THE RELATIONSHIP BETWEEN AGE AND PERFORMANCE ON THE TRAIL MAKING TEST IN A CHILEAN POPULATION

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ABSTRACT

According to literature, the Trail Making Test A-B is one of the most frequently used tests in the US. The TMT test has been adapted in different countries including France, Italy, Israel, Spain and Brazil. The relationship between TMT and age has also been studied in Chinese, Arabian, and Korean speakers. In South America as well as Chile, the Bender Gestalt continues to be the most frequently used "neuropsychological" test instrument. In order to ameliorate this situation, studies need to be completed that provide evidence of sensibility, adaptability, and normative information about commonly used tests, such as the Trail Making Test in Latino countries. The Trail Making Test, with instructions in Spanish (and available from the authors in written or video form), was administered by three independently licensed health professionals as part of their routine clinical activities. Subjects were 165 Chilean adults with ages ranging from 21 to 82 years and at least 12 years of education. Results corroborated the previous findings from other countries in which age was positively related to time in completing Trails A and B. Variability of performance in parts A and B 7of TMT was significantly accounted by age in 36% and 27% respectively. As a consequence, TMT appears to be a sensitive test to normal cognitive decline in Chilean Spanish speakers.

INTRODUCTION

Neuropsychology and Neuropsychological Testing

Stringer & Cooley (2002) defines neuropsychology as the science that "centers on the study of the relationship between brain function and behavior", (p. 3). In this regard, it involves neuroscientific and cognitive research. According the Division 40 of the American Psychological Association (2007), clinical neuropsychology is defined as;

> A specialty that applies principles of assessment and intervention based upon the scientific study of human behavior as it relates to normal and abnormal functioning of the central nervous system. The specialty is dedicated to enhancing the understanding of brain-behavior relationships and the application of such knowledge to human problems.

In the same way, a clinical neuropsychologist is a professional with a doctoral degree who assesses and makes interventions based on scientific evidence about the normal or abnormal relation between central nervous system and behavior (American Psychological Association, 2007). Assessment is an important part of the diagnosis process, and it is also a crucial stage in neurophysiologists' work. Clinical neuropsychological assessment has been defined by Goldstein & Beers (2004) as the process of assessing individuals searching for relationships between behaviors and brain function. In clinical settings, brain dysfunction is identified by using procedures and tests that have been validated for that purpose.

According to a study conducted by Camara, Nathan & Puente (2000) in the United States, the most common psychological assessment involves neuropsychological tests. One of the tests studied in this research, the Bender Gestalt Visuomotor Test, has

decreased in frequency of use in the past decades. New tests have been developed that easier to administer and interpret, and are valid and reliable. In Chile, the most widely used test is the Bender Gestalt Psychomotor Test while in The United States it is the 25th most frequently used. In the same study, the researchers identified the most frequently used neuropsychological in The United States, in descending order, Trail Making Test A-B (TMT A-B), Verbal Fluency Test (FAS), Finger Tapping Test, Halstead-Reitan Battery, Boston Naming Test, Category Test, Wisconsin Card Sorting Test (WCST), Rey Complex Figures Test, Hooper Visual Organization Test and Hand Dynamometer. The Trail Making Test while no widely used in Chile, may represent a more valid reliable screening instrument as long as its cultural appropriateness is established.

Trail Making Test

TMT A-B was originally designed to be part of a battery of tests administrated to US Army forces (Soukup, Ingram, Grady & Schiess, 1998) but became more widely used as part of the Halstead-Reitan Neuropsyhcological Battery (Reitan & Wolfson, 2000). Reitan took the TMT from the Army manual and he made several changes in the original version and in the administration procedure described in the Army Manual. Based on these modifications, Reitan recognizes himself as one of the authors of TMT but he also credits psychologists in the Army who developed the original test (R. Reitan, personal communication, November 16, 2007). In one of the earliest studies, Reitan (1955) describes the Trail Making Test as paper pencil test involving two parts. The first part, called A, consists of 25 circles distributed on a paper sheet and numbered from 1 to 25. The subject is required to connect with a pencil the 25 numbers as quickly as possible and in numerical order. The second part is named B and the task consists of using a pencil to

connect circles containing letters in alphabetic order from A to L and numbers from 1 to 13 distributed on the paper sheet. Numbers and letters are also spread at random on a paper sheet. Subjects must alternate letters and numbers. In other words, subjects must connect 1 with A, then A with 2, then 2 with B, and so forth. Both exercises are timed independently. When a subject makes an error, the examiner must point it out and immediately asks the subject to correct the mistake. The test continues until it is finished no matter how many errors are made. The score of the test is equal to the time used to complete both parts A and B independently.

Since lesions in left brain hemisphere are associated with language impairment, Reitan (1958) hypothesized that patients with that type of brain damage would perform with major difficulty in Part B because this part involves the ability of recognizing and shifting between numbers and letters. Similarly, since right hemisphere brain damage is associated with impairment in comprehending spatial configurations, Reitan hypothesized that those patients would perform poorly in Part A of the TMT.

Most studies show that patients with brain damage need significantly more time to finish parts A and B, especially part B (Mitrushina, Boone & D'Elia, 1999). Other longitudinal studies have found that as subjects become older, the time required to finish the TMT increases significantly. In older patients with dementia, the time spent to complete TMT is significantly longer (Rasmusson, Zonderman, Kawas & Resnick, 1998).

Other documented uses of TMT are in assigning differential diagnosis between vascular dementia and Alzheimer's dementia type (Baillon, Muhommad, Marudkar, Suribhatla, Dennis, Spreadbury, Munro & Lindeasy, 2003) and assessment of cognitive

deficits in patients with damage due to substances abuse (Roberts & Horton, 2001). TMT is also sensitive to changes during cognitive recuperation, marijuana chronic use (Horton & Roberts, 2002), and cognitive decline in chronic alcoholic patients (Hamblin, Hyer, Harrison & Carson, 1984).

Ecological validity is an important property of all psychological tests and there is evidence that TMT provides a sufficient level of ecological validity in different contexts. Ecological validity is defined as the extent to which the examinee's experiences in everyday situations are related to a construct that is meaningfully represented in an assessment situation (Bernal, Bonilla & Bellido, 1995). TMT has been successfully used to make predictions about daily instrumental abilities in inpatient older patients (Cahn-Weiner, Deborah, Boyle & Malloy, 2002). Chaytor, Scmitter-Edgecombe & Burr (2006) examined ecological validity of several executive neuropsychological test included TMT. All the participants had a neurological diagnosis such as epilepsy or traumatic brain injury. The intellectual capacity was also measured with the Wechsler Intelligence Scale and TMT was administered with other neuropsychological tests. For measuring executive functioning in everyday situations, the authors used two questionnaires that were completed by significant others, the Dysexecutive Questionnaire (DEX) and The Brock Adaptive Functioning Questionnaire. The results showed a statistically significant relation for the test Stroop Color-Word (r= 0.38) and Trails B (r= 0.33) with the measure of executive functioning in everyday situations BAFQ. Stroop Color-Word was the only test that was found to be related to the measure of everyday situations(DEX). The authors concluded that Stroop Color-Word Test and Trails B also are measures of speed

processing and that variable may account for part of the variability for the high ecological validity of these tests.

According to Reitan (1992) there are three types of abilities involved in TMT performance: immediate recognition of number and letters, flexibility in integrating alphabetic and numeric series and performing time pressured tasks. The specific abilities and the weight that each ability has in TMT A-B have been studied by observing the relation between individuals' performance in TMT A-B and the same individuals' performance in other specific tests. The tests used to these purposes have been previously validated as measuring motor, visual or cognitive components. The components that TMT A-B measures are identified by observing statistically significant variations between the performances in TMT A-B and the other administered tests. Using this method, Ehrenstein, Heister & Cohen (1982) tested visual search as a component of performance in TMT in aphasic and brain damage non aphasic patients. The study selected two clinical groups of German speaking male patients, one with Wernicke's or Broca's aphasia and the other one with brain damage. From the high correlations in most of the groups of patients the authors concludes that Visual Search is an important component of performance in TMT.

In another study, Crowe (1998) tested the differential contribution of visual search, mental tracking, cognitive flexibility and motor speed on parts A and B of TMT. This study was conducted with male and female healthy normal undergraduate Australian students. Crow used the TMT and other different measures to discriminate the abilities involved in parts A and B. The tasks used were several. The Wide Range Achievement Test – Version 3 (WRAT-3), the digit span, letter span and block span forward and

reverse were taken from the Wechsler Memory Scale-Revised. A task involving repeating the alphabet was added. The task consisted in counting to 26, and recites the sequence by alternating between numbers and letters up to 26. In addition, the study included two modified versions of TMT: one that required connecting a sequence of circles following a dotted line. This task was designed to measure the motor component. The other task was created to measure only visual search which requires drawing lines between numbers from 1 to 13 and continuing with letters from A to L. In this last case, the alternation component was eliminated. The study utilized regression and partial correlation to differentiate the different abilities assessed by the tasks which contribute to performance in the two Trails. Part A measured only visual search and motor speed. Part B involved visual search and cognitive alternation of operations. In particular, setting aside the contribution of the factors measured by part A, poor performance in part B was explained by lowered verbal IQ, poor skill in visual search, poor ability in maintaining two simultaneous sequences, attention and working memory.

Two clear components of TMT are spatial and symbolic factors. Fossum, Holmberg & Reivang (1992) studied the contribution of those factors in normal and brain injured patients. TMT involves dealing with symbols, numbers and letters, and one spatial task that required connecting a different configuration of symbols in the space of each part A and B. Fossum et al. (1992) were concerned about the differential sensitivity of part B for left hemisphere lesion because of the difficulties experienced by patients in tasks involving letters. The assumption that the complexity of spatial configuration is the same for both parts A and B was questioned. In this study, two new alternative forms of Part A and B were created. The form Ba conserves the spatial configuration of part A but

uses two systems of symbols. For Ab, the spatial arrangement of part B is preserved but only numbers are used as symbols. The sample was composed of three groups: a normal group of, an elderly normal group, and a head injured group. There was a significant difference between the performance of the normal group and the brain injured group in the forms A, B and Ab and a significant main effect for spatial arrangement and symbolic complexity. The authors concluded that form B is not just more complex in symbolic factors but also in spatial arrangement. They concluded that it is difficult to separate both factors for describing lesion probability in right or left hemisphere because of the differential performance in parts A and B.

The order in which TMT A and B parts correlate to speed processing and inhibitory mechanisms has also been studied. Miner & Ferraro (1998) hypothesized that subjects with a better level of inhibitory skill, the ability to inhibit the non-relevant previous information to solve a new Trail, will perform better in time with fewer errors in TMT than individuals with lower inhibitory processing. In the same study they also hypothesized that processing speed is also a predictor of performance in TMT including the order in which the Trails are presented (A-B, B-A). Finally, Miner & Ferraro attempted to measure any effect of two possible combinations in the presentation of each Trails while looking for a fatigue effect in the lower performance that individuals have in Trails B relating to the A part. The subjects were all volunteer college students mostly female. All the individuals completed the Background Information Questionnaire, Geriatric Depression Scale and the WAIS-R Vocabulary Test to rule out confounding variables. Half of the participants completed TMT in the normal order and the other part completed TMT in reverse order: B-A. As a measure of processing speed, Simple

Reaction Time task was administered with a computer screen. Finally, all the subjects completed a Negative Priming task to measure inhibitory processing. Speed was operationalized by dividing the group of subjects in two: slow and fast performance in Reaction Time task depending of scoring above or below the median. The results showed that subjects with best inhibitory ability didn't perform better in TMT, so inhibitory effect was not found relevant in TMT performance. In the same way, speed of processing was positively related with time to complete part B, although this effect was not statistically significant. Finally, the order in which parts A and B are presented was found statistically significant. Participants who completed TMT in A-B order were faster than participants who completed TMT in reverse order (B-A).

The arithmetical relation between parts A and B in TMT has been studied in clinical samples. Corrigan & Hinkelday (1987) investigated comparing the subtracted difference B minus A (A-B) and the ratio B divided by A (A/B) with several neuropsychological measures in patients with different neuropsychological pathologies. The sample was composed of 497 batteries administrated to adult inpatients and outpatients during a period of 5 years. The scores came from patients who were treated for traumatic head injury, cerebrovascular accidents, and brain injury of different origin or chronic pain with some compromise of mental abilities. The study did not use healthy subjects as a control group and no information about age was provided. The neuropsychological battery involved the tests used to compute the Halstead impairment index: TMT, Category Test, Tactual Performance Test, Speech-sounds Perception Test, Rhythm Test, dominant hand Finger Oscillation, Wechsler Memory Scale and as measure of intelligence, the scores in performance, verbal and full IQ in the Intelligence Wechsler

Adult Intelligence Scale were included. Because of the size of the sample, most of the correlations between TMT A/B, A-B and the neuropsychological measures are statistically significant. Corrigan & Hinkelday describe the results in terms of statistically and practical significance. However, the study didn't define a cut off for practical significance. Parts A, B and the subtraction A-B were found significantly correlated with verbal, performance, full IQ, Impairment Index, and some subscales of Wechsler Memory Scale. The ratio A/B and these previous measures were statistically but not practically significant accounting for less than 1% of the variance. The relation between parts A and B and ratio A/B and A – B was also studied. Part B alone was practically and statistically correlated with A – B and A/B ratio but the correlation between A – B and the B part alone was higher than the relation between part B and A/B ratio.

As part B of TMT has become important for diagnosis of cognitive impairment, Kortte, Horner & Windham (2002) measured how cognitive flexibility and the ability to maintain set account for performance in TMT part B. Kortte et al. (2002) defined cognitive flexibility as the ability to change the course of an ongoing activity and the ability of maintain set as the ability of maintain two response sets simultaneously. In this study the subjects were 121 outpatients with different pathologies involving cognitive disorder such as dementia, cognitive disorder not other specified and psychiatric disorders. To measure the studied variables, TMT A-B was administered and two scores from the Wisconsin Card Sorting Test were used: cognitive flexibility was operationalized as the percentage of perseverative errors. Also, ability to maintain set was defined as failure to maintain set score or the number of times the individual made a mistake after answering correct a sequence of five to nine items. As part this study,

Controlled Word Association was administered to measure verbal fluency, Digit Span subscale of the WAIS-R to measure attention and California Verbal Learning Test to measure Verbal memory and learning. The correlation analysis showed that part B in TMT was more sensitive to deficits in cognitive flexibility than the ability to maintain a complex response set. Verbal fluency, attention, verbal learning and verbal memory were related with part B and A of TMT. This result identifies cognitive flexibility as one component, but not the only one, that makes TMT part B more difficult than part A.

Demographic factors such as age have an important effect on performance in TMT. Wahlin, Bäckman, Wahlin, Å. & Winblad (1996) studied the effect in accuracy and time to complete TMT of very old but healthy samples. In their study, Wahlin et al. (1996) controlled important variables with great specificity such as levels of vitamins and thyroid gland functioning that would interfere with performance in TMT. The healthy sample was selected excluding subjects with possible early dementia, psychiatric disease, potential sensory problems, abnormal levels of vitamin B_{12}, hypothyroidism, and hyperthyroidism. Four groups were created: ten subjects in the group between 76 to 79 years of age, a group with 32 subjects with ages between 80 and 84, 38 subjects in a group of subjects with ages between 85 and 89 years and a group with ages between 90 and 93 years with only 14 subjects. All the subjects took Mini Mental Status Examination test, TMT, Block Design and Digit Span forward and backward from the Wechsler Adult Intelligence Scale Revised WAIS-R, and a test of optic-spatial organization and dynamic organization of motor act. Also, measures of blood test components such as ferritin, albumin, folic acid, fructuoseamine/albumin, vitamin B_{12} and thyroid stimulant hormone (TSH) were included as a predictor variable for TMT performance together with

psychometric and biological factors. The analysis showed only demographic variables, specifically age, contributed statistically to differences in TMT performance. Psychometric variables accounted only marginally to performance in TMT part B with the higher correlation with Block Design. Measures of biological parameters didn't statistically predict performance in TMT with the exception of TSH that was significant for performance in TMT part B. Older participants took statistically significant more time to complete the TMT both parts A and B, but accuracy didn't deteriorate.

Variables such as age, education and gender and their relation with performance in TMT, have also been studied in other countries. Hester, Kinsella, Ong & McGregor (2005) examined TMT performance and derived scores in a sample of healthy older Australian adults and compared their findings with a similar study in an American sample. Many subjects were excluded from the original sample for premorbid history of neurological or psychiatric disease, drug abuse, being under psychoactive medication or scoring 25 or less in the Mini Mental Status Examination test. The final sample was composed of 363 Australian Adults divided in four groups according age: 60-69 years, 70-74 years, 75-79 years and 80-89 years. The only instrument administered was TMT A-B. The results indicate that even though gender was a statistically significant predictor for TMT part A, its influence accounted for just 1% of the variance. A statistically significant and important contribution of age in TMT performance was found. Older subjects performed slower than the younger and this was true for the measures of TMT parts A, B and the derived difference score TMT-B minus TMT-A. Although, the performance in TMT measured by the ratio TMT-B divided by TMT-A was not related with age. This last derived score estimates the executive function since the motor speed

and visual scanning components were removed. Education affected the performance of TMT but only in part B which is explained in the study because, again, the strong relationship of part B with executive functioning. The performance in TMT A-B in this Australian sample was compared with a normative study of Tombaugh's (2004). It was found that there were statistically significant differences only in TMT-B for the groups of 60 to 69 years of age and 80 to 89 years of age.

The popular use of TMT A-B has been identifying patients with brain damage. Reitan (1955), in an early study examined the performance of brain damage patients and brain non-damage patients in TMT. Twenty seven patients with different neurological diagnosis were tested: brain tumor, head injury, cerebral vascular injury, cerebral abscess, cerebral atrophy, subdural hematoma, lobotomy, dementia and congenital anomaly of the brain. The control group were non brain damaged patients with diagnose of paraplegia, neurosis, congenital heart disease and general surgery. The average age for both groups was about 30 years, ranging from 17 to 62 years for the clinical group and 16 to 60 for the control group. In the study, the time in seconds for completing each part was transformed to points in a scale from 1 to 10 points according the Army Manual published in 1944. The results, even though there were patients with psychiatric diagnosis in the control group, showed a statistical significant difference between groups for Trails A and B. Control patients performed statistically significant faster than brain damage patients.

Reitan (1958) published another article about the validity of TMT as indicator of brain damage. In this study, Reitan used more subjects: 84 patients with neurological diagnosis such as multiple sclerosis, traumatic head injury, cerebrovascular disease and

epilepsy. The control group comprised the same number of patients but with diagnosis other than brain damage. Both groups were homogeneous in age and years of education. Using the same previously described scale of 1 to 10 points for the time to complete parts A and B, each performance of each subject was scored. Again, there were statistical significant speed differences between the clinical and the control groups to complete parts A and B of TMT. Compared to the anterior study, Reitan pointed out part B of TMT as a more powerful score to discriminate between brain damage patients and non brain damage patients. He also indicated the abilities that possibly TMT assesses: spatial distribution, differentiation of numbers and letters, shifting between numbers and letters, alertness, concentrated attention and recognition and comprehension of numbers and letters. Finally, Reitan in reference to the diverse skills which performance in TMT involves, named TMT as a powerful test to use for brain damage but not able to specify localization of the lesions.

A more recent study with patients with dementia was performed by Rasmusson, Zonderman, Kawas & Resnick (1998). A large sample of 765 individuals of 60 years or greater were tested with TMT A-B, Mini Mental State Examination and the Blessed Mental Status exam. They were also assessed by neurologists. After the assessment, 667 subjects were classified as non demented, 40 had a mild cognitive decline and 58 were diagnosed with dementia of different types: Alzheimer's, Parkinson's, cerebrovascular disease and unspecified dementia. A sub sample of 385 non demented subjects was tested by TMT A-B again after two years. All the subjects were assigned according to age in groups: 60 to 69 years of age, 70 to 79 years of age, 80 to 89 years of age and 90 to 96 years of age. In the no dement group, performance in TMT parts A and B becomes

statistically significant slower as the age increased. Years of education accounted for 3% of the variance with a statistically significant meaning. The longitudinal part of this study reveled that within each group of age, time to complete TMT part B becomes statistically significant longer in the second test. The greater performance loss was observed in the older group (80-89). After controlling the influence of age, gender and education; the condition of dementia accounts for a statistical significant part of the variance in TMT in both parts A and B. Once again, TMT A-B was found reliable and a valid instrument to measure cognitive decline across age and a powerful indicator of the pathological cognitive decline that is found in different types of dementia. However, TMT part B appears to be more sensitive to an age decline than part A which probably is due to the cognitive flexibility component.

The differential component of part B in TMT in relation to part A may also be explained by studies in which the correlated brain activity and TMT was examined. One research was performed in Brazil by Moll, De Oliveira-Souza, Tovar, Bramati & Andreiuolo (2002) in seven healthy well educated adults with age average of 24 years (SD=9). Moll et al. (2002) utilized a functional magnetic resonance imaging (fMRI) to monitor the brain activity of the subjects while they performed a verbal version of TMT. In this version of TMT, the subjects were required to close their eyes and start counting from one and then alternated numbers with letters as quickly as possible when they hear the word "*alternate*". The hemisphere of the brain more activated was the left and the specific areas more activated were dorsolateral prefrontal cortex, premotor cortex, left medial frontal cortex and intraparietal sulcus. The authors related these findings with the fact that dorsolateral prefrontal cortex is strongly associated to working memory and

cognitive flexibility and prefrontal cortex is also associated to the ability to suppress responses and switch to another response. In spite of the low sample size and that it was used a verbal version of TMT; the findings were partially confirmed for a Canadian study in which the paper version of TMT was used (Zakzanis, Mraz & Graham, 2005). The subjects in this study were 12 also healthy very well educated and with an average age of 29.2 years (SD=4.8). For purpose of this study, subjects used a virtual stylus to draw the lines between the numbers and then numbers and letters. Subjects were in supine position while they were scanned by an fMRI but they were able to look throw fMRI compatible goggles the virtual panel in which TMT A and B was placed. Again, the fMRI results showed that left hemisphere was significant more activated that the right. The specific areas more differentially activated were dorsolateral prefrontal cortex and motor cortex. The authors presented these findings as evidence of how TMT is able to assess executive functioning.

Latin American Culture

It is important to understand the conceptual and methodological complexity that cross cultural neuropsychology has to deal with and also it is crucial to define what Hispanic culture is. According to Perez-Arce & Puente (1996), race addresses the clear physical features that make identified groups of people different from each other: color skin, eyes color and shape, stature, etc. Ethnicity, on the other hand, involves a more behavioral definition of the common characteristics that make a difference among people, such as customs and language. A single Hispanic race can't be identified because the wide variability in the physical characteristics of the Latin American population. However, the concept of Hispanic Ethnicity can be applied for all the people from South

America who share at least a common language and customs. One problem is the relationship between culture and the geographic regions that South America includes. There are countries in South America that are part of Latin America but they don't share the same language. For instance, the official language of Brazil is Portuguese, not Spanish. Although Brazilians come from South America and they are Latin Americans, they shouldn't be named Hispanics because they don't share the Hispanic heritage. Brazil, before it becomes an independent country, was a Portuguese colony (Halperin, 1993). Summarizing, Latin America involves all the countries located to the southern border of the United Sates that once were colonies of Spain or Portugal. However, from the North American point of view, Hispanic is the word to name all the Latino Americans. This singular issue brings the initial misconception that for North Americans, people who live south of the border of the United States should share the same culture (Sanchez, 2002). Therefore, the second problem that it concerns here is how a single Latino American culture could be defined. Across Latin countries, language might be the same but there are many differences in the common use of vocabulary. In the same way, religious traditions, music, communication styles, cultural heritages are also diverse across Latin countries (Perez-Arce & Puente, 1996). Perhaps be the first common factor of Latino Americans is that they do not want to be called Hispanics. Moreover, the concept of Hispanic reminds the times of colony in Latino Americans countries where Spain owns great part of South America. This word Hispanic doesn't trig a good feeling because it carries the implicit meaning of belonging to another country, Spain, that used to has dominance over the own country. According Sanchez, another aspect of the Latino identity is that Latino Americans don't distinguish between races. Latino Americans have

white, dark and black skin color. They have South American native Indian heritage but also they have heritage from Spain, Germany, Italy and Africa because the migration of European populations to Latin American countries in the past centuries (Halperin, 1993).

Cole (2005) reviewed different anthropological definitions of culture. He summarizes the concept of culture in three main ideas. First, culture involves the heritage from the past generations in the form of tools, rituals, understandings about persons, society and nature, beliefs and ways to conceive the world. Second, culture is an organized system of social institutions, concepts and multiple acceptable ways to behave in family and social life, economics and political practices. Finally, culture is also is the medium in which all the cultural products are preserved.

From a scientific point of view, defining the characteristics of Hispanic culture is not an easy task. The database PsycINFO provides 38 articles, chapters and book chapters with the words Hispanic and culture in their titles. However, only two articles are about the particular behaviors, ideologies and conceptions of the world that Hispanics have. Twenty one publications are about Hispanic mental health issues, seven articles address health issues in Hispanics and the rest are distributed in Hispanic related topics in Education, migration and industrial psychology. These results are not different when searching for the same words in the UNC Coastal Library Consortium. This library system is comprised of the libraries of Fayetteville State University, The University of North Carolina at Pembroke, and The University of North Carolina Wilmington. In this search, few publications address the concept of Hispanic culture. Only several books about Hispanic literature and arts in addition to the publications about Hispanic issues in health, migration, mental health, history and business were identified. When taking three

examples of publications about culture and customs of three different Latino countries, again, not much it is said about the particular way that Hispanics behave and see the world. Castillo-Feliú (2000) titled his book C*ulture and Customs of Chile*. However, only twenty per cent of that book talks about social customs and religion among Chileans. The rest of the book addresses topics such as Chilean History and arts. Similar publications addressing culture and customs, one about Colombia (Williams & Guerrieri, 1999) and another about Mexico (Standish & Bell, 2004) have the same problem. In these publications less than twenty percent of all the content is about social behaviors, ways to see the world and customs. The rest of the content addresses, again, history and arts. After this review, it is clear that the particular way in which Latinos or Hispanics behave or their social customs and institutions are avoided in the literature. The concepts of Latino or Hispanic and culture make reference to the history of Latin American countries and their artistic production in literature, plastic arts and media.

Based on the fact that it is impossible to address what Hispanic Culture is from only one discipline such as psychology, sociology or anthropology, several sources will be taken from different types of knowledge to begin a description of what Latino culture is.

The culture of Latin America has been described in the Arts by important painters, muralists and writers. Carlos Fuentes, a great Mexican novelist, makes an important contribution when depicting some of the aspects of the multicultural Latino ethnicity in his book *This I Believe* (2005). In the chapter titled Iberoamérica, Fuentes addresses Latino culture in several features. Conscious of their fragility against natural forces and the concept of fatality are typical cultural ideologies that do exist in the Latin

American thought. Fatality addresses to the idea that something is going to happen no matters what efforts human beings make. Fragility is the notion of being always vulnerable to natural forces, natural disasters, illnesses, and to the unconquerable nature of wild animals, oceans, rivers, mountains, fires, jungles and weather. The relationship between human beings and nature is understood in a frame of respect and fear. These ideas that underlie the culture and history of Latin America are also depicted in Latin American stories. For instance, a Uruguayan writer, Horacio Quiroga (1993) shows this concept in several short tales such as *Anaconda*. These ideological concepts might be seen as related to the approach that Latinos use to solve and cope with problems (Mynatt, Omundson, Schroeder & Stevens, 1997). Latinos tend to perceive that the best way to solve a problem is to modify themselves and to adapt to the circumstances rather than change something in the situation. Anglo-Americans are more competitive, individualistic and active in changing the external situation. The Latino style of facing problems tends to be more cooperative and less competitive. The presence of those ideas in Latin American culture could lead us to explain the high rates of depression in the Latino population in the United States. Latin Americans have a less active strategy to cope with feelings of distress but at the same time, they are more exposed to other sources of distress, such as lower income and acculturation processes. Kennard, Stewart, Hughes, Patel & Emslie (2007) researched about cognitions and depressive symptoms among adolescents from different ethnic groups in the United States. They found that some symptoms of depression such as lack of self-efficacy and hopelessness were more frequent in Hispanics than in Caucasian Americans. However, this difference was mediated by the lower socioeconomic status of the Hispanic adolescent group. Then, the

difference in depressive symptoms was better explained by the lower income in the Hispanic group rather than the more negative cognitive style of the Latin Americans.

The simultaneous existence of two opposite cultural ideologies is also a feature of Latin American culture (Fuentes, 2005). In spite of this idea of the unavoidability of death, the opposite cultural construction of overcoming obstacles and adverse situations is also present in Latino culture. The feelings of community and belonging result in a clear sense of having more opportunities and finding support in others and thus in resulting the ability to overcome obstacles more readily. This last concept has been clearly shown in all the histories that low educated and non-English speaking immigrants tell about their own experiences of illegally crossing the United States border, getting a place to stay, and finding a job.

The sense of humor is also linked to the way that Latinos cope with adverse situations. Making fun of adverse and painful conditions is often a strategy that Latino people use to decrease the unpleasant feeling associated with suffering. Humor helps Latinos to feel more close to each other when facing the same type of problems. This sense of humor has been linked to a social characteristic of Latinos called *simpatía*. Simpatía is a concept linked to social interaction and involving the ability of sharing feelings with others, to maintain a certain level of conformity, and to behave with dignity, emphasizing positive aspects and avoiding negative aspects in one situation (Triandis**,** Marín Lisansky, Betancourt, 1984). Simpatía has high social worth among Latin Americans and it might result in avoidance of conflict and confrontation. Triandis et al. (1984) explored the perceived value of social behaviors in Hispanics and non-Hispanics. They found that Hispanics tend to expect more associative positive behaviors from others

than non-Hispanics in social interactions. Hispanics expect to find more simpatía and to behave with more simpatía in social contexts and they tend to reject behaviors of criticizing and competing. This expectation changes when there is a higher status individual in that social context. For high status individuals, Hispanics don't reject and they tend to expect them to perform non-sympathetic behaviors, such as giving orders and disciplining. Consequently, in that context Hispanics are less likely to expect a high status person to reveal intimate thoughts or personal problems. In the same way, Hispanics are more likely to talk with friends even if that makes them late for another engagement. Also, Latinos are more easily offended than white Americans and Black Americans by comments that carry a personal meaning. Furthermore, they prefer a service that a friend provides no matter if there are others professionals providing the same service with better quality. These characteristics make Latin Americans more collective oriented and more centered in others' values, needs, goals and points of view. Traditional white American culture is more individualistic oriented, emphasizing values such as competition, pleasure, a comfortable life and social recognition (Triandis, Leung, Villareal, & Clack, 1985).

Personalism is a word to name another important characteristic of relationships in Latino culture. Personalism refers to the importance of face to face relationships. Latin Americans trust more in a particular person they can identify with rather than an institution (Egaña, Hosty & Hobbs, 2006). Consequently, they are less likely to attend a meeting or an event when they are just invited using a flyer or publicity. Phone calls, personal letters, notes, and short conversations are a better way to contact Latinos.

Similarly, the best way to make Latinos trust someone is to contact a person who already knows other Latino people.

Suffering is experienced as part of life and this idea is close to the religious concept of experiencing pain during life to gain a place in heaven. Suffering for Fuentes (2005) is placed in every period of Latin American history and the history of Spain as it is observed in historical facts, such as revolutions, wars, civil wars, long dictatorships, torture, exile, war for independence, natural disasters, etc. But suffering facing adversity is, for Fuentes, the way that Latin Americans and Spaniards have developed strength. This force to fight against adversity is also recognized in the literature of Gabriel Garcia-Marquez, Nobel Literature Prize in 1982 for his novel *Cien Años de Soledad* (1969) and in his speech when receiving the Nobel Literature Prize in 1982. García-Marquez, in this last performance, describes a long list of unbelievable, illogical and sad, but real, events in the history of Latin America. He asks the rest of the world for a more comprehensive and emphatic response and judgment about the reality of Latin America and its cultural independence. Finally, he describes the response that Latin Americans have after all the history of wars, floods, plagues, oppression, abandonment, famines and cataclysms. The response of Latin America is life, is the choice of living, the choice of building families, and raising children.

Fuentes also shows Latinos as very religious individuals and communities. Their sense of religion and spirituality are always present in the implicit beliefs that doing things right according to the Catholic commandments will result, sooner or later, in getting what is wanted in life. The feeling of deserving punishment might come from the opposite. Behaviors and thoughts against the Catholic commandments will cause a direct

sanction in the form of suffering or endurance when facing a difficult situation. This punishment may occur in any time during the life span of that individual and the sanction will be proportional to the damage or severity of the previous fault. This deterministic ideological construction is also related to the patience that Fuentes places as another characteristic of Latin Culture. Patience to wait for things that will happen in the future is based on according what each one has done during their personal past. This patience is also the patience to accomplish something that has been planned with anticipation and it is the reason for which some constant and persistent work has been done. This patience and constancy are depicted in the goals of every immigrant who comes to the United States carrying just a dream for the long term future. The attitude of being patient is often misinterpreted as passivity or inactivity by those perceiving Latino behavior with stereotypical eyes. Unfortunately, several Latino stereotypes are depicted in the media and there are many Americans that use them to make decisions about immigration issues and exterior policies (Suarez-Orozco & Paez, 2002).

Another characteristic dimension often found in the behavior of Latinos is dominance – obedience. Latin Americans are very respectful of authority. Latino children are socialized to be pleasant and to adopt a passive attitude to adults. However, resistance to authority is also present throughout the histories of Latin American countries in the presence of military governments with dictatorial styles. Even during the worst abusive dictatorial regimes, there was always some kind of strong resistance by people in different ways: armed, civil, passive or active non-violent opposition.

Finally, in his book, Fuentes (2005) describes another visible useful feature, in particular, of Mexicans: the capability of improvising, fixing and reassembling objects

and non-functioning machines of any type. With few basic elements Mexicans are quickly able to restart something to make it work. Evident to everyone are all the cars that Mexican immigrants buy for an inexpensive price and then they fix the cars by themselves. Moreover, later more details are added to these cars, such as paint and drawings.

The importance of the family in Latin American culture is again noticed in another of Fuentes' books, *The Buried Mirror: Reflections on Spain and the New World* (1992). Here, Fuentes characterizes the Latin American family as the most important source of support, warmth and security. There is a very strong commitment of all the family members to stay emotionally and physically together to the point of preferring to be poor but staying close to the family, rather than being in a lonely richness. The chapter in Fuentes' book titled *Hispanics in the USA* also makes reference to the willingness of first generations of Hispanics in USA to keep Spanish as a first language and to speak English as a second. Despite the fact that there are many who argue for forgetting Spanish in a culture in which English is the dominant language, over time, there are more who support the idea of bilingualism. In the study of Radey & Brewster (in press), it is shown that Latino families prefer for relatives to take care of their children rather than enrolling their children in daycare centers. Hispanic mothers living in the United States are more likely than black and white mothers to rely on their relatives for child care. White mothers, in this research, had the higher levels of reliance on non-family care. The cohesion, closeness, pride and mutual obligation are stronger in Latino families than in white American and black American families (Marsiglia, Miles, Dustman & Sills, 2002).This closeness is still preserved even after marriage. Married Latino couples tend

to settle close their parents and other family members. This strength in the Latino family is called cohesiveness and it is highly associated with resisting drug use in youth. Marsiglia et al. (2002) investigated the role of families in affecting pre-adolescent substance use. It was found that no matter how high poverty rates are strong bonds in families and school commitment are sources of developing resistance against substance use in Latino youth. Latino families are strong in providing youth with advice, direction, modeling and support. On the other hand, the school, in this research, was a protective institution that provided Latino youth with support, structure, discipline and modeling of pro-social behaviors.

Latino family members are strongly oriented to seek support in the family rather than in friends or closer non-relatives. Latino college students are more likely to seek support in non-family members (friends, neighbors and peers) than in family members. Latino college students experience great stress facing language difficulties, cultural incompatibilities and family concerns. Rodriguez, Mira, Myers, Morris & Cardoza (2003) researched the contribution of perceived social support from family and friends to psychological adjustment in Latino college students. They found that family made a great contribution to the well-being of Latino college students but the group of peers was more important for coping with feelings of distress.

The idea of preserving one language and learning another as a second reflects the types of cultural adaptation that some immigrants develop. This style of adaptation redefines a double consciousness in which it is possible to interact with American institutions and with other ethnicities and cultures in the United States. At the same time, by preserving the language, traditions, and values it is possible to maintain linguistic,

social, economic, political and cultural links with compatriots in Latin America (Suarez-Orozco & Paez, 2002). This double identity and cultural belonging could be of concern to American authorities who demand loyalty to Latinos with to the country that welcomes and supports the quality of life they have here. But American authorities do not have much to be afraid of. The sense of patriotism and loyalty is also present in the Latino culture. Therefore, it is possible to observe in the histories of many Latino soldiers who have served and are currently enrolled in the US military forces (Montemayor & Mendoza, 2004). One hundred and ten thousand Latinos are currently serving in the US armed forces and they represent 8% of total US Military Forces. Some might think that they are there solely with the purpose of earning citizenship. However, the United States history says something different. According to Montemayor & Mendoza, 200,000 Latinos served in War World I, 500,000 during War World II and 100,000 in the Vietnam War. Did they just serve? No, they served with honor and courage. During the American civil war, Latino soldiers received 42 Medals of Honor. In 2004, one of very eight American soldiers killed in Iraq was Latino. More than 22 Latino soldiers have died in combat in the Iraq War, four of which were not U.S. citizens. These last four Latino soldiers died for their adopted country.

Moreover, Latino soldiers have faced more stress in war than white American soldiers (Ruef, Litz & Schlenger, 2000). Besides the stress of war combat condition, Latin American soldiers have coped with stressors such as racism and the conflict of being incorrectly perceived as enemies because of their physical similarity with the enemy in the Vietnam War. Latin American soldiers also have a higher risk of developing post traumatic stress disorder than American and Black American soldiers.

Addressing some issues of Latino everyday life, it appears that some Latino customs are also very different from American ones. Latinos prepare and experience their meals with important meaning associated and in a particular and characteristic manner (Castillo-Feliú, 2000; Williams & Guerrieri, 1999; Standish & Bell, 2004). In many Latino countries, lunch is the main meal and breakfast and dinner are lighter ones. Coffee with milk and fresh baked bread are common during breakfast and fresh baked bread is a food that accompanies every meal. During lunch, a stew or another heavy dish is consumed, frequently including any kind of meat, such as chicken or pork with potatoes and/or rice and a fresh vegetable salad. Lunch time lasts one and a half hours or more. In some countries, some professionals and workers go home and have lunch with their families. The time that is spent during lunch doesn't involve only having food. Lunch and dinner are social activities and it is common that during meals and right after the food has been consumed, there is a period of time spent talking about issues other than work related situations. The time dedicated to talk during and after meals is longer during weekends. On Saturdays, Sundays and national holidays, family members get together and they have lunch and/or dinner sharing several traditional dishes while spending enjoyable time talking about social issues, politics, religion and their personal lives.

For Latinos, food is not only something to enjoy or something to provide them necessary energy for working. Food and drinks are part of their lives, of their cultures, of their habits and it is also one of their more pleasurable activities. This sense of enjoying meals is part of the heritage from Spain and other European and Middle Eastern cultures. Food is also an important component of social interactions either in formal or informal gatherings. In some Latino countries, homemade snacks, a dish and drinks are served

when a person is visiting your home. While the visit is taking place, home owners serve homemade drinks or food. Usually, they don't ask whether the visitor would like to have some food. In fact, they do offer the visitor food or drinks with the purpose of sharing love, feelings of welcome or thankfulness. In those cases, rejection of what is offered might be interpreted by the house's owners as a sample of rejection and discomfort. Feelings of Latino home owners could easily be hurt when what they offer at home has not been well accepted. In Latin America food, feelings and emotions have very strong tides. For a reference of the link among food, emotions and relationships, check Laura Esquivel's novel, *Como Agua Para Chocolate* (1994).

Social interactions also have an important and particular component of physical contact and social distance (Castillo-Feliú, 2000). Latinos have fewer concerns and they don't experience very unpleasant feelings when standing close to strangers in public places such as elevators, public transportation and crowds. Latinos physically greet each other once a day when seeing the person for the first time during the day and when leaving. However, there is variability across Latino countries, in general, men shake hands. With women it is going to depend on the situation. In informal situations, women shake hands with men and women. In no formal relationships, women shake hands with men and women and they lightly kiss the other's cheek. Hugs are also accepted when there is a stronger affective relationship. Because the importance of physical contact and intimacy among Latinos, introductions could take a considerable amount of time as a demonstration of appreciation of those with whom they interact.

Male and female roles in the Latino families are also different. Women have, in general, a position more subordinate and less powerful than men (Gonzalbo, 1997).

However, there are differences by countries and economical status. Overall, women in Latin America are hired in positions with less power and lower responsibility and their average income is lower than men. At home, the leadership and powerful role of men among family members is well known by the word *machismo*. For instance, in societies with high levels of machismo, adultery is more accepted and sometimes it is perceived in men as normal. In contrast, adultery in women is severely sanctioned. Housekeeping and childcare are duties considered proper of women and family economical support is seems to be part of male responsibilities. Children are taught to be very respectful of adults and are more dependent on their parents. It is expected that parents provide economic support for their children's studies and personal expenses in college. There are some gender differences about this. For males it is more expected to get a college degree and they have more freedom to go out with friends at night. Young women have less freedom and they are commanded to be very involved in housekeeping duties. This unequal situation has decreased in countries such as Argentina and Chile in which women have become more able to achieve higher levels of education and more work opportunities.

The Relationship between Neuropsychology and Culture

Cross-cultural Neuropsychology has been defined by Wong, Strickland, Fletcher-Janzen, Ardila & Reynolds (2000) as the science concerning the relationship between cultural variables and brain and behavior. As this definition, Wong et al. (2000) refer to culture as an independent variable affecting the relation brain – behavior. The first studies in the history of Neuropsychology were focused to test how environmental factors affect neuropsychological functioning. At this respect, the history of Neuropsychology starts with the important cross-cultural research accomplished by the Russian Psychologist,

Alexander Romanovich Luria in 1931 (Neel, 2000). Luria traveled to the Soviet Republic of Uzbekistan, in Central Asia, with the purpose of test the hypothesis of Vygotzky, another Russian psychologist. Vygotzky's theory was that cortical brain development is mediated by social experience and the material conditions in which the individual lives. Luria selected individuals living in different levels of modernization searching for differences in simple neuropsychological tasks. The Vygotzky's theory and ideas and Luria's research represent the source of one extreme environmental position about the influence of culture in mind that Neel called *Radical Environmentalism*. This theoretical approach holds the idea that culture accounts to full explain the development of all the human cognitive processes. As this regard, Vygotsky noticed that higher psychological functions such as logical reasoning, creative thinking, executive planning, willingness and even emotions are developed from outside the organism. According this vision, human brain is conceived as a shapeable structure involving several organized and interacting systems and its development depends on the materials that culture and social structures provide. In this explanation, the concept of materials involves language, social structure, methods and content of education and social experiences of life. Further, the idea of Vygotsky takes in account the time dimension across life in which mind is created by the influence of all the experiences during the history of life including the availability and access to cultural materials. In addition, cognitive processes occurring in human mind are also determined by the history of that particular group of individuals because they hold the materials that are preserved across the historical time. Following this theoretical approach, human beings are thought to be products of their culture but also during their lives, they in fact are active creators of what their culture is. This historical

interaction between brain, cultural materials and social experiences is dynamic. Change is conceived as always possible in cognitive processes because the active role of human willingness in preserving, developing and changing their culture.

The opposite position is called by Neel (2000) as the *nativist* view. According this conception the development of all the cognitive processes is almost completely determined by genes. This biological and controversial perspective has been defended by many authors during the history of psychology and Neuropsychology. For those who hold this theoretical approach, the environmental influence accounts for as much as 20% in how the cognitive processes born and change (Jensen, 1968). This position brings the polemic and extended argument that the differences in performance between whites, blacks and Hispanics in intelligence test can be explained by the genes they share in each race group. This theoretical biased explanation has reappeared several times in the history of psychology even until 1994 in the book The Bell Curve (Daniels, Devlin & Roeder, 1996). In this book, the authors develop the idea that intelligence quotient is highly heritable across generations in the way that society has become stratified in different cognitive groups such as, a group of cognitive elite and a group less cognitively developed. As long these social groups don't interact and there are no many of these individuals from heterogeneous groups forming couples and getting marriage, the chance of producing changes in these cognitive groups is low. Following this reasoning, the cognitive groups segregated by their intelligence will become in real castes. Fortunately, this extreme hypothesis is broadly debated from statistical, biological, cultural, economical, psychological and educational perspectives in the book Intelligence, Genes, and Success (Devlin, Fienberg, Resnick & Roeder, 2002). One frequent problem that

arises in measures of intelligence and cognitive abilities across minority groups with clear differences in culture, ethnicity or race is the bias presents when using tests that have been developed by and in a dominant culture with a different cultural background. Many problems appear in the testing situations that affect the performance of people with different race, ethnicity or culture. Next, this paper will review the most important aspects of neuropsychological testing in Hispanics and some problems with using neuropsychological tests in people who belong to cultures that are different from the culture in which tests have been developed.

Neuropsychological tests have been validated among specific populations and their use is risky with other culturally different group of individuals. One important problem about using a test in a different culture, other than the group of individuals in which the test was originally validated, is that the construct that the test addresses to measure must also exist in the group in which the test wants to be used (Nell, 2000). For instance, the construct of speed of processing fits appropriately in the western cultures because the high value that being fast has in solving problems. Although, many cultures and some minorities groups consider accuracy more important than time in timing situations (Puente & Agranovich, 2003). As a consequence, in some cultures individuals haven't been trained in performing tasks with maximum of speed as the same meaning that Americans and Western cultures understand and perform the concept of speed of performance. This issue points out the fact that there are tasks in which individuals are required, verbatim in the instructions given during the administration, to perform "*as fast as you can*". It is not well established that the meaning of fast is the same for two different cultures during testing situations and also "*fast*" would not have an equal value.

As a consequence, in two different cultures performing fast is an ability that would have different levels of training. Also, in cultures where standardized tests are not common, such as Latino culture, the experience of facing a timing task in a test has been poorly trained comparatively to individuals with many expositions to timed tasks experiences. As a result, the scores from two culturally different groups in a timed task are not equally comparable and the norms developed in one culture are not useful to understand the performance of individuals from another culture. In United States, spelling is an important skill that has been over trained to the point that the use of abbreviations is very common (ADHD, CIA, FBI, etc.). This skill is not important and it is not trained in Hispanics (Puente & Ardila, 2000). Then, when testing Hispanics the use of spelling as part of one test to measure verbal skills it will underestimate the measurement of verbal skills in that group. For one culture part of the variability across subjects in the construct of *verbal skill* can be measured across the factor spelling. For another culture, spelling is a factor not related to the construct of verbal skill. Then, spelling and verbal skills are not going to vary together in the same direction and as result spelling is not going to explain variability of verbal skill in that culture. Each culture defines what skills are relevant and what skills are not relevant to develop and being successful in that particular environment (Puente & Perez-Garcia, 2000). In case of assessing ethnic minorities, Puente and Perez recommend to consider abilities with cultural equivalence. In other words, neuropsychological tests should be used in individuals who belong to a culture in which the constructs that are attempted to measure do exist with the same equivalent value and meaning.

As it has been said language is an important component of culture and it is also one big problem when testing Hispanics. Spanish is not a unique standard language. Many objects, actions and grammatical uses vary across Latino countries. For instance, the word *cobija* is used to name a blanket and it is used commonly in Mexico and the Caribbean. However, the same object is named *frazada* en Chile. Both are correct nouns for the same object but there is a large variability in the frequency for their use. This variability in the use of language is called *regionalism* (Puente & Ardila, 2000). Another complex situation that test translators face is the syntactic and grammatical differences between languages (Puente & Perez-Garcia, 2000). The location of nouns, adjective and verbs varies across languages and it makes hard to bring the same meaning when a question or instructions are translated to another language. In the same way, Spanish language has two letters in the alphabet, ll-LL and ñ-Ñ, that don't exist in English. In other words, there are phonetic differences between English and Spanish in which some sounds in Spanish are not common and even they don't exist in English. Language issues also interact with the problem of translation of tests. Across cultures, there is an important variability in the number of words to name or describe an object, emotion, relationship or a situation. Moreover, when a scale has been validated in a group of individuals to measure a construct, such as depression, the items of that scale will cover all the aspects of that construct by using different words for each aspect of that theoretical construct. However, languages differ in the number of adjectives or nouns for a specific construct. This problem is described by Nell (2000) when translators tried to validate a mood scale in African population. Compared to English language, some African languages have fewer synonyms to name some dimensions of mood that the original

scale had. As a consequence, the same synonyms had to be used in several items. Later, when administered the translated mood scale the Africans subjects understood that they were asked twice the same question.

The function of language during a testing situation can also be a source of cultural differences in neuropsychological assessment. Instructions in a testing context are interpreted different by Americans and Latin Americans test administers (Ardila, 2005). Latin American neuropsychologists understand the instructions in a test as guidelines about what is expected for examiner and examinee to do and the instructions can be read and adapted according the specific test situation. Conversely, in United States instructions are belief to be a standard set of statements that are read and followed for examinee and examiner as the same as the manual. Ardila also refers that academic language in which instructions are written carry also some difficulties for examinees with limited education or with a different cultural background. Some standard testing procedures and/or instructions don't allow examiners to clarify questions or give any more clues to examiners about how respond.

For western cultures, individual administration of tests is a normal over learned context for assessments (Ardila, 2005). The assessment involves an interpersonal relationship between two previously non-related and unknown individuals, examiner and examinee. In Latino culture it is expected a friendly talk to set up a relationship between the participants before starting testing. A testing situation in which the examinee is required to accomplish a series of unknown difficult tasks can be experienced by a Latino person as a rude and non-polite social interaction. As a consequence, the testing situation will elicit in the examinee feelings of rejection, lost of orientation and affects of being

misplaced. As a result, examinee's performance in tests will be interfered for emotions and cognitions that are not expected to appear in a standard testing situation which required full concentration and effort. Ardila also notices important cultural values that underlie testing situations. Many tasks ask to examinees to give the most common sense answer and avoiding creative and extensive responses. This standard condition of testing will probably miss lead to erroneous conclusions when testing individuals in a culture which values creativity. In the same way, one to one testing situation can be experienced with high level of novelty in some group of individuals, such Latino groups, in which collaborative and associative work has high value and individual performance is less valuable. Novelty of the task is an important factor affecting performance between two groups of subjects with different cultural background. The test situation assumes that the examiner is required to pay attention to the examiner, following and recalling instructions and avoiding comments or actions that would interrupt the test administer (Nell, 2000). There are cultures in which individuals have less testing exposure even in the formal education system. Those subjects with less experience in testing situations will lose important time and points during a testing condition trying to adapt their behavior and learning an efficient form to behave in that context.

Another factor affecting neuropsychological testing performance is level of acculturation in minorities. In general, Latinos living in United States perform lower than white Americans in neuropsychological tests (Puente & Perez-García, 2000) and there is some evidence that level of acculturation mediates the differences (Arnold, Montgomery, Castaneda & Longoria, 1994; Evans, Miller, Byrd & Heaton, 2000). Acculturation refers to a process in which a person, who lives inside a larger cultural mainstream, is able to

progress to understand and adjust to the social, cultural and psychological requirements of that culture (Puente & Perez, 2000). This process varies across the different activities that an individual performs. For instance, an Hispanic adolescent could dress as an American wearing Brooks Brothers clothing and behave according social rules when interact with others at school but still maintaining the preference of studying in a college close to parent's home. Neuropsychological tests and testing contexts are designed and originally validated base on the values that exist in the dominant culture of a group of individuals. For minority groups such as Hispanics in the United States, acculturation becomes in an ability to develop and be able to perform better in testing situations. Arnold et al. (1994) studied the effect of acculturation in Hispanics when performing several tests of the Healstead-Reitan neuropsychological battery. The subjects in this study were 150 students from the University of Texas-Pan American. The level of acculturation was measured by the Acculturation Rating Scale for Mexican Americans (ARSMA) across four factors: language familiarity, usage and preference; ethnic identity and generation; reading, writing and cultural exposure; and ethnic interaction. According their scores in the ARSMA, the subjects were classified in three groups: Mexican, Mexican American and Anglo American. The neuropsychological tests used were: Lateral Dominance Examination, Tactual Performance Test, Category test, Finger Taping Test, Seashore Rhythm Test and Trail Making Test. The groups with significant levels of acculturation didn't show any difference in performance of Trail Making Test, Finger Taping Test and Tactual Performance Test for the memory and localization components. However, a significant effect for acculturation was found for the adaptive motor learning component of Tactual Performance Test. Individuals in the group with lower level of

acculturation, the Mexican group, required longer time to complete the task than the subjects in the group with higher level of acculturation, the Anglo American group. The same pattern was observed in the differences between group's performance in the Category Test and Seashore Rhythm Test. Visual motor ability, visual spatial tracking and visual, spatial and auditory processing for basic language information appears to be less affected by acculturation.

Trail Making Test Across Cultures

TMT has been applied in several different cultures and countries with different results. Stanczak, E., Stanczak, E. & Awadalla (2001) studied performance of TMT in Sudanese, Sudanese residing in United States and American samples. The normal samples were composed of 497 American citizens and 77 Sudanese. The brain damage samples were 53 American citizens and 28 Sudanese with neurologically confirmed brain lesions. Unfortunately, the groups were not statistically equal samples in terms of education and age. Five forms of TMT were administered A,B,X,Y and Z. Forms X, Y and Z were validated by Stanczak, Lynch, McNeil & Brown (1998). These forms corresponds to alternative Trail Making Tests that Stanczak et al. (1998) named Expanded Trail Making Test (ETMT). ETMT follows the same principle of connecting with a pencil, in a logical order, figures spread in a sheet of paper. For instance, form X involves a series of 25 clock faces in which the individual is required to connect in order (e.g., 12:15 to 12:30 to 12:45, etc.) drawing lines with a pencil. Total scores were not taken in account for subjects who didn't finish the tests before 3 minutes and it was required their scores to be prorated. An Arabic version of TMT was constructed replacing the English symbols with appropriate Arabic letters and numbers. Additionally, the words

begin and *end* were translated into Arabic. Stanczak et al. (2001) found that the performance of Sudanese normal subjects and the Sudanese brain damage group was different in the forms A, X and Z. Normal Sudanese were different also from the American normal group in forms A,B,Y and Z. Brain damaged Sudanese were also statistically different from American brain damaged sample in forms A and Z. Moreover, because the groups were statistically different in age and years of education, an analysis of covariance was performed between normal and damages groups and between the samples from different countries. After statistically controlled for age and education, the differences between brain damage and normal subjects were still statistically significant. One interesting finding was that the scores obtained by Sudanese normal subjects were similar to those of American brain damage subjects. This last point states that it is not recommended using an American sample to interpreter TMT scores due to the probable high rate of false positives. Stanczak et al. (2001) do not explain the differences between samples of different countries but it is hypothesized that, in general, Sudanese population is not familiarized with standardized neuropsychological tests. However cultural differences might explain this effect, more research is necessary.

Culture involves an important language component. Chinese is a language in which reading requires the same amount of ability of visual search in both directions: horizontally and vertically. Lee, Cheung, Chan, & Chan (2000) studied the performance in TMT of Chinese subjects who have English and Chinese as first language. Also, Lee et al. (2000) examined the effect of speaking two languages in two different trails making tasks: TMT A-B and Colors Trails Test (CTT). In this study, the samples consisted of 52 subjects who were fluent in English and Chinese and 32 English monolinguals. The Color

Trails Test is a variation on TMT in which the part A in TMT is homologue to CTT part 1 (CTT-1). In CTT-1 the odd numbers are embedded in pink circles and the even numbers in yellow circles. In part 2 of the CTT, there are two groups of numbers, 1 to 25 and no letters. One group is embedded in yellow circles and the other group in pink circles. The individual is asked to connect the numbers from 1 to 25 alternating yellow and pink circles. The results showed that bilingual subjects performed statistically different in CTT from TMT A-B. Conversely, the performance in TMT A-B and CTT of English monolingual speakers was strongly related. The authors concluded that language can affect the equivalence of TMT A-B and CTT. No significant statistical differences were found between monolingual and bilingual speakers in all the trails with the exception of TMT-A in which Chinese English speakers performed slower than monolinguals. Finally, this study concludes that CTT appears to be more language fair than TMT A-B.

Another language from a different culture and symbols system in which TMT has been tested is Hebrew. Axelrod, Aharon-Perestz, Tomer & Fisher (2000) used a Hebrew version of TMT to create a ratio score to differentiate between normal and head injured patients. Axelrod et al. (2000) created a version of TMT in which spatial distributions of the targets are the same but modified the content in the circles in the case of part B. In Hebrew, the use of letters in place of numbers is frequently in the same as Roman numerals used in English. As a result, the first 20 items in a simple version of TMT are easier for most of Israelis. In this study, the circles in TMT-B consisted of Hebrew numbers and letters which replaced English numbers and letters until the item 20. After the item 20, and from the item 21 to the 25, letters changed to combinations of letters

instead of a single letter. All the participants were Hebrew speakers. The normal sample was comprised for 30 subjects. The clinical subjects were individuals who had participated in a car accident with and without loss of consciousness. The results showed that the clinical subjects were significantly slower than the normal individuals in both trails. A ratio score was composed by dividing time to complete Trails B by the time to complete Trails A. Axelrod et al. (2000) defined a TMT ratio cutoff of 2.26 as the optimum to discriminate between clinical and normal individuals.

Another interesting study performed in a European culture is the research of Bonnaud, Audouin, Goanas'h & Gil (2003). This study was conducted in France using the same TMT A-B but with the words *begin* and *end* translated to French. The rest of the administration and instructions were performed in French. The goal of this research was to study the similarities of parts A and B of TMT based on the differential effect of longitude of connections and spatial configuration in healthy and ill populations. The subjects were 72 volunteers divided into three groups: a young group, an aged group, and a group subjects diagnosed with Parkinson's disease. There were no statistically significant differences between groups in age and educational level. For the purpose of controlling cognitive complexity and to examine the effect of spatial configuration and the different longitude in connections in Trails A and B four alternative forms of TMT were created: $TMTA_N$, which entirely preserves the form A of TMT. The form $TMTA_p$ presents the circles in the same distribution of the traditional form A but the numbers inside of circles were erased and the empty circles are connected by a line of small dots. The form $TMTB_N$ conserves the same distribution of circles of TMT part B but the letters are replaced by numbers 1 to 25. The last alternative form is $TMTB_p$ that retains the same

spatial distribution of TMT part B but the circles are empty and are connected by a line of small dots. The results showed a significant effect for age in all the forms, the young group performed faster than the old healthy group and the group diagnosed with Parkinson's disease the lowest. Between forms, all the groups were statistically significantly slower on the Form B than in the Form A. Thus, there is an effect of the difference between the Form A and the Form B in the distance between circles that must be connected. Indeed, Part B exceeds 52 centimeters part A. As the spatial arrangement in part B is harder than part A, after controlling for cognitive complexity, younger subjects were significantly faster than subjects with Parkinson. Spatial arrangement has a significant effect for groups with a degenerative illness.

Normative studies of TMT A-B in other cultures have been performed for clinical use. Giovagnoli, Del Pesce, Simoncelly, Laiacoma & Capitani (1996) performed a normative study in adult Italian population. This research examined the effect of age and gender in performing TMT of 287 normal healthy Italian subjects. The results showed statistical significant effect for age and education. For gender, the effect was minimal low and the authors excluded this factor. A test re-test was performed resulting in high correlations pre-post test in Trails A and B. Ratio scores taking the time to complete parts A and B were attempted: B minus A and B divided were B – A but TMT part B is highly correlated with these two ratio scores, consequently, there is no reason to replace part B with these other fixed scores. The study provides tables with adjustments for raw scores according to age and education.

Normative studies have also been performed in oriental cultures. Seo, Lee, Kim, Lee, et al. (2006) studied the performance in Trail Making Test in an old Korean healthy

large sample. Numbers and letters in TMT forms were replaced by letters and numbers from the Korean alphabet. This Korean version of TMT was administered to 396 Korean individuals in Seoul between 60 and 89 years of age. For normative purposes, the sample was divided in four groups according their ages: 60 – 69, 70-74, 75-79 and 80-89 years. Years of education also varied in the sample, so the subjects were also classified in three different groups according the number of complete years of education: 0 to 6, 7 to 9 and 10 years or more. Similarly to other studies, most of the groups showed statistical significant differences in TMT performance. Moreover, also gender had an effect in TMT performance: women performed better than men in TMT part A but equal to men in part B. A test-retest procedure was also implemented. Twenty seven individuals were asked to repeat TMT part A after two months; the same for 19 individuals for TMT part B. The two times of performance were highly correlated with a small but not statistical significant improvement in the second time of assessment.

In Spanish speakers, there is one important study in Spain performed by Periañez et al., (2007). Periañez et al. used TMT to compare large normal and clinical samples. The normal sample was composed by 223 healthy subjects with age range between 15 to 80 years (M=38.9, SD=18.7) and average education of 13.3 years (SD=3.6). The clinical samples involved a group of 127 patients with diagnosis of non-affective psychosis, and a group of 90 patients with diagnosis of traumatic brain injury. In the sample of healthy subjects, significant positive correlations were found between age and TMT-A (r=.438) and also between age and TMT-B (r=.453). Correlations between age and other composed scores such as B minus A, B divided by A or B-A/A was also significant but lower. Performance in TMT was significantly different between groups when comparing

them using the time in seconds to complete TMT and also using the other derived scores. Periañez et al. provide mean, standard deviation, range and percentiles for age groups in healthy subjects and separate mean, standard deviation, range and percentiles for the clinical groups. In the healthy group, the age groups were 4: 16-24 years, 25-54 years, 55-80 years. Moreover, this study provides stratified norms for educational level in the 25-54 years group.

Neuropsychological Assessment in Chile

Chile is a country located in the South West end of South America. It is bordered to the north by Perú, to the south by the Antarctica, to the east by Bolivia and Argentina and to the West by the Pacific Ocean. Chile is a narrow Country, its average width is 150 Kilometers, with a population of 15.116.435 people who speak Spanish (Castillo-Feliú, 2000). Chile is administratively and geographically divided in 13 regions. The biggest region is Region Metropolitana that concentrates more than 6 million of people and it is also the region in which Santiago, the capital of Chile, is located (Instituto Nacional de Estadisticas, 2003).

According the Chilean National Statistics Institute report, the age structure of the Chilean population has experienced a noticeable change in the past 50 years (Instituto Nacional de Estadísticas, 1999). Changes in population size and composition started in 1996 with the sudden increased in fecundity and life expectancy. For instance in 1950, a 60 year old Chilean woman lived to 77 years of age. Now in 2000, an average woman of 60 years of age will live to the age of 83. In 2000, the ageing Chilean population, defined as over 60 years old, represented 10% of the general Chilean population. It has been estimated that by 2010 the ratio will be 50 individuals with age over 60 years for every

100 children. Moreover, it is estimated by 2034, the aged population will equal the population of children (Organización Mundial de la Salud, 2003).

This demographic change has important consequences for psychological practice in order to provide accurate and reliable methods to assess medical conditions that rapidly aging population is presenting. The health paradigm that focused on mother and childhood health is changing to a model that emphasizes caring for prevalent illnesses in an aging population: hypertension, diabetes and nervous degenerative medical conditions (Organización Mundial de la Salud, 2003). Among the health problems that an aging population will face are cerebral vascular disease, dementia of the Alzheimer's type and cognitive impairment. AVISA is an indicator that measures the relative importance that any illness has related to the years loss caused by premature death and disability. In the general Chilean population, cerebral vascular disease and Alzheimer's diseases accounts for more than 5% of the all the year loss by premature death and disability (AVISA) and people over 60 years old with cognitive impairment, measured by Mini Mental State Examination, reach 9 percent. Moreover, the prevalence in Chile of cognitive impairment in an old population is 43% in the group of 80 or more years, 18% for individuals between 70 to 79 years and, 6% between the group 60 to 69 years (Ministerio de Salud. Gobierno de Chile, 2003).

On the other hand, there are not many reliable and valid instruments to measure cognitive decline and brain damage. Studies in Chile related to measurement of cognitive decline are more related to the cognitive consequences associated to psychiatric disorders such as schizophrenia. Servat, Lehmann, Harari, Guajardo & Eva (2005) studied the efficacy of several neuropsychological instruments to detect cognitive disorders in

Chilean schizophrenic patients. Their sample was of 20 schizophrenic patient males and females with a range of age of 19 to 48 years and with an average age of 31.85 years. All the diagnosed patients were out patients from the Clínica Psiquiátrica Universitaria with 2 or more years of treatment. The control group was composed of 20 normal subjects with no antecedents of brain damage or psychiatric disorders and an average age of 30.55 years. All the subjects in the control and experimental group had at least 12 years of education and both samples were also homogeneous in socioeconomic status. For the experimental group the average IQ was 94.95 and for the control group was 93.3, measured by the abbreviate version of WAIS. The cognitive skills assessed were visual perception, visual memory, verbal fluency, motor function, visual scanning speed, mental flexibility, inadequate responses inhibition, immediate memory and numerical reasoning. The test included in the battery were Benton Visual Retention Test, Trail Making Test (TMT A–B), Stroop Test, Test de Asociación Controlada de Palabras and WAIS subscales Digits and Arithmetic. The study used two statistical analyses. Using a means comparison, the Benton Visual Retention Test showed statistically significant differences between the two groups ($p < .05$). As expected in this specific test, the performance of the clinical group was lower than the control group but the other neurocognitive measurements didn't show significant differences between the clinical and the control group. Consequently, Servat et al. (2005) performed another statistical analysis using the same data but another statistical test, Chi Square. In this case, statistically significant differences were found in perceptual visual function assessed by the Benton Test and in visual scanning, mental flexibility and motor function, assessed by Trail Making Test. It is interesting that the authors used two different statistical analyses for their statistical

testing. The first statistical test was *t* test because all the data is quantitative in the level of interval ratio. However, in the second analysis, a non parametric statistical test was used, Chi Square, that is in fact a test for nominal or ordinal data. Furthermore, the study doesn't specify how different the scores of clinical groups are from the representative norms. Unfortunately, there is no local norms for the tests that were administered.

Other studies published in Chilean journals about neuropsychological testing are literature reviews. The earliest is an article published in Revista Chilena de Psicología in 1983 by A. E. Puente. Puente discussed the controversial findings in the clinical use of the neuropsychological battery Luria-Nebraska on the light of an extensive literature review. The author concludes the important need of more studies addressing the psychometric proprieties of that instrument and its value across cultures.

Orellana, Slachevsky & Silva (2006) made another review about neurocognitive disturbances in schizophrenic patients. This study mentions the Trail Making Test and Wisconsin Card Sorting Test as valid and reliable instruments to measure deficits in voluntary motor ability but the article doesn't tell anything else about other tests to measure cognitive decline. In another review, Slachevsky, Pérez, Silva, Orellana, Prenafeta, Alegría & Peña (2005) searched in the literature about explicative models and methods of assessment in pre frontal cortex and behavioral disorders. Several tests were mentioned in this study and were associated to different measures of executive functioning. The Stroop test is named as an instrument sensible to interference in information processes. Trail Making Test is named as a reliable test to measure cognitive flexibility. The ability of building categories is associated to the Wisconsin Card Sorting Test, the Brixton test for assessing the skill to deduct norms to operate with different

tasks and the London Tower as a task to measure planning capacities. Even though the article explains all of these neuropsychological tasks stating that they are valid and reliable instruments, it is not concluded that these neuropsychological tests have norms for Chilean population. Clearly, the absence of normative studies in Chile about those neuropsychological instruments is an important barrier for their use as reliable instruments of diagnosis in neurodegenerative disorders and cognitive decline.

Bender Gestalt Visuomotor test is the more common instrument that psychologists in Chile are trained to use to screen for brain damage or dementia (Universidad Católica de Chile, 2008). The administration of the Bender test in adults takes about 20 minutes and its correction approximately 30 minutes. Only psychologists are prepared to use the Bender test in clinical settings. However, availability of normative and clinical studies of Bender in Chilean population is poor or does not exist. On the other hand, Trail Making Test is an instrument with several publications evidencing its clinical validity and reliability across cultures. Moreover, TMT is a shorter test and it does not require further correction after the times of completing the test has been registered. Also, TMT might be administered by a trained technician. After considering cultural issues related to the administration procedure and testing situation, the development of normative studies on TMT for healthy and clinical Chilean populations would increase the accuracy and validity in diagnosing pathologies that have an increased rate in elderly population. As this regard, normative and clinical studies would help psychology in Chile to reach a higher level of scientific standard and to update the existent obsolete knowledge and testing procedures with what is relevant in neuropsychology in developed countries.

Present Study and Hypotheses

The literature only lately has explored TMT performance in a Spanish speaking population (Periáñez, et al., 2007) and no studies have addressed the relationship between age and TMT performance in a healthy Chilean population. The purpose of this study was to determine any relationship between age and performance in Trail Making Test A-B in a Chilean population.

This study hypothesized that age is positively related to performance in Trail Making Test in Trails A. It is also hypothesized that age is positively related to time to perform Trails B. To test these hypotheses, the relation between age and elapses time on Trails A and B was assessed in separate correlation analyses. Also, the relationship between years of education and performance in TMT A-B was analyzed using 2 correlation analyses. Two separate regression analyses were performed to examine the portion of the performance in TMT A-B predicted by age after controlling for education. Gender was not included as variable because the literature reviewed has not shown any significant gender differences in TMT performance. The 12 years of education as a requirement to be part of the sample increases the likelihood that subjects are familiar with timed testing situations. Also, after twelve completed years of formal education, differences in test performance tend to decrease (Periañez, et al., 2007). Since all the subjects had at least 12 years of formal education, no significant relationship between education and performance in TMT was expected. It was predicted that most of the variability of performance in TMT is explained by age.

METHOD

Participants

Volunteers were Chilean citizens recruited mainly but not exclusively in the city of Concepción, Region del Bío-Bío, Chile. Other subjects were recruited from other cities in the Region del Bío-Bío.

Concepción is the principal city of the Region Del Bío-Bío and Region del Bío-Bío is the second largest region in Chile (Instituto Nacional de Estadísticas, 2003) and one of the regions with lower income and higher rate of unemployment. In the region Del Bío-Bío the average of years of education in population above 15 years of age is 9.5 that is lower than the national average of years of education (10.2) (Ministerio de Planificación, 2003). Population in region Del Bío-Bío is mostly urban (82%) as well as the general Chilean population (86%).

Subjects were volunteers recruited in numerous ways, including but not limited to, word of mouth, social contact, contact through academic and institutional settings such as staff and students in Universidad de las Americas, Concepcion, Chile. A room in the Department of Psychology at that University was used for the interview and testing procedures. All subjects had at least 12 years of formal education in school and they had no history of psychopathogy. The information in the sheet of inclusion / exclusion criteria was used to exempt subjects with history of disorders

One hundred sixty eight subjects were recruited. Three individuals were not included in the final sample due to having a diagnosis of cerebral paralysis and traumatic brain injury. One subject was excluded because he did not meet the minimum years of education requirement. The final sample was comprised of 165 Chilean Spanish speaking

subjects. The mean age of the sample was 39.9 years (SD=11.8). The mean of years of education was 15.2 (SD= 2.2).

Materials

Trail Making Test forms A and B. The standard original Trail Making Test forms A and B was used as described previously. Also, a translation to Spanish of the instructions to administer Trail Making Test A and B was used. This translation was previously used in Chile in the study of Bure-Reyes, Puente, Gontier and Sanchez (2007).

Administration Protocol

The protocol included a Spanish translation of the instructions to administer the Trail Making Test. The administrator were trained and instructed to read and follow these instructions carefully during the procedure.

A demographic sheet was to be completed by the test administrator and included questions involving: age, date of birth, years of education, previous accidents, and psychiatric and neurological illnesses.

Video in Spanish of TMT administration sample. To teach the administration of the TMT procedure in Spanish to data collectors, a video in Spanish was recorded by two Spanish speaking technicians with experience in bilingual neuropsychological testing. The video was formatted in DVD and Real Media Player. The reader may obtain a copy by contacting the author.

Procedure

Three Chilean professionals collected the data in Chile. Two professionals were physicians who worked in mental health in Concepción, Chile. The third examiner was a Spanish fluent graduate psychology student also a trained technician with experience in

TMT administration procedures. Prior to start collecting data, the two data collectors with no experience in neuropsychological testing were trained in the administration of TMT procedures in Spanish using the video. Two native Spanish technicians with prior experience in bilingual neuropsychological testing played the roles of examiner and examinee in the video. The video was recorded in a room in the University of North Carolina Wilmington that it is specifically equipped for media productions purposes. The video was formatted in *DVD* and *Real Media Player* to assure the research collaborators access to the material. A package including the DVD, two sets of protocols, 200 copies of the sheet of demographics items and the TMT was sent by mail to two medical professionals who were charge of the testing. The collaborators were instructed to review the protocol and the TMT A–B material. Once the researchers had the DVD, they watched it at least two times. After that, both collaborators were contacted and a training session was conducted by the main researcher. Using an internet web camera, a training session for the Chilean test examiners was performed in Spanish to assure that collaborators understood correctly the procedures and they mastered the administration of Trail Making Test in Spanish. During the end of the session, the data collectors had to perform an appropriate administration of TMT procedure to each other to evaluate that they master the TMT administration. During the test administration session, the examiners read the protocol to the subject emphizing that participation is anonimous and voluntereed. After the examinee consented, the examiner completed the sheet of inclusion / exclusion criteria by asking the examinee about age, date of birth, years of education, previous accidents, and psychiatric and neurological illnesses. During the completion of the sheet of inclusion / exclusion criteria, a brief conversation took place to

determine if the subject was comfortable and agrees with the testing situation. Next, TMT was administered. The examiner wrote the completion time in seconds in each part as the protocol.

In the US, the Institutional Review Board (IRB) at UNCW required researchers to complete the human subject protections training program that it is available online. This training program was in English at the time the researchers were about to start the data collection process. For an English native speaker, the successful completion of this training program would take approximately two hours to complete it successfully. In this study only the main researcher completed this program, the Chilean data collectors did not. Reasons to explain why the collaborators in Chile did not complete this training are several. The training program was in English and the data collectors were not English native speakers. They reported having tried to read and follow the online training but with no translation available, the time to complete the training would have taken more than 6 hours with no guaranty of success. They also reported struggling to follow directions in the website to complete each part of the program. After receiving the IRB approval, completing the training program for the collaborators in Chile was not longer considered first priority and the collaborators were allowed to start collecting data. On the other hand, psychological and neuropsychological research in Chile has a brief history and many of the concepts and criteria described in the training program were considered unfamiliar and strange to the cultural context. In Chile, there are few situations in which a writing signed consent is required. In medical services, common use of writing signed consents for surgery began in 2002. The rest of writing consents for different procedures such as physical exams, registers of history of medical issues, consent for information

release, psychotherapy, and psychological evaluations are orally expressed by the client. In many other situations writing or orally expressed consent are not expected or required. Finally, human subject protection training program states that any research with humans in other cultures must maintain the same standards to protect subjects who participate in research but it also states that researching in other cultures must respect and attain cultural values and social norms of that culture.

Variables

Trail Making Test A-B performance was measured with the time that each subject uses to complete Trails A and B, in seconds. Each trail, A and B, was considered as an independent measure.

Age was measured by chronological age of each subject in years. This information was taken from the sheet of inclusion / exclusion criteria.

Education was measured by number of years of formal education completed.

RESULTS

Due to the continuous nature of all the measures in the present study, parametric statistics were employed. All statistics analyses were performed as two-tailed tests. All correlations between variables were Person's product-moment correlations. Additionally, two independent regression analyses were performed to estimate the portion of variability in the variables performance in TMT-A and TMT-B that are explained by age after statistically controlling for years of education.

Many of hypotheses were confirmed. TMT-A and age were significantly related in a positive direction, $r(163)=.61$, $p=.001$. In that, time to complete the TMT increased as age of the subjects increased. TMT-B and age were also significantly related in a

positive direction, r (163) =.54, p=.001. TMT-A and years of education were found to be significantly related in a negative direction, r (163) =-.23, p=.001. In that, people with more years of education tended to take less time to complete the test. The same relationship was found between TMT-B and years of education, r (163) =-.28, p=.001. The correlation between the time performance on the TMT-A and TMT-B was also computed. Elapsed time on the TMT-A and TMT-B were significantly related in a positive direction, r (163) =.73, p=.001.

Two independent regression analyses were performed for Trails A-B, age and years of education to partial out the effect of years of education. By using these analyses, it was possible to determine the extent in which performance in both trails of TMT can be uniquely explained for age. For TMT-A performance, regression analysis showed that after statistically controlling for years of education, age accounted for .36 of the total variability in TMT-A, and age significantly predicted times on Trails-A, β=.60, $\underline{t}$(162)=9.97, p=.001. For TMT-B performance, regression analysis showed that after statistically controlling for years of education, age accounted for .27 of the total variability in TMT-B and age significantly predicted times in Trails-B, β=.52, $\underline{t}$(162)=8.29, p=.001.

For education and time to complete TMT-A and TMT-B, regression analysis showed unexpected results. After statistically controlling for age, years of education accounted for only 0.04 of the total variability in TMT-A and education significantly predicted times in Trails-A, β=-.20, $\underline{t}$(162)=-3.32, p=.001. Also, education accounts for 0.06 of the total variability in TMT-B, and education significantly predicted times in Trails-B, β=-.26, $\underline{t}$ (162) =-4.03, p=.001.

DISCUSSION

The purpose of this research was to determine any relationship between age and performance in Trail Making Test A-B in a Chilean population. In general, the results support that age and education are related to performance in TMT A-B. Performance in TMT, measured by time in seconds, was positively related to age in this Chilean Spanish speaking sample. This finding confirms previous studies performed in other cultures (Giovagnoli et al., 1996; Tombaugh, 2004; Seo et al., 2006; Periañez et al., 2007). However, the relationship between age and time to complete Trails-A was found to be stronger than the relation between age and time for Trails-B. Previous studies in other cultures such as Periañez et al. (2007) in Spain, and Tombaugh (2004) in Canada, found the opposite pattern: the correlation between age and TMT was higher for Trails B than for Trails A. In this study, after statistically controlling for education, the variability in part A explained by age was higher than the variability for part B. In other words, it was found that as the age of subjects increased, time to finish parts A and B of TMT also increased. However, this increment in time was higher for part A than for part B. Since part B involves more complex abilities such as working memory, ability to maintain two simultaneous sequences (Crowe, 1998), cognitive flexibility (Kortte, Horner & Windham (2002) and executive functioning (Chaytor, Scmitter-Edgecombe & Burr, 2006), it would seem that there would be a higher correlation between age and Trails-B than for Trails-A. This, however, was not the case.

When comparing the mean times of Trails A-B obtained in this sample with other normative samples from Spain and United States, times to complete Trails A and B are larger for the Chilean sample. In an American normative study described by Mitrushina,

Boone and D'Elia (1999), mean times for Trails A and B were 29 and 75.2 respectively. In the Spanish sample of Perianez et al. (2007) mean times for Trails A was 31.7 and 68.1 for Trails B. Meanwhile, times in the Chilean sample were 37.3 for Trails A and 80.4 for Trails B.

One explanation for the discrepancy might be found in the characteristics of the sample in this study. When compared with the studies of Periañez et al. (2007) and Tombaugh (2004), the samples in these studies are larger, 680 and 223 subjects respectively. Periañez et al. and Tombaugh samples have larger age ranges, 16 to 80 years and 18 to 89 years respectively. They also have larger ranges for the variable years of education. In Periañez et al. study, the range of years of education varies between 2 and 23. In Tombaugh study, years of education varies between 5 and 25. Years of education in the present study ranged between 12 and 24.

A more plausible explanation for these findings addresses cultural factors and language. In this study, when TMT was administered many subjects asked questions to the examiner about the purposes of the testing during performing parts A and B of TMT. Some of them made comments related to their performance or about the possible results that the examiner would conclude. Moreover, some comments were told in a humoristic style. Some subjects appeared to struggle when changing from Trails-A to Trails-B and others appeared to enjoy the increasing complexity of the part B. In both cases, all these subjects interrupted the testing process. Information about these particular situations is not provided in others studies of TMT in normal population. Ardila (2005) states that culture affects what is relevant in a testing situation and that there are assumptions that underlie standard testing procedures. Conventions of communication are culture-

dependent in regard to how instructions are followed by examinees and how patterns of communication are performed between examiner and examinee in a testing situation. One assumption in this study was that the individuals should adjust their behavior to follow a particular order according the protocol. First, examinees should listen and to understand the purpose of the study and the time that the testing would take. Second, individuals are verbally asked to consent to their participation. Third, individuals can provide personal information. Fourth, samples and tasks of TMT A-B are presented and performed by the individuals. In this study, many individuals did not follow the expected pattern of communication that was implicit in the protocol. Some of them stopped the test performance in the middle of the timed task to ask questions from previous steps of the protocol. Others made comments. These observations about examinees' behavior appear to be related to the issued addressed by Ardila regarding cultural differences in understanding instructions of tests. American psychologists interpret given instructions in a test as a standard set of statements that must been followed in the same way with each subject. Latin American psychologists understand instructions as guidelines that can be adapted according specific situations. It appears that Chilean subjects of this sample also interpret instructions such as *do it as fast as you can* as general guidelines. As a consequence, some subjects interpreted the give instructions in a flexible manner and consequently behave differently than what examiners expected. More research is needed to examine the behavior of Chilean individuals to standard testing situations and how this issue affects performing in standard neuropsychological testing.

On the other hand, the variable years of education was found to be significantly related to time in Trails A and B. This was true even when all the subjects had 12 or more

years of education. The portion of performance in TMT predicted uniquely by years of education was higher for Trails-B than for Trails-A. For the two Trails, these portions have low practical value and it is importantly lower than the portion predicted by age in both trails. This finding confirms what other studies have found (Giovagnoli et al., 1996; Tombaugh, 2004; Seo et al., 2006; Periañez et al., 2007). However, clinicians should be cautious when using norms established in culturally different populations to interpret results in clinical subjects. Normative studies often provide norms for individuals with less than 12 years of education and for individuals with 12 or more years of education and there are no distinctions within those groups. In this study, education had an effect in performing TMT even when the subjects had at least 12 years of education. This finding might suggest that there are differences in TMT performance between individuals with more than 12 years of education. A more extensive and stratified sample is necessary to provide normative values for different groups of age and education.

Future research projects as this regard should include academic achievement of subjects when providing norms for Chilean population. There are historically recognized differences between education before college in public and private schools in Chile. Students from private high schools achieve higher scores on college admission tests than students from public schools. Only 20% of all the students of public high schools meet the academic requirements to be accepted in a Chilean University.

Another consideration for future TMT administrations in this population is the presence of differences in the alphabet. One of the data collectors reported that some subjects older than 50 years scanned the part B of TMT looking for the letter “ch”. This letter was taught as part of the Spanish alphabet in Chile until it was eliminated from the

Spanish alphabet in 1994, during the X Congreso de la Lengua Española in Madrid, Spain. The location in the alphabet of the letter "ch" was between the letter "c" and "d" (a, b, c, and ch, d). In that case, the administration procedure should change by requiring subjects to tell the alphabet during the instructions part in Trails-B. If subjects include the letter "*ch*" when telling the alphabet (for instance: a, b, c, d, *ch*, d, etc.), subjects should asked to repeat the alphabet but not include the letter ch (a, b, c, d, e, etc.), a clear statement should be included that letters from the alphabet in part B do not include the letter *ch*.

Another modification to improve the administration procedure is to translate into Spanish the words *sample*, *begin* and *end* in Trails A and B. This consideration might have more importance in case of administration of TMT in population with less than 12 years of education. In Chile, individuals who do not complete high school are less likely to be familiar with foreign languages. In regard to the requirements for TMT takers in Chilean population, data collectors agreed that no matter the educational level, almost anybody who is able to count from 1 to 25 and to tell the alphabet letters from A to L in correct order making no mistakes, can take the test.

This study is the first in examining the use of a neuropsychological test in a Chilean sample with subjects of different age. However, even in an unfamiliar standard testing situation, evidence was found that TMT is a sensitive measure of normal decline cognitive functioning in Chilean individuals.

One important limitation of this study is that the sample was not appropriately distributed across ages of the subjects. This limitation did not allow the creation of groups of ages that are necessary to provide norms for different groups of age and

education. More effort is needed to develop normative values for different groups of age. Further research would target clinical populations examining the clinical validity of TMT to differentiate between normal and abnormal performance expected for age groups.

Academic achievement was not measure in this study. Results could be different by using academic achievement instead of years of education. Given the differences in quality of education between public and private Chilean schools, achievement might be a more accurate way to measure the effect of education in performing TMT. However, no studies have been performed with standardized achievement tests in Chile.

The develop of a standard procedure, norms and clinical validity of TMT will benefit the field of clinical psychology and research in neuropsychology in Chile by providing a reliable measure of cognitive decline. In the same way that psychometric proprieties of neuropsychological tests must be explored, the influence of cultural issues related to the behavior of subjects during testing should be examined and quantified. Puente (1983) noticed it in a review about Luria-Nebraska battery that cultural aspects of behaviors and communication patterns involved in the testing situation must be observed, reported and integrated in the developing of neuropsychological testing across cultures. In summary, the development of neuropsychology in Chile, as well as in other Latin countries, needs an important effort in translating, validating, developing norms and standard testing procedures.

REFERENCES

American Psychological Association (2007). Archival Description of Clinical Neuropsychology. Retrieved August, 9, 2007 from http:www.apa.org/crsppp/neuro.html.

Ardila, A. (2005). Cultural values underlying psychometric cognitive testing. *Neuropsychology Review*, 4, 185-195.

Arnold, B.R., Montgomery, G.T., Castaneda, I. & Longoria, R. (1994). Acculturation and performance of Hispanics on selected Halstead-Reitan neuropsychological tests. *Assessment*, 3, 239-248.

Axelrod, B., Aharon-Peretz, J., Tomer, R. & Fisher, T. (2000). Creating Interpretation guidelines for the Hebrew Trail Making Test. *Applied Neuropsychology*, 3, 186-188.

Baillon, S., Muhommad, S., Marudkar, M., Suribhatla, S., Dennis, M., Spreadbury, C., Munro, D. & Lindeasy, J. (2003). Neuropsychological performance in Alzheimer's disease and vascular dementia: Comparisons in a memory clinic population. *International Journal of Geriatric Psychiatry*, 18, 602-608.

Bernal, G., Bonilla, J. & Bellido, C. (1995). Ecological validity and cultural sensitivity for outcome research: Issues for the cultural adaptation and development of psychosocial treatments with Hispanics. *Journal of Abnormal Child Psychology*, 1, 67-82.

Bonnaud, V., Audoin, V., Gaonach, D. & Gil, R. (2003). La comparabilité des formes A et B du Trail Making Test: Les effets différentiels de la Longueur du parcours et de la dispisition spatiale des cibles chez différentes populations normales et pathologiques. *Revue Européenne de Psychologie Appliquée*, 2, 139-149.

Bure-Reyes, A. , Puente, A. E., Gontier, J. J. & Sanchez, L. (2007). Neuropsychological test performance of Spanish Speakers : Is performance similar across subgroups ? Poster Session presented at the 115th Annual conference of the American Psychological Association, San Francisco, CA.

Castillo-Feliú, G.I. (2000). *Culture and customs of Chile*. Westport, CT: Greenwood Press.

Cahn-Weiner, D., Boyle, P. & Malloy, P. (2002). Test executive function predict instrumental activities of daily living in community-dwelling older individuals. *Applied Neuropsychology*, 3, 187-191.

Camara, W., Nathan, J. & Puente, A. (2000). Psychological test usage: implications in professional psychology. *Professional Psychology: research and Practice*, 2, 141-154.

Chaytor, N., Schmitter-Edgecombe, M. & Burr R. (2006). Improving the ecological validity of executive functioning assessment. *Archives of Clinical Neuropsychology*, 21, 217-227.

Cole, M. (2005). Culture in development. In Bornstein, M. H. & Lamb, M. E. (Eds.) *Developmental Science: An Advanced Textbook* (pp. 45-101). Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Corrigan, J. & Hynkeldey, N. (1987). Relationships between parts A and B pf the Trail Making Test. *Journal of Clinical Psychology*, 4, 402-409.

Crowe, S. F. (1998). The differential contribution of mental tracking, cognitive flexibility, visual search, and motor speed to performance on parts A and B of the Trail Making Test. *Journal of Clinical Psychology*, 5, 585-591.

Daniels, M., Devlin, B. & Roedor, K. (1997). Of genes and IQ. In Devlin, B., Fienberg, S.E., Resnick, D.P. & Roedor, K. (Eds.) *Intelligence, Genes, & Success* (pp. 45-70). New York, NY: Springer-Verlag.

Devlin, B., Fienberg, S.E., Resnick, D.P. & Roeder. K. (2002). Intelligence and success: Is it all in the genes? In Fish, J.M. (Ed.) *Race and Intelligence: Separating Science from Myth* (355-368). Mahwah, NJ: Lawrance Erlbaum Associates Publishers.

Egaña, M., Hosty, M. & Hobbs, B.B. (2006). Recruiting Latino youth to participate in resident camps. *Camping Magazine,* 6, 1-5.

Ehrenstein, W. H., Heister, G. & Cohen, R. (1982). Trail Making Test and visual search. *Archiv für Psychiatrie and Nervenkrankl*, 231, 333-338.

Esquivel, L. (1994). *Como agua para chocolate : novela de entregas mensuales, con recetas, amores y remedios caseros.* Barcelona, Spain: Mondadori.

Evans, J.D., Millar, S.W., Byrd, D.A. & Heaton, R. K. (2000). Cross-Cultural Applications of the Halstead-Reitan Betteries. In Fletcher-Janzen, E., Strickland, T.L. & Reynolds, C.R. (Eds.) *Handbook of Cross-Cultural Neuropsychology* (pp.287-303). New Cork, NY: Kluwer Academic/Plenum Publishers.

Fossum, B., Holmberg, H. & Reinvang, I. (1992). Spatial and symbolic factors in performance on the Trail Making Test. *Neuropsychology*, 1, 71-75.

Fuentes, C. (1992). *The buried mirror: reflections on Spain and the new world*. New York, NY: Houghton Mifflin Company.

Fuentes, C. (2005). This I believe: an A to Z of a life (Kristina Cordero, Trans.). New York, NY: Random House.

García-Marquez, G. (1969). *Cien años de soledad*. Fourteenth Edition. Buenos Aires, Argentina: Sudamericana Sociedad Anónima.

García-Marquez, G. (1982). La soledad de America Latina. Retrieved June 21, 2007, from http://nobelprize.org/nobel_prizes/literature/laureates/1982/marquez-lecture-sp.html

Gaudino, E., Geiser, M. & Squires, N. (1995). Construct validity in the Trail Making Test: What makes part B harder? *Journal of Clinical and Experimental Neuropsychology*, 17, 529-535.

Giovagnoli, A. R., Del Pesce, M., Mascheroni, S., Simoncelly, M., Laiacoma, M. & Capitani, E. (1996). Trail Making Test: normative values from 287 normal adult controls. *The Italian Journal of Neurological Sciences*, 17, 305-309.

Goldstein, G. & Beers, S. R. (2004). Intellectual and neuropsychological assessment. In Goldstein, G., Beers, S.R. & Hersen, M. (Eds.) *Comprehensive Handbook of Psychological Assessment* (pp. 101-104). Hoboken, NJ: John Wiley & Sons Inc.

Gonzalbo, P. (1997). *Género, familia y mentalidades en América Latina*. San Juan, P.R: Editorial de la Universidad de Puerto Rico.

Halperin, T. (1993). *A contemporary history of Latino America* (John C. Chasteen, Trans.) Durham, NC: Duke University Press.

Hamblin, K., Hyer, L., Harrison, W. & Carson, M. (1984). Older Alcoholics: profiles of decline. *Journal of Clinical Psychology*, 40 (6), 1510-1516.

Hester, R., Kinsella, G., Ong, B. & McGregor. (2005). Demographic influences on baseline and derived scores from the Trail Making Test in healthy older Australian adults. *The Clinical Neuropsychologist*, 19, 45-54.

Horton, A. M. & Roberts, C. (2002). Derived Trail making Test indices in a sample of marijuana abusers: demographic effects. *International Journal of Neuroscience*, 112, 429-438.

Instituto Nacional de Estadísticas. (1999*). Chile y los adultos mayores: Impacto en la sociedad del 2000.* Retrived March 26, 2007, from http://www.ine.cl/canales/chile_estadistico/estadisticas_sociales_culturales/adultosmayores/pdf/mayor2000.pdf

Instituto Nacional de Estadísticas. (2003). Censo 2002. Síntesis de resultados. Santiago, Chile: Empresa Periodística La Nación S.A.

Jensen, A.R. (1968). Biogenetic perspectives. In Deutsch, M., Katz, I. & Jensen, A.R. *Social Class,Race and Psychological Development* (pp.7-10). Washington, D.C.: Holt, Rinehart and Winston, Inc.

Kennard, B. D., Stewart, S. M., Hughes, J. L., Patel, P. G. & Emslie, G. J. (2007). Cognitions and depressive symptoms among ethnic minority adolescents. *Cultural Diversity & Ethnic Minority Psychology*, 1, 18-25.

Kortte, K. B., Horner, M. D. & Windham, W. (2002). The Trail Making Test, part B: cognitive flexibility or ability to maintain set? *Applied Neuropsychology*, 2, 106-109.

Lee, T. M. C., Cheung, C. Y. C., Chan, J. K. P. & Chan, C. C. H. (2000). Trail Making across languages. *Journal of Clinical and Experimental Neuropsychology*, 6, 772-778.

Marsiglia, F. F., Miles, B.W. & Dustman, P. (2002) Ties that protect: an Ecological perspective on Latino/a urban pre-adolescent drug use. *Journal of Ethnic & Cultural Diversity in Social Work,* 11, 191-220.

Miner, T. & Ferraro, F. R. (1998). The role of speed of processing, inhibitory mechanisms, and presentation order in Trail Making Test performance. *Brain and Cognition*, 38, 246-253.

Ministerio de Salud, Gobierno de Chile. (2003). *Primera Encuesta de Salud. Resultados*. Retrieved March 26, 2007, from http://epi.minsal.cl/epi/html/elvigia/VIGIA20.pdf.

Ministerio de Planificación, Gobierno de Chile (2003). Encuesta CASEN. Retrieved October 3, 2007, from http://www.mideplan.cl/casen/modulo_educacion.html.

Mitrushina, M. N., Boone, K. B. & D'Elia, L. (1999) *Handbook of normative data for neuropsychological testing*. New York: NY: Oxford University Press.

Moll, J., De Oliveira-Souza, R., Tovar, F., Bramati, I. E. & Andreiuolo, P. A. (2002). The cerebral correlatos of set-shifting. A fMRI study of the Trail Making Test. *Arquivos of Neuro-Psiquiatria*, 4, 900-905.

Montemayor, R. & Mendoza, H. (2004). *Right befote our eyes: latinos past, present & future*. Tempe, AZ: Scholargy Publishing.

Mynatt, P. G., Omundson, J. S., Schroeder, R.G. & Stevens, M.B. (1997). The impact of Anglo and Hispanic ethnicity, gender, position, personality and job satisfaction on turnover intentions: a path analytic investigation. *Critical Perspectives on Accounting*, 8, 657-683.

Neel, V. (2000). *Cross-Cultural neuropsychological assessment: theory and practice*. Mahwah, New Jersey: Lawrence Erlbaum Associates.

Orellana, G., Slachevsky Ch. & Silva J. R. (2006). Modelos cognitivos en la esquizofrenia: rol del cortex prefrontal. *Revista Chilena de Neuropsiquiatría*, 44 (1), 39-47.

Organización Panamericana de la Salud / Organización Mundial de la Salud. (2003). *Final Report Intra Chile. Chilean Profile* (chap. 1). Retrieved March 26, 2007, from www.who.int/entity/ageing/projects/intra/phase_one/alc_intra1_finalreport_chile_en.pdf

Perez-Arce & Puente. (1996). Neuropsychological assessment of ethnic-minorities: The case of assessing hispanics living in North America. In Sbordone, R. J. & Long. C.J. (Eds.) *Ecological Validity of Neuropsychological Testing* (pp. 283-300). Delray Beach, FL: Gr Press/St Lucie Press, Inc.

Periañez, J.A., Ríos-Lago, M., Rodríguez-Sánchez, J.M., Adrover-Roig, D., Sánchez-Cubillo, I., Crespo-Facorro, B., Quemada, J.I. & Barceló, F. (2007). Trail Making Test in traumatic brain injury, schizophrenia, and normal ageing: Sample comparisons and normative data. Archives of Clinical Neuropsychology, 22 (4), 432-447.

Puente, E. A. (1983). La batería neuropsicológica Luria-Nebraska: mito, realidad o falta de tacto". *Revista Chilena de Psicología*, 6, 35-40.

Puente, A.E. & Perez-Garcia. (2000). Psychological assessment of ethnic minorities. In Goldstein, G. & Hersen, M. (Eds.) *Handbook of psychological assessment*. Kidlington, Oxford: Elsevier Science.

Puente, A.E. & Agranovich, A.V. (2003). The cultural in Cross-Cultural neuropsychology. Goldstain, G., Beers, S.R. & Hersen, M. (Ed.) *Comprehensive Handbook of Psychological Assessmen* (pp. 321-332). New Jersey: John Wiley & Sons.

Puente, A.E. & Ardila, A. (2000). Neuropsychological assessment on Hispanics. In Fletcher-Janzen, E., Strickland, T.L. & Reynolds, C.R. (Eds.) *Handbook of Cross-Cultural Neuropsychology* (pp.87-104). New Cork, NY: Kluwer Academic/Plenum Publishers.

Quiroga, H. (1993). *Todos Los cuentos*. Signatarios acuerdo archivos (Ed). Primera edición. Madrid, Spain.

Radey, M. & Brewster, K. L. (in press). The influence of race/ethnicity on disadvantaged mothers' child care arrangements. *Early Childhood Reasearch Quarterly*

Rasmusson, X., Zonderman, A., Kawas, C. & Resnick, S. (1998). Effects of age and dementia on the Trail Making Test. *The Clinical Neuropsychologist*, 2, 169-178.

Reitan, R. M. (1955). The relation of the Trail Making Test to organic brain damage. *Journal of Consulting and Clinical Psychology*, 19, 393-394.

Reitan, R. M. (1958). Validity of the Trail Making Test as a indicador of organic brain damage. *Perceptual and Motors Skills*, 8, 271-276.

Reitan, R. M. (1992). *Trail Making Test. Manual for administration and scoring*. South Tucson, Arizona: Reitan Neuropsychology Laboratory.

Reitan, R. & Wolfson, D. (2000). The neuropsychological similarities of mild and more severe head injury. *Archives of Clinical Neuropsychology*, 5, 433-442.

Roberts, C. & Horton, A. (2001). Using the Trail Making Test to screen for cognitive impairment in a drug abuse tratment sample. *International Journal of Neuroscience*, 109, 273-280.

Roberts, C. & Horton, A. (2003). Trail Making Test cut-offs for malingering among cocaine, heroin, and alcohol abusers. *International Journal of Neuroscience*, 113, 223-231.

Rodríguez, N., Mira, C. B., Myers, H., Morris, J. K & Cardoza, D. (2003). Family or friends: who plays a greater supportative role for Latino collage students? *Cultural Diversity and Ethnic Minority Psychology*, 3, 236-250.

Ruef, A.M., Linz, B.T. & Schlenger, W. T. (2000). Hispanic ethnicity and risk for combat-related posttraumatic stress disorder. *Cultural Diversity & Ethnic Minority Psychology*, 3, 235-251.

Sanchez, G. (2002). "Y tú qué? Latino history in the new millennium". In Suarez-Orozco, M. M. & Paez, M. M. (Eds.), *Latinos* (pp. 45-58). Los Angeles, CA: University of California.

Seo, H. S., Lee, D. Y., Kim, K. W., Lee, J. H., Jhoo, J. H., Youn, J. C., Choo, I. L., Ha, J. & Woo, J. I. (2006). A normative study of the Trail Making Test in Korean Elders. *Internacional Journal of Geriatric Psychiatry*, 21, 844-852.

Servat, M., Lehmann, Y., Harare, K., Fajardo, L. & Eva, P. (2005). Evaluación neuropsicológica en esquizofrenia. *Revista Chilena de Neuropsiquiatría*, 3, 210-216.

Slachevsky, A., Pérez, C., Silva, J., Orellana, G., Prenafeta, M. L., Alegría, P. & Peña, M. (2005). Cortex prefrontal y trastornos del comportamiento: modelos explicativos y métodos de evaluación. *Revista Chilena de Neuropsiquiatría*, 2, 109-121.

Soukup, V., Ingram, F., Grady, J. & Schiess, M. (1998). Trail Making Test: Issues in normative data selection. *Applied Neuropsychology*, 5, 65-73.

Stanczak, D.E., Lynch, M.D., McNeil, C.K. & Brown, B. (1998). The expanded Trail Making Test: rationale, development, and psychometric propieties. *Archives of Clinical Neurpsychology*, 5, 473-487.

Stanczak, D. E., Stanczak, E. M. & Awadalla, A. W. (2001). Development and initial validation of the Arabic version of the expanded Trail Making Test: Implication for cross-cultural assessment. *Archives of Clinical Neuropsychology*, 16, 141-149.

Strandish, P. & Bell, S.M. (2004). *Culture and customs of Mexico*. Westport, CT: Greenwood Press.

Stringer, A.Y. & Cooley, E.L. (2002). Neuropsychology: a twenty-century science. In Stringer, A.Y., Cooley, E.L. & Christiensen, A.L. (Eds.) *Pathways to prominence in Neuropsychology* (pp. 3-26). New York, NY: Psychology Press.

Suarez-Orozco, M. M. & Paez, M. M. (2002). The research agenda. In Suarez-Orozco, M. M. & Paez, M. M. (Eds.) *Latinos* (pp. 1-37). Los Angeles, CA: University of California.

Tombaugh, T. N. (2004). Trail making A and B: Normative data stratified by age and education. *Archives of Clinical Neuropsychology*, 19 (2), 203-214.

Triandis, H.C., Marín, G., Lisansky, J. & Betancourt, H. (1984). Simpatía as a cultural script for Hispanics. *Journal of Personality and Social Psychology*. 47(6), 1363-1375.

Triandis, H.C., Leung, K, Villareal, M.J. & Clack, F.L. (1985). Allocentric versus idiocentric tendencies: Convergent and discriminant validation. *Journal of Research in Personality*, 4, 395-415.

Universidad Católica de Chile. (2008). Descripción de cursos escuela de psicologia. Retrieved March 23, 2008, from Universidad Católica de Chile, escuela de psicología Web site: http://www.puc.cl/dara/registro/catalogo/c_psicologia.html

Wahlin, T. B. R., Bäckman, L., Wahlin, Å. & Winblad, W. (1996). Trail Making Test performance in a community-based sample of healthy very old adults: effects of age on completion time, but not on accuracy. *Archives of Gerontology and Geriatrics*, 22, 87-102.

Waldmann, B. W., Dickson, A. L., Monahan, M. C. & Kaselskis, R. (1992). The relationship between intellectual ability and adult performance on the Trail Making Test and the Symbol Digit Modalities Test. *Journal of Clinical Psychology*, 3, 360-363.

Williams, R.L. & Guerrieri, K.G. (1999). *Culture and customs of Colombia*. Westport, CT: Greenwood Press.

Wong, T.M., Strickland, T. L., Fletcher-Janzen, E. Ardila, A. & Reynolds, C. R. (2000). Theoretical and practical issues in the neuropsychological assessment and treatment of culturally dissimilar patients. In Fletcher-Janzen, E., Strickland, T.L. & Reynolds, C.R. (Eds.) *Handbook of Cross-Cultural Neuropsychology* (pp. 3-18). Dordrecht, Netherlands: Kluwer Academic Publishers.

Zakzanis, K. K., Mraz, R. & Graham, S. (2005). An fMRI study of the Trail Making Test. *Neuropsychologia*, 43, 1878-1886.

APPENDIX

Appendix A. Institutional Review Board Approval.

Human Subjects Protocol Form
ised November 2006

RECEIVED
JUN 28 2007
SPONSORED PROGRAMS

ORIGINAL

For IRB Use Only
Protocol #: 2007-565
Approval Date: 6/28/07
Expiration Date: NA

University of North Carolina Wilmington
Institutional Review Board
Human Subjects Protocol Form

RT A: GENERAL PROJECT INFORMATION

Title of Project (use same title as grant proposal, if applicable):

The relationship between age and performance on the Trail Making Test in Chilean population

Project Type:

☒ **Research** **Proposal #** _____ ***Attach a copy of the proposal**
☐ **Funded** **Account #** _____ ☐ **Under Review**
Funding Agency*: ☐ DOE ☐ NIH ☐ Other _____
☒ **Student Research** (Check if student is primary researcher and faculty is providing oversight only. If checked, provide student name at #7 below.)
☐ **Teaching** **Course Number:** _____

Proposed Start Date: June/2007 **Proposed End Date:** August, 2007

IRB Use ONLY:
Type of IRB Review: ☐ **Full Review** ☐ **Expedited #**_____ ☒ **Exempt**
Results: ☒ **Approved** ☐ **Approved Pending Revisions** ☐ **Deferred** ☐ **Disapproved**

C Gauthier — **Signature of the IRB Chairperson**
6/28/07 — **Date**

☐ **If necessary, revisions/clarification received:** _____
Results: ☐ **Approved** ☐ **Approved Pending Revisions** ☐ **Disapproved**

_____ **Signature of the IRB Chairperson**
_____ **Date**

Principal Investigator: (If student research, PI should be Faculty Advisor)

Name: Antonio Puente	**Date of IRB Training:** 05/26/2003
Title: Professor of Psychology	**Phone:**910-962 3812
Department: Psychology	**Fax:**910-9627010
Campus Post Box #:	**E-mail:**puente@uncw.edu
Building OR Mailing Address (if off-campus): Social and Behavioral Sciences	

A copy of this page, signed by the IRB Chair, serves as formal notice of the approval of, disapproval of, or the need to revise this protocol. The protocol and consent form or assent/permission form are effective for ONE year from the date of approval. Any changes to this study, no matter how small, are subject to approval by the IRB. UNCW policy requires the submission of a Closure Report upon completion of a study. ***Please note: If this study will continue beyond the expiration date specified upon approval, it is the responsibility of the Principal Investigator to file an Annual Renewal Form prior to the expiration date.***

****IRB forms are available at** http://www.uncw.edu/orssp/conduct-human-forms.html.**

Appendix B. Human Participant Protection Education for Researcher

Completion Certificate

This is to certify that
Jorge Gontier
has completed the **Human Participants Protection Education for Research Teams** online course, sponsored by the National Institutes of Health (NIH), on 06/24/2006.

This course included the following:

- key historical events and current issues that impact guidelines and legislation on human participant protection in research.
- ethical principles and guidelines that should assist in resolving the ethical issues inherent in the conduct of research with human participants.
- the use of key ethical principles and federal regulations to protect human participants at various stages in the research process.
- a description of guidelines for the protection of special populations in research.
- a definition of informed consent and components necessary for a valid consent.
- a description of the role of the IRB in the research process.
- the roles, responsibilities, and interactions of federal agencies, institutions, and researchers in conducting research with human participants.

National Institutes of Health

http://www.nih.gov

Appendix C. Protocol of Administration.

Neuropsychological Test Performance in Trail Making Test in Chilean Spanish Speakers Population

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PROTOCOLO

El propósito de este estudio es describir el desempeño neuropsicológico en el Trail Making Test de población chilena hispanoparlante a través de diferentes grupos de edad.

El estudio consiste en la administración del Test Trail Making Test o Test de Trazos Rápidos con una duración aproximada de 7 minutos

Dos cosas importantes acerca de su participación en este estudio son las siguientes:

1. **Primero, su participación es completamente voluntaria.**
2. **Segundo, toda la información obtenida a través de este estudio es anónima.**

ADMINISTRACION DE LA PRUEBA

Orden que se debe seguir:
1- Registro de antecedentes del sujeto
2- Administración de la prueba

1- Registro de antecedentes

- Use la Ficha de registro de antecedentes para consignar edad, fecha de nacimiento, años de escolaridad completos, antecedentes de infarto cerebral, accidente vascular, accidente de transito, atropellos, traumatismo encéfalo craneano (TEC), historia de patología psiquiátrica o patología psiquiátrica actual y medicamentos neurológicos o psiquiátricos actualmente en uso.

2- Test de conexiones rápidas (Trail-making test)

- Coloque el ejemplo de la parte A hacia arriba, enfrente del participante. Déle un lápiz bien afilado al participante y diga: "Mire los números que hay en esta hoja (muéstreselos). Empiece en el 1 y trace una línea del 1 al 2 (señale del 1 al 2), del 2 al 3 (señale), del 3 al 4 (señale) y siga de esta manera hasta que llegue al final (señale el círculo que dice "END"). Trace las líneas lo más rápido que pueda. Listo? Empiece!"

- Si el participante termina el ejemplo correctamente y da muestras que sabe lo que debe hacer diga: "Muy bien. Hagamos el siguiente" (déle la vuelta al papel y pídale al participante que complete la parte A de la prueba).

- Si el participante comete un error en el ejemplo de la parte A muéstreselo y explíqueselo. Las siguiente explicaciones sirven como ejemplo:
  1- Empezó con el círculo incorrecto. Aquí es donde debe comenzar (muéstrele el número 1).
  2- Omitió este círculo (señale el círculo omitido). Debe de ir del número 1 (señale el 1) al 2 (señale el 2), del 2 al 3 (señales el 3), y seguir de esta manera hasta llegar al último círculo (señálelo).

- Muéstrele la parte A la participante y diga: "En esta página hay números del 1al 25. Hágalo en la misma forma. Empiece con el número 1 (señálelo) y trace una línea del 1 al 2 (señale), del 2 al 3 (señale), del 3 al 4 (señale), y siga de esta manera, en orden hasta que llegue al final (señale el final). Recuerde que debe trabajar lo más rápidamente posible. Listo? Empiece!"

- Empiece a medir el tiempo con el cronómetro tan pronto como las instrucciones para empezar hayan sido dadas. El examinador deber corregir inmediatamente cualquier error que el participante cometa. Cuando cometa un error indíqueselo inmediatamente y pídale que prosiga desde donde el error ocurrió (NO PARE EL CRONOMETRO).

- Parte B- Coloque la hoja de la parte B con el ejemplo hacia arriba. Señale el ejemplo y diga: “En esta hoja hay números y letras. Empiece con el número 1 (señale el 1) y trace una línea del 1 a la letra “A” (señale la A), de la A al 2 (señale el 2), del 2 a la letra “B” (señale la B), de la B al 3 (señale el 3), del 3 a la letra “C” (señale la C), y siga de esta manera en orden hasta llegar al final (señale el final) Recuerde que primero tiene un número y después una letra… Trace las líneas lo más rápido que pueda. Listo? Empiece!”

- Muéstrele al participante la parte B (diga las mismas instrucciones que en el ejemplo). Continúe la prueba de la misma manera que en la parte A.

Appendix D. Sheet of inclusion / exclusion criteria

Ficha de Antecedentes #_____

Fecha_____/_____/_____

Fecha de nacimiento: _____/_____/_____.

Edad:_____años.

Examinador: _____.

Años de escolaridad completados:_____(Ej: enseñanza media completa : 12 años. Sumar años **completos** de **estudios universitarios o técnicos formales**. No incluir los años correspondientes a tesis, seminario y/o práctica profesional o internado.

Mórbidos:

Infarto cerebral. Año: _____.

Accidente vascular. Año: _____.

Accidente de tránsito. Año: _____.

Atropello. Año : _____.

TEC. Año : _____.

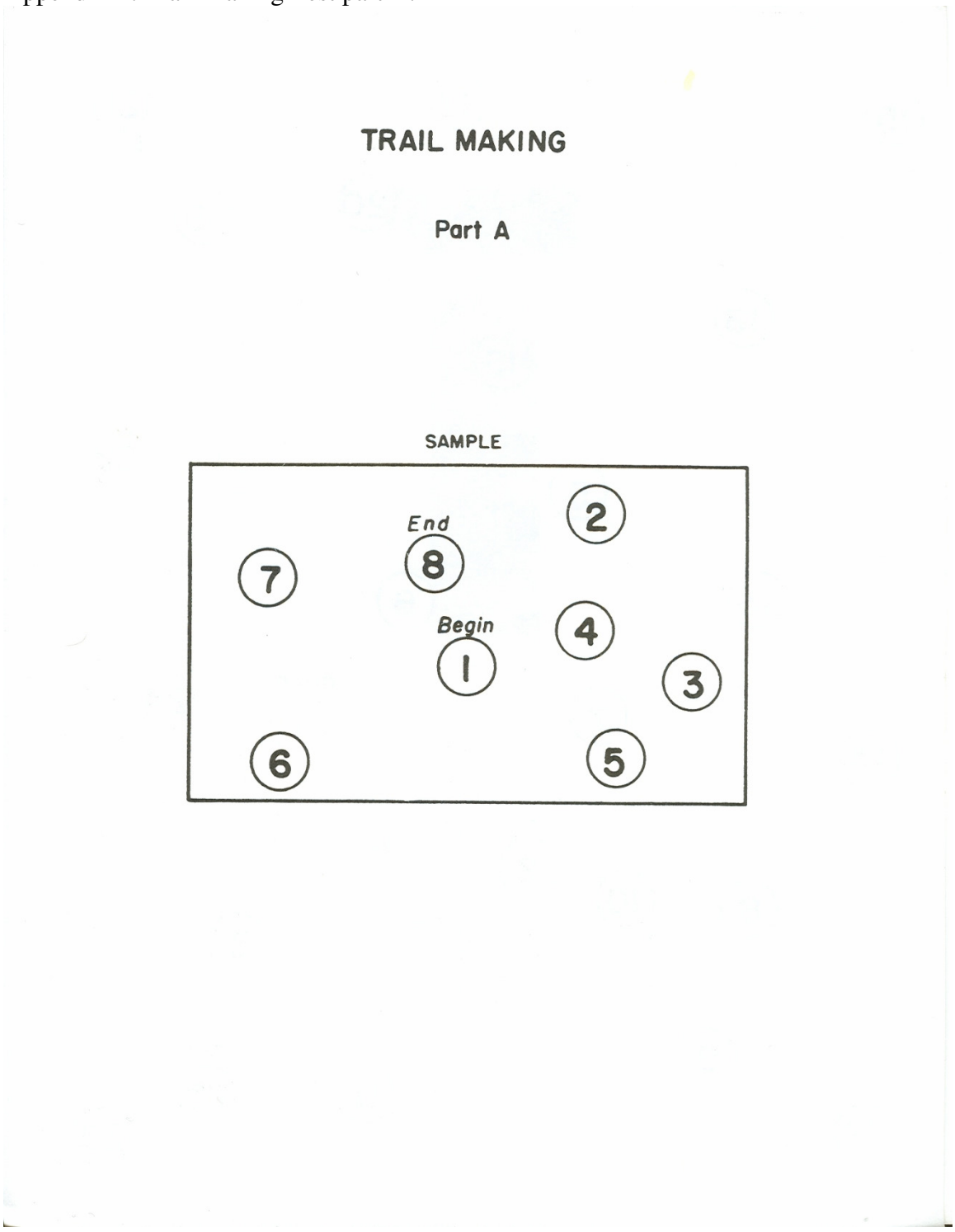
Hria. patología Psiquiátrica. Diagnóstico: _____. Año: _____

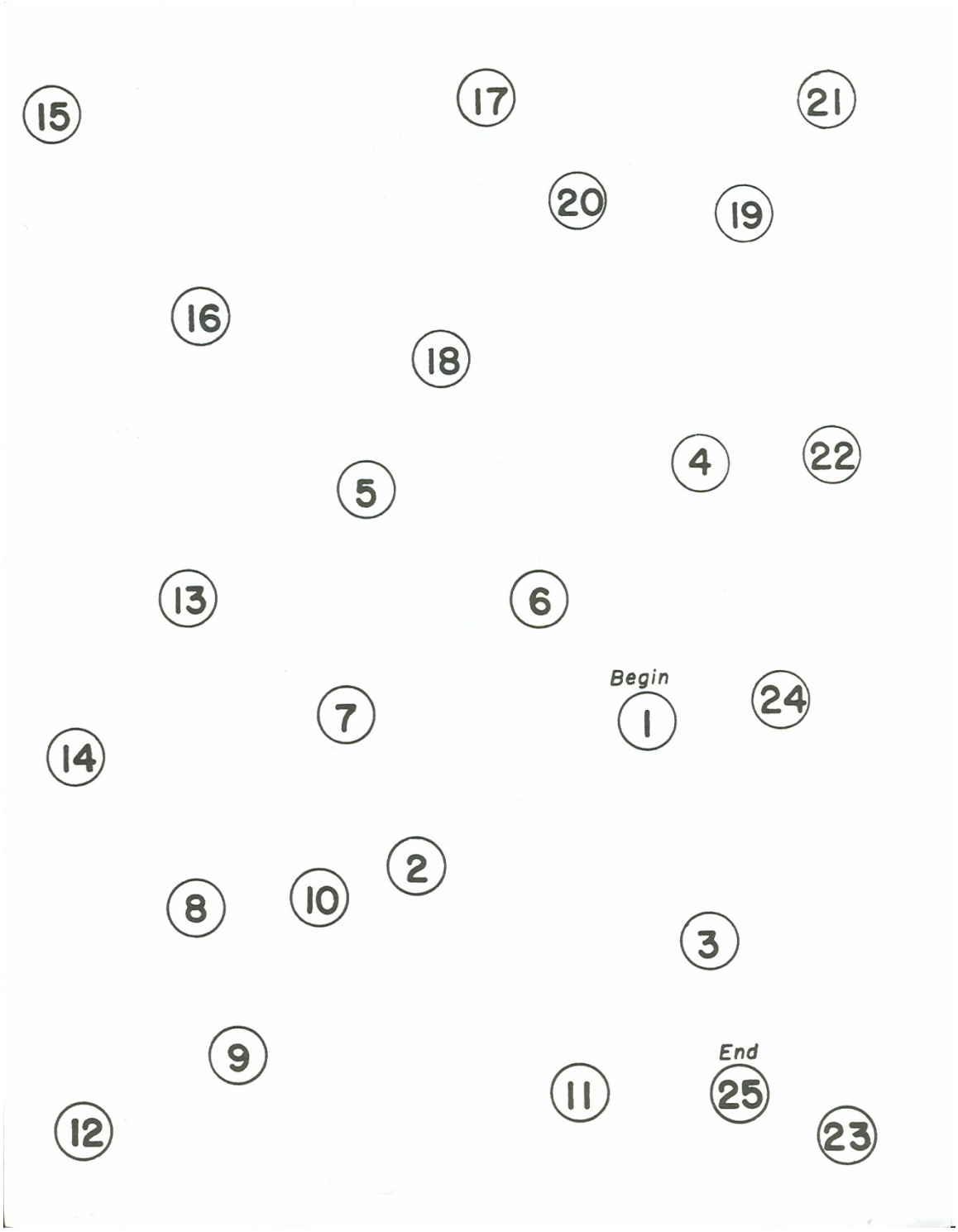
Patología Psiquiátrica actual. Diagnóstico: _____. Año:_____

Medicamentos neurológicos o psiquiátricos en uso:_____

_____

Appendix E. Trail Making Test part A.

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Begin
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14
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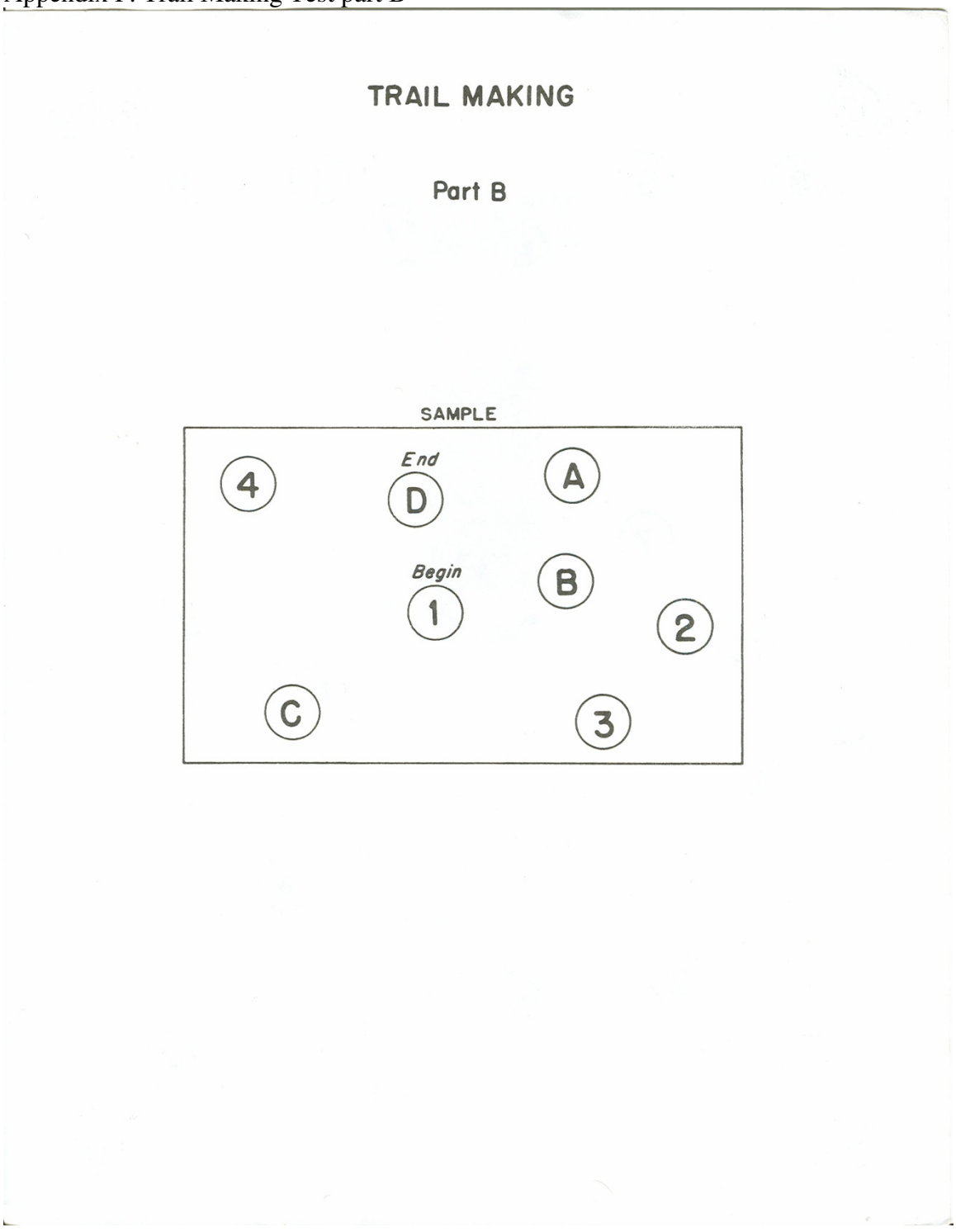
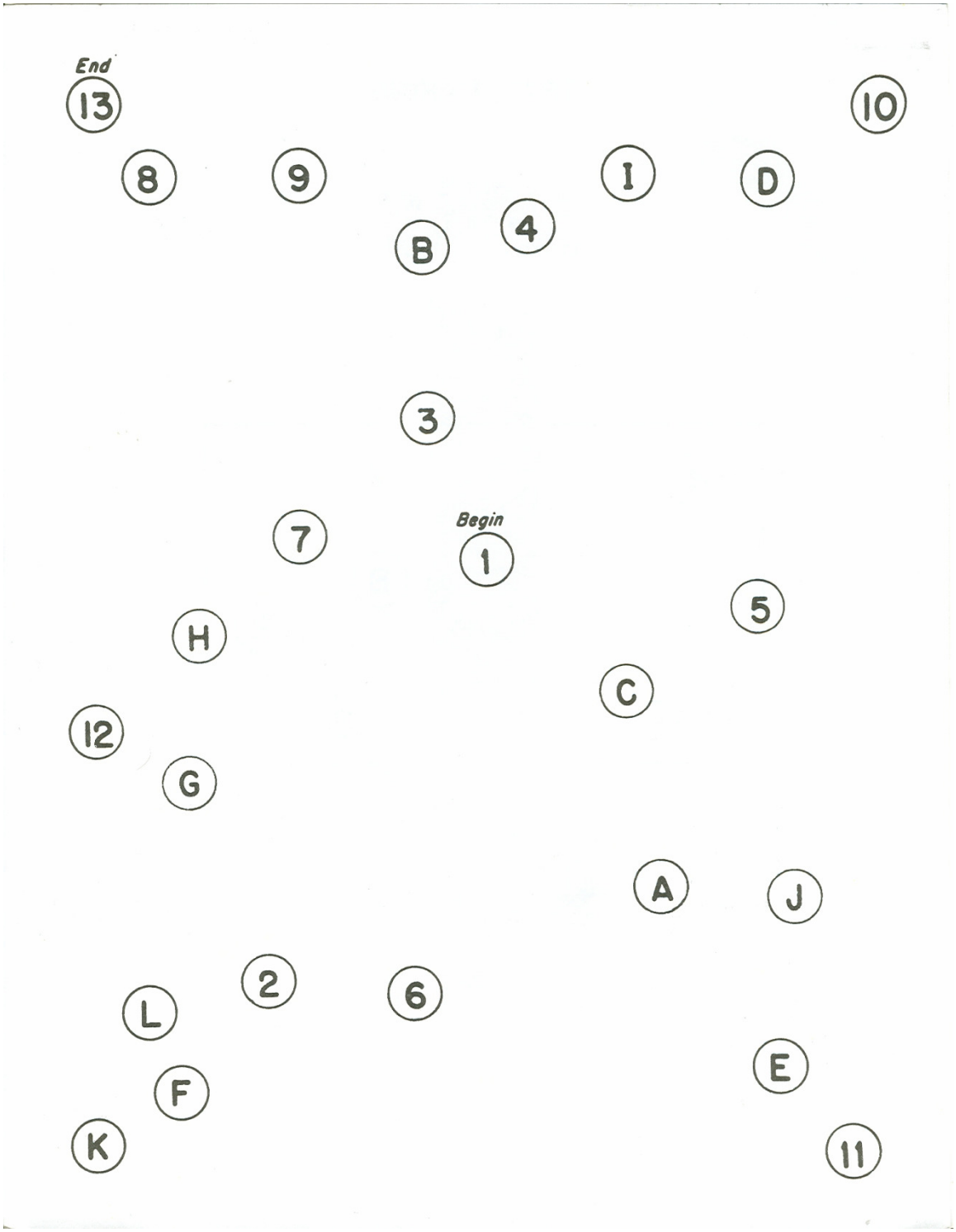
10
3
9
End
11
25
12
23

Appendix F. Trail Making Test part B




End
13
10
8
9
1
D
4
B
3
7
Begin
1
5
H
C
12
G
A
J
2
6
L
E
F
K
11

Appendix G. Video in Spanish of TMT administration sample.