue CVLT-II-SF with 10 minute delay

**TRAILS**

**Notes:** If at any time the participant makes a mistake during either Trail A or Trail B, stop them, correct them and then let them finish. Correction is allowed as many times as needed. Stop after 5 minutes.

**TRAILS A**

Place the sample side of Trails A sheet in front of the participant with a pencil and say:

**"On this page are some numbers. Begin at number 1** (point to number 1) **and draw a line from 1 to 2** (point to 2), **from 2 to 3** (point to 3), **from 3 to 4** (point to 4) **and so on, in order, until you reach the end** (point to the word "end"). **Draw these lines as fast as you can. Ready?…begin."**

Start timing. When the participant is finished, record the time in seconds at the top of the paper and flip it over.

**"On this page are some more numbers. Do this one in the same way. Begin at number 1** (point to 1) **and draw a line from 1 to 2** (point to 2), **2 to 3** (point to 3), **3 to 4** (point to 4) **and so on, in order, until you reach the end** (point to the word "end"). **Remember to work as fast as you can. Ready?…begin."**

Start timing. When the participant is finished, record the time in seconds and tenths of seconds at the top of the paper.

**TRAILS B**

Place the sample side of Trails B on the table in front of the participant and say:

"**On this page are some numbers and letters. Begin at 1** (point to 1) **and draw a line from 1 to A** (point to A), **from A to 2** (point to 2), **from 2 to B** (point to B), **from B to 3** (point to 3) **and so on, in order, until you reach the end** (point to the circle marked "end"). **Remember, first you have a number** (point to 1) **then a letter** (point to A) **then a number** (point to 2) **then a letter and so on. Draw the lines as fast as you can. Ready?…begin."**

Star timing. When the participant is finished, record the time in seconds at the top of the paper and flip it over.

"**On this page are both numbers and letters. Do this the same way. Begin at number 1** (point to 1) **and draw a line from 1 to A** (point to A), **A to 2** (point to 2), **2 to B** (point to B), **B to 3** (point to 3), **3 to C** (point to C) **and so on, in order, until you reach the end** (point to the circle marked "end"). **Remember, first you have a number** (point to 1) **then a letter** (point to A) **then a number** (point to 2) **then a letter** (point to B) **and so on. Do not skip around, but go from one circle to the next in the proper order. Draw the lines as fast as you can. Ready?…begin."**

Start timing. When the participant is finished, record the time in seconds and tenths of seconds at the top of the paper.

________ am pm Clock time @ continuation of CVLT-II-SF (approximate 10 minute delay)

**CVLT-II-SF (Continued)**
CVLT-II-SF Long-Delay Free Recall
CVLT-II-SF Long-Delay Cued Recall
CVLT-II-SF Long-Delay Yes/No Recognition

**BOSTON NAMING TEST – 2nd ED. - SF**
Notes: 20 second latency for clue. Write all answers down.
√ = *Correct; List word if incorrect; NR = No response*

"**I am going to show you some pictures and I would like you to tell me what the objects are."** Place the stimulus booklet in front of the examinee and open to the first item.

1. Ask the examinee: **"Can you tell me what this is?**
2. If no response, or incorrect response, cue participant: **"It's ______."**
3. If still no response, or incorrect response, cue participant: **"The word starts with the sound _____."** (Use underlined portion of word.)

| | Without cue | Stimulus Cue | Phonemic Cue |
|---|---|---|---|
| HIGH | | | |
| (2) 1. tree<br>(something that grows outdoors) | ___________ | ___________ | ___________ |
| (1) 2. bed<br>(a piece of furniture) | ___________ | ___________ | ___________ |
| (5) 3. whistle<br>(used for blowing) | ___________ | ___________ | ___________ |
| (8) 4. flower<br>(grows in a garden) | ___________ | ___________ | ___________ |
| (4) 5. house<br>(a kind of building) | ___________ | ___________ | ___________ |
| MEDIUM | | | |
| (26) 6. canoe<br>(used in the water) | ___________ | ___________ | ___________ |
| (10) 7. toothbrush<br>(used in the mouth) | ___________ | ___________ | ___________ |
| (23) 8. volcano<br>(a kind of mountain) | ___________ | ___________ | ___________ |
| (18) 9. mask<br>(part of a costume) | ___________ | ___________ | ___________ |

(17) 10.camel ___________ ___________ ___________
(an animal)

LOW
(30) 11.harmonica ___________ ___________ ___________
(musical instrument)

(54) 12.tongs ___________ ___________ ___________
(a utensil)

(39) 13.hammock __________ ___________ ___________
(you lie on it)

(46) 14.funnel ___________ ___________ ___________
(used for pouring)

(35) 15.dominoes ___________ ___________ ___________
(a game)

**NAART**
**"I am going to point to a number of words that I would like you to read. I must tell you that there are many words that your probably won't recognize; in fact, *most* people don't know them, so just guess at these, ok? Go ahead."**
The examinee should be encouraged to guess, and all responses should be reinforced ("good," "that's fine," etc.). The examinee may change a response but if more than one version is given, the examinee must decide on the final choice. No time limit is given.

0 1 1. DEBRIS

0 1 2. SIMILE

0 1 3. SUBTLE

0 1 4. BOUQUET

0 1 5. COLONEL

0 1 6. RAREFY

0 1 7. GIST

0 1 8. CORPS

0 1 9. HORS D'OEUVRE

0 1 10.SIEVE ('siv)

0 1 11. HIATUS

0 1 12. GAUCHE ('gOsh)

0 1 13. ZEALOT

0 1 14. PARADIGM

0 1 15. FAÇADE

0 1 16. CELLIST

0 1 17. INDICT

0 1 18. DETENTE

0 1 19. IMPUGN

0 1 20. AEON

0 1 21. EPITOME

0 1 22. REIFY

0 1 23. INDICES

0 1 24. ASSIGNATE (assign-not)

0 1 25. TOPIARY

0 1 26. CAVEAT (ka-vE-at)

0 1 27. LEVIATHAN

0 1 28. QUADRUPED

0 1 29. SIDEREAL (sy-daer-eal)

0 1 30. ABSTEMIOUS (ab-‘stE-me-s)

0 1 31. BEATIFY (be-‘at-i-fi)

0 1 32. GAOLED (jailed)

0 1 33. DEMESNE (di’mAn)

0 1 34. SYNCOPE (sin-co-pEE)

0 1 35. ENNUI (on-we)

**COWAT**

Notes: It is permissible to remind the participant of each of the general rules once. Also, if there is a long pause in the participant’s performance, it is permissible to encourage the participant to continue or to remind them of the particular letter they are working on. Mark 15 sec intervals. If unsure of word/spelling given, ask after time limit.

**This is a test to see how fast you can say some words. I am going to give you a letter of the alphabet and I would like you to tell me all of the words you can think of that begin with that letter. There are a couple of rules. First, you cannot use proper nouns. For example, if I gave you the letter B, you could not use Bill, or Betty or Boston. Also, you cannot slightly change the end of a word to get another. For example, you could not say box and boxes, or borrow and borrowing. Third, you can only use each word one time. Tell me, what are some other words that begin with the letter B?**

Allow patient to come up with a few examples and make corrections as needed per the above rules. After the patient has come up with a few appropriate examples, proceed.

“**That is fine. Now I am going to give you another letter and again say all the words beginning with that letter that you can think of. Remember, no names of people or places, just ordinary words. Also, if you should draw a blank, I want you to keep on trying until the time limit is up. You will have one minute for each one. The first letter is “F”. Please begin.“**

| TIME INTERVAL | | F | |
|---|---|---|---|
| 0-15 SECONDS | ________ | ________ | ________ |
| | ________ | ________ | ________ |
| | ________ | ________ | ________ |
| | ________ | ________ | ________ |
| 16-30 SECONDS | ________ | ________ | ________ |

31- 45 SECONDS

46-60 SECONDS

Begin timing, allowing for 60 seconds. Then say: "**STOP**."

**The next letter is “A”.  Please begin.“**

| TIME INTERVAL | | A | |
| --- | --- | --- | --- |
| 0-15 SECONDS | ____________ | ____________ | ____________ |
| | ____________ | ____________ | ____________ |
| | ____________ | ____________ | ____________ |
| | ____________ | ____________ | ____________ |
| 16-30 SECONDS | ____________ | ____________ | ____________ |
| | ____________ | ____________ | ____________ |
| | ____________ | ____________ | ____________ |
| | ____________ | ____________ | ____________ |
| 31- 45 SECONDS | ____________ | ____________ | ____________ |
| | ____________ | ____________ | ____________ |
| | ____________ | ____________ | ____________ |
| | ____________ | ____________ | ____________ |
| 46-60 SECONDS | ____________ | ____________ | ____________ |
| | ____________ | ____________ | ____________ |
| | ____________ | ____________ | ____________ |
| | ____________ | ____________ | ____________ |

Begin timing, allowing for 60 seconds.  Then say:  "**STOP**."

**The next letter is "S".  Please begin."**

| TIME INTERVAL | | S | |
|---|---|---|---|
| 0-15 SECONDS | ______ | ______ | ______ |
| | ______ | ______ | ______ |
| | ______ | ______ | ______ |
| | ______ | ______ | ______ |
| 16-30 SECONDS | ______ | ______ | ______ |
| | ______ | ______ | ______ |
| | ______ | ______ | ______ |
| | ______ | ______ | ______ |
| 31- 45 SECONDS | ______ | ______ | ______ |
| | ______ | ______ | ______ |
| | ______ | ______ | ______ |
| | ______ | ______ | ______ |
| 46-60 SECONDS | ______ | ______ | ______ |
| | ______ | ______ | ______ |
| | ______ | ______ | ______ |
| | ______ | ______ | ______ |

Begin timing, allowing for 60 seconds. Then say: "**STOP**."

**ANIMAL NAMING**

**"Now, I am going to give you a category and I want you to name, as fast as you can, all of the things that belong in that category. For example, if I say Articles of Clothing you could say shirt, tie, or hat. Can you think of other articles of clothing?**

**That is fine. I want you to name all of the things that belong to another category. That Is Animals. You will have one minute. It can be any animal at all. Animals that fly in the air, swim in the ocean, live on the farm, in the jungle or in the forest. I want you to tell me all the animals you can think of in one minute. Ready, go!"**

| **TIME INTERVAL** | **ANIMALS** | | |
|---|---|---|---|
| 0-15 SECONDS | ________ | ________ | ________ |
| | ________ | ________ | ________ |
| | ________ | ________ | ________ |
| | ________ | ________ | ________ |
| 16-30 SECONDS | ________ | ________ | ________ |
| | ________ | ________ | ________ |
| | ________ | ________ | ________ |
| | ________ | ________ | ________ |
| 31- 45 SECONDS | ________ | ________ | ________ |
| | ________ | ________ | ________ |
| | ________ | ________ | ________ |

________________ ________________ ________________

---

| | | | |
|---|---|---|---|
| 46-60 SECONDS | ________________ | ________________ | ________________ |
| | ________________ | ________________ | ________________ |
| | ________________ | ________________ | ________________ |
| | ________________ | ________________ | ________________ |

Begin timing, allowing for 60 seconds.

If participant provides several types of a certain animal (i.e., types of birds), ask for another category of animal (i.e., something other than a bird).

**REY-O 45-MINUTE DELAY**
45 minutes after the completion of the copy condition, place another blank half sheet in front of the participant. Say:
**"Remember that figure that I first had you copy and then draw from your memory? I would like you to draw it again from your memory. Please draw it here on this piece of paper. Take your time and try to be as accurate as you can."**
Caution the patient to take his/her time if it appears that he/she is going too fast.

Put the participant's ID #, date, and #3 (for Rey-O 45-minute delay) on the drawing.

________ am pm Clock time @ end

**That concludes this portion of the study. Congratulations! How do you feel now that it's over? What are your thoughts and feelings about this testing? Thank you for working so hard. Now, I'll escort you to the next station.**

Date __________

Completed:
Yes................1
No.................2

A1. What is your date of birth? ____________

A2. Your gender?

Male……………………….……………1
Female……………………….….................2

A3. In what country were you born?

United States…………….………………………..1
Others………………………………………..2
Specify ______________________________

A4. What is your marital status?

Never married…………….…….…………….1
Married……………...………….…………….…2
Divorced/separated…………….…………......3
Widowed…………………………………......4
Other (specify).……………………………….5
Specify:_____________________________

A5. What was the highest level of education you completed?

Elementary school or less...……………..…….1
Some high school (#_____)………...……….2
High school……………………………………3
Some college (#_____)………………………4
College…………….…………………………..5
Graduate degree or above……………………..6
Don't know………………..…………………98
Refused..……………………………………..99

A6. About how much household income did you and your spouse receive in the last calendar year (income from all sources and before taxes)?

Under $10,000…………………………………1
$10,000 to $19,999…………………………….2
$20,000 to $29,999…………………………….3

$30,000 to $39,999…………………………….4
$40,000 to $49,999…………………………….5
$50,000 or above………………………………6
Don't know……..…………………………....98
Refused
….……………………………………..99

**The Geriatric Depression Scale**

Obtain a clear yes or no answer. Circle an answer to every question**.**

| ***For each of the following questions, please respond*** | ***Yes*** | ***No*** |
|---|---|---|
| | *1* | ***2*** |
| *F1. Are you basically satisfied with your life?* | | |
| *F2. Have you dropped many of your activities and interests?* | ***1*** | *2* |
| *F3. Do you feel happy most of the time?* | *1* | ***2*** |
| *F4. Do you prefer to stay at home rather than going out and doing new things?* | ***1*** | *2* |

***If none of the above responses suggests depression, STOP HERE. If any of the bolded responses above are circled, ask the following questions***

| | | |
|---|---|---|
| | *1* | *2* |
| *F5. Do you feel that life is empty?* | | |
| *F6. Do you often get bored?* | *1* | *2* |
| *F7. Are you in good spirits most of the time?* | *1* | *2* |
| *F8. Are you afraid that something bad is going to happen to you?* | *1* | *2* |
| *F9. Do you feel helpless?* | *1* | *2* |
| *F10. Do you feel that you have more problems with memory than most?* | *1* | *2* |
| *F11. Do you think it is wonderful to be alive?* | *1* | *2* |
| *F12. Do you feel pretty worthless the way you are now?* | *1* | *2* |
| *F13. Do you feel full of energy?* | *1* | *2* |
| *F14. Do you feel that your situation is hopeless?* | *1* | *2* |
| *F15. Do you think that most people are better off than you are?* | *1* | *2* |

**Social Support**

G1. What is your current living arrangement?

Living alone……………..………………1
Living with spouse/partner….…………...2
Living with other family members………3
Living with others………………………..4
Please specify ______________________

Considering the people to whom you are related either by birth or marriage…

G2. How many relatives do you see or hear from at least once a month?

None ………………………………………0
One ………………………………………. 1
Two ……………………………………… 2
Three or four ……………………………...3
Five thru eight ……………………………4
Nine or more ……………………………...5

G3. How many relatives do you feel at ease with that you can talk about private matters?

None ………………………………………0
One ………………………………………. 1
Two ……………………………………… 2
Three or four ……………………………...3
Five thru eight ……………………………4
Nine or more ……………………………...5

G4. How many relatives do you feel close to such that you could call on them for help?

None ………………………………………0
One ………………………………………. 1
Two ……………………………………… 2
Three or four ……………………………...3
Five thru eight ……………………………4
Nine or more ……………………………...5

Considering all of your friends including those who live in your neighborhood . . .

G5. How many of your friends do you see or hear from at least once a month?

None ………………………………………0
One ………………………………………. 1
Two ……………………………………… 2
Three or four ……………………………...3
Five thru eight ……………………………4
Nine or more ……………………………...5

G6. How many friends do you feel at ease with that you can talk about private matters?

None ………………………………………0

One ………………………………………. 1
Two ……………………………………… 2
Three or four ……………………………...3
Five through eight …………………..…….4
Nine or more ……………………………...5

G7. How many friends do you feel close to such that you could call on them for help?

None ………………………………………0
One ………………………………………. 1
Two ……………………………………… 2
Three or four ……………………………...3
Five thru eight …………………………….4
Nine or more ……………………………...5