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Psychometric Differences in Motor Functioning

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PSYCHOMETRIC DIFFERENCES IN MOTOR FUNCTIONING

by

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ABSTRACT

Clinical experience has shown that patients performing the Grooved Pegboard Test have difficulty maintaining the manualized right-to-left placement strategy with their left hand. This study sought to investigate possible differences in placement time on the Grooved Pegboard task between participants using the standardized left hand approach and a reversed manualized left hand placement strategy (i.e., left-to-right). The participants included 63 male and female undergraduate volunteers between the ages of 18 and 25 years. All participants had no history of neurologic disease/trauma, or conditions that would affect motor functioning of the right and left upper extremities. Data were analyzed using a 3-way mixed-design ANOVA. Results revealed a significant main effects for gender ($F(1, 59) = 5.215$, $p = .026$) and handedness ($F(1, 59) = 6.362$, $p = .014$). Of primary interest was the main effect for placement direction, which was not significant, $F(1, 59) = .120$, $p = .731$. No significant interaction was observed (all $p > .40$). Recommendations for the use of this test in applied neuropsychological settings are offered.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my thesis chair, Dr. Ed Fouty, his support and wisdom made this thesis possible. I would also like to thank Dr. Steven Berman and Dr. Leslee Damato-Kubiet for serving on my thesis committee. I would also like to extend my thanks to all of the professors that have helped contribute to my interest in the field of Psychology.

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INTRODUCTION

Psychology may be a relatively new science, but the concepts behind Psychological testing date back centuries. (Anastasi, 1993). Evidence indicates that variations of psychological measurement can be traced back to Ancient Greece. According to Doyle (1974), approximately 2500 years ago, testing was used primarily for educational and military purposes. Achievement tests were used to assess mathematical and reading abilities, music, astronomy, and medical practice. Early aptitude tests also covered general reasoning and learning ability, as well as identifying certain preferred personality traits. The tests utilized for military purposes were designed to test the physical, mental, and personality traits that were deemed important for military competence. These tests also appeared to have basic standardized procedures. There is also mention in early literature of common problems such as cheating and examiner bias (Anastasi, 1993). According to Anastasi (1993), another example of early testing is provided by the system of civil service examinations, commonly utilized by the Chinese empire as many as 2,000 years ago (Bowman, 1989; DuBois, 1970). Biologist, Francis Galton, strongly influenced the testing movement. In his study of human heredity, Galton understood that he needed to measure the characteristics of different individuals. This became an effective method for understanding the amount of resemblance between family members. Galton gathered a vast amount of data on children and adults, and is credited for creating the majority of his tests. His tests encompassed measures of visual, auditory, tactile, and kinesthetic discrimination, muscle strength, coordination, reaction time, and other related abilities. Galton believed sensory discrimination tests could serve as a scale of a person's intelligence. A major contribution was Galton's development of statistical methods. Adapting several techniques from mathematicians, he was able to simplify them, to enable their use by investigators that lacked mathematical competency, as a way to analyze test results. These statistical methods were carried on by a few of his students, such as Karl Pearson, and James Mckeen Cattell. Cattell's tests were based off of Galton's sensorimotor instruments but were extended to include tests for simple motor processes, such as memory. These early tests failed to measure what they were supposed to measure and the data lacked consistency (Anastasi, 1993).

Today, psychological assessments are used to measure a defined concept. Different definitions of the same concept can lead to different approaches of measurement. When an objective concept is tested, the results focus on the extent and quality of an individual achievement. These data can be utilized to discover an existing impairment, the severity of the impairment, and how it is effecting functioning and behavior. (Rapaport, Merton, & Schafer, 1946). Objective assessment attempts to measure an operationally defined concept. An operationally defined concept is a concept that can be observed and measured. (Shaughnessy, Zechmeister, & Zechmeister, 2012). The Wechsler Adult Intelligence Scales (Wechsler, 2008) are common examples of objective assessment. The Wechsler scales consist of two parts, Verbal and Performance. Because subtests of the Wechsler demand little verbal ability, this test is effective for studying individuals with learning disabilities and limited education. (Eggen & Kauchak, 2007). Projective content, however, focuses on different spontaneous thought processes. How much a subject deviates from the norm becomes the basis of diagnostic criterion. One common test that uses projective measures is the Thematic Apperception Test (TAT; Murray, 1973). Patients are shown a series of ambiguous pictures and are asked to tell a story, based off of their own subjective perceptions, of what is occurring in the pictures. (Kothari, 2004).

A tests quality is determined by its validity and reliability (Thurstone, 1931). The validity of a test refers to the extent to which an instrument measures what it is supposed to measure. Face validity, simply refers to how valid the test looks in appearance. However, the content of the test containing face validity might not be a valid assessment (Goodwin, 2010). Content validity is the extent to how relevant a measuring instrument is to the population that it wishes to assess. Criterion validity refers to the ability to predict the results of an assessment, or predict an outcome of some current condition. Criterion is a broad term to refer to predictive validity and concurrent validity. Predictive validity refers to the usefulness of a test to predict future performance. Concurrent validity refers to the usefulness of a test in closely relating to other measures of known validity. Construct validity refers to how well a measurement, or measurement instrument, measures the construct that is being investigated (Kothari, 2004). Internal validity is the degree to which differences in performance can be unequivocally credited to an independent variable's effects, as opposed to an effect of another unrelated variable. It is damaging to a test's internal validity if an unknown variable is affecting the results. Therefore, it becomes imperative to control for any variables that might influence the data. (Shaughnessy, Zechmeister, & Zechmeister, 2012).

In any type of measurement, it is essential that the test be reliable. A test's reliability refers to the consistency of its measurement; i.e., it measures the same thing each time. Interrater reliability refers to if two or more observers can observe the same thing (Kothari, 2004). Split-half reliability involves taking the items of a particular subtest, divide the items in half, and correlating the two halves. If the test is a reliable measure, then the correlation of the test should be high. Test-retest reliability refers to the relationship between two separate administrations of the test (Goodwin, 2010).

When dealing with psychometrics it is imperative that the data are measured in the same way each time. For collecting norms for a new standardized test, each subject is given the same set of instructions after periods of giving tests and receiving data. Inferences can be made off of future data in reference to the norms of a given population. Norm referenced testing is a standardized design. It is used to compare a test taker's scores to the results of a reference group that have taken an identical test. Using this design, a test publisher gathers normative data through field trials of the test with a representative sample to norm a test. Results are used to provide a reference group for other data. The purpose of criterion-referenced tests is to measure a level of a skill, and how it corresponds to a specific set of performance standards. These tests often consist of more focused subjects than norm referenced tests. In criterion-referenced tests, test takers scores correspond to a performance level, such as basic or advanced proficiency. Standards-based testing utilizes norm-referenced testing and criterion-referenced testing simultaneously by incorporating features from both designs. The data are normed to a reference group and aligned to a set of performance standards (Zucker, 2003). Test scores have no meaning unless they can be compared with the scores obtained by distinct samples of people who share the same basic demographic traits of those being tested. It is essential that tests have standardized administration and scoring procedures so that everyone takes a test under the same conditions.

In a study where multiple trials occur one after the other, performance may improve or decline due to effects that occur from taking the test. Progressive effects refer to effects that progressively change trial to trial. The two different types of progressive effects are practice effects and fatigue effects. Practice effects occur when a participant's performance improves after the first trial. Fatigue effects occur when a participant's performance declines from trial to trial. Counterbalancing (i.e., using more than one sequence) is often used to control for these effects (Goodwin, 2010).

Psychological assessments exist in essentially every area in the field of psychology; e.g., School Psychology, Clinical Psychology, and Neuropsychology (Camara, Nathan, & Puente, 2000). Adaptive functional behavior assessments, aphasia assessments, behavioral medicine or rehabilitation assessments, developmental assessments, intellectual assessments and achievement tests, neurobehavioral clinical examinations, personality-psychopathology assessments, and neuropsychological assessments are all common instruments used by professionals (Camara et al., 2000). According to Sattler (1992), adaptive-functional behavior assessments measure the degree of individual functioning and how well an individual can successfully meet culture enforced personal and social responsibility. Behavior scales, behavioral checklists, and direct observation are the most common instruments used to gage independent functioning skills, physiological development, linguistic development, and academic proficiencies (Camara et al., 2000). Agranowitz, McKeown, and Nielson (1964) stated that the purpose of assessments for aphasia (the loss or impairment of language abilities, typically caused by trauma to the brain) is to uncover the areas of language that are affected, and try to determine a starting point for retraining linguistic abilities. Most of these assessments focus on what a patient can do, as opposed to what they cannot do. These assessments typically include assessments for the following: perception and recognition of language, motor functions of language (speaking and reading), ability to use symbols for reading, writing, and mathematics, and expression and conception of language, both oral and written. Assessments of behavioral medicine or rehabilitation, according to Schneiderman and Tapp (1985) seek to evaluate the patient's current status. These assessments account for the patient's past and his or her larger social structure and environment. This includes their psychosocial and physical stressors. Objective instruments are used to evaluate the patient's observable behaviors and assess biophysical processes, as well as the patient's subjective feelings (Camara et al., 2000). Developmental assessments, as defined by Johnson and Goldman (1990) are typically utilized to obtain clinical information about a child for the purpose of answering questions related to development, and if needed, create an appropriate intervention strategy. These assessments may entail attaining a comprehensive index of development or securing a detailed assessment of the child's different levels of functioning (motor development, language development, social development, etc.) (Camara et al., 1990). Sattler (1992) described intellectual assessments as ways to evaluate the knowledge learned in a variety of life experiences. With children, the main objectives of intellectual assessments are to determine the nature of the child's learning or behavior problems. These evaluations are based on norms from similar aged individuals. Aptitude Tests are standardized tests designed to predict the potential for future learning and measure general skills developed over long periods of time. Personality-psychopathology assessments, according to Knoff (1986), are usually conducted when an individual's behavior problems, emotional difficulties, social interactions, or ability to function independently become so notably disruptive that mental health involvement becomes imperative. Personality assessments help to identify and characterize an individual's social-emotional development, or self-concept formation (Camara et al., 2000). Neurobehavioral clinical examinations are used to evaluate the degree to which an individual's social and emotional functioning are affected by the brain and its processes. These assessments are designed to assess the degenerative infirmity in the brain following cerebral insult by assessing daily problem solving and reasoning abilities, and how they may be influenced by brain injury (Camara et al., 2000).

Neuropsychological assessments utilize the same methods, assumptions, and theories that other psychological assessments rely upon. The purpose of a neuropsychological evaluation is to assess higher cerebral function. These assessments provide information necessary for diagnosis, clinical management, and research (Lezak, Howieson, Bigler, & Tranel, 2012). Diagnostic applications of neuropsychological evaluations involve identifying neuroanatomical localization of cerebral dysfunction as an adjunct to neuroimaging studies, and ascertaining cognitive patterns associated with different neurological disorders. Evaluations are becoming more common in clinical management, as precise information concerning a patient's cognitive strengths and weaknesses is essential for medical management and planning an effective rehabilitation program (Kelly & Doty, 2005).

There are numerous psychometric instruments designed to assess cognitive abilities and other behaviors (Brooks, Sherman, & Strauss, 2009). Within the realm of neuropsychological assessment, tests are combined and administered as a battery. There are two different battery approaches to a neuropsychological assessment; a fixed battery approach and an individualized battery approach. In a fixed battery approach an unchanging set of tests are administered to each client. In contrast, an individualized approach has the flexibility of adding or removing tests to better address and assess the presenting problem (Conway & Crosson, 2000).

Psychometric instruments used by neuropsychologists are standardized and normed for the accurate assessment of an individual's current level of cognitive and emotional functioning. Multiple domains of cognitive functioning are assessed and include: orientation (person, place, time, and situation), general level of functioning (i.e., intelligence), academic achievement (primarily in children only), visuospatial ability, visuoperceputal functioning, visuoconstructional ability, language functioning, attention, concentration, memory functioning (verbal and visual), executive functioning (planning, prioritizing, sequencing, abstraction, and conceptualization), and motor/sensory status (fine motor speed and dexterity, right-left orientation, tactile functioning, praxis [ideomotor, ideational, gait], tremor, drift, anosmia, and visual acuity). Emotional status is examined in order to rule out a functional component to any positive neurologic findings. This assessment involves evaluating personality and/or psychological symptom distress (Lezak, Howieson, Bigler, & Tranel, 2012; Miller, Lovler, & McIntire, 2013).

There are two types of dexterity within the domain of motor functioning, gross and fine. Gross dexterity is the general movements of fingers, hands, and arms. Fine motor dexterity is the skill necessary to coordinate finger movements in order to perform complex manipulation (Chen, Shih, & Chi, 2010). Motor speed is universally considered the benchmark for detecting deficits in the motor domain during neuropsychological assessments. Motor ability is typically measured in one of two ways, fine motor speed or fine motor speed and dexterity. Strauss, Sherman, and Spreen (2006) reported that one of the most widely used psychometric instruments for assessing fine motor speed is the Finger Tapping Test (Halstead, 1947). These authors indicated that fine motor speed and dexterity is most often measured with the Purdue Pegboard (Tiffin, 1968) or the Grooved Pegboard Test (Klove, 1963; Lafayette Instruments, 1989).

The Grooved Pegboard is a superior measure of fine motor speed and dexterity because the pegs must be rotated in order to insert them into their slots (Brydon & Roy, 2004). The manualized administration of the Grooved Pegboard Test requires strict adherence to how the pegs are placed. For the right hand, pegs are placed from left to right; pegs are placed from right to left for the left hand. According to Strauss, Sherman, and Spreen (2006), there is evidence that a number of different medical conditions can affect peg placement on the Grooved Pegboard Test. These conditions can include stroke, tumor (Haaland & Delaney, 1981), autism (Hardan, Kilpatrick, & Keshavan, 2003), nonverbal learning disabilities (Harnadek & Rourke, 1994),Williams syndrome (MacDonald & Roy, 1988), bipolar disorder (Wilder-Willis, Sax, Rosenberg, Fleck, Shear, & Strakowski, 2001), heart disease (Putzke, Williams, Daniel, Foley, Kirklin, & Boll, 2000), toxic exposure (Bleecker, Lindgren, & Ford, 1997; Mathiesen, Ellingsen, & Kjuus, 1999), substance abuse (withdrawn cocaine users) (Smelson, Roy, Santan, & Engelhart, 1999), and HIV infection (Carey, Woods, Rippeth, Gonzalez, Moore, Marcotte, Grant, Heaton, & HNRC Group, 2004). It has been noted that there may be reasons other than neurological impairment for an individual to perform poorly on the Grooved Pegboard. Deficits in tactile acuity can cause an individual to have significant difficulty with this test. (Tremblay, Wong, Sanderson, & Cote, 2002). Depression has also been negatively correlated with performance. (Hinkin, van Gorp, Satz, Weisman, Thommes, & Buckingham, 1992).

Clinical experience has demonstrated that examinees often have difficulty following the right-to-left placement requirements for the left hand. Frequently examinees revert to a left-to-right placement strategy after completing the first (and subsequent) row of the test. When this occurs the examiner must point to the correct placement of the next peg and remind the examinee of the correct placement direction with the command, “place the next peg here and place the pegs right-to-left”. This correction results in loss of time on this speed-dependent task. The tendency to revert to a left-to-right placement strategy has not been addressed in the scientific literature. Under this assumption it is likely that this motor test is confounded with memory functioning (the examinee must recall and attend to the novel task instructions while attempting to place the pegs as quickly as they can). If the variable of memory is removed, the test will be a more reliable and valid measure of fine motor speed and dexterity. Strauss, Sherman, and Spreen (2006) reported that a practice effect exists on the Grooved Pegboard Test, usually after the first trial when multiple trials are given in one session (Schmidt, Oliveira, & Rocha Abreu-Villaca, 2000). Past research from Bornstein, 1985; Ruff & Parker, 1993; Schmidt, Oliveira, & Rocha Abreu-Villaca, 2000, has found that females typically perform faster than males. (Strauss et al., 2006).

Statement of Significance

This study seeks to determine if peg placement direction influences performance on a standardized test of fine motor speed and dexterity. Currently, the manualized right-to-left placement strategy results in the frequent need to interrupt the examinee (when they switch to a left-to-right placement approach) in order to remind them of the proper placement direction. This can result in an increased time to complete the test due to the time it takes for the examiner to correct the examinee, as well as the time it takes for the examinee to correct himself or herself. All these added factors can lead to a lower performance score. A lower score may place the examinee's performance in an artificially lowered status classification due to the extraneous effect of direction. A finding that a left-to-right placement approach for the left is faster than the manualized right-to-left placement strategy may lead to a change in the administration instructions and allow a left-to-right placement approach. In summary, the goal of the present study is to determine if there is a need to alter the standardized instructions for the left hand peg placement (i.e., recommend a left to right placement approach). The findings of this study will fill a significant gap in our current knowledge about the testing procedures of this popular neuropsychological test.

Statement of Hypothesis

It is hypothesized that performance speed (measured in seconds) in the left-to-right peg placement condition will be less than in the right-to-left peg placement condition. The present study will further investigate the effects of gender and handedness on Grooved Pegboard performance.

METHOD

Participants

The sample consisted of 63 male and female undergraduate volunteers attending the University of Central Florida (UCF). Participants were recruited from the UCF Department of Psychology Research Participation System. All participants had no history of neurologic disease/trauma, or conditions that would affect motor functioning of the right and left upper extremities. The age range of the participants was 18 to 25 years (M = 18.43, SD = 1.30). The sample consisted of 21 males between the ages of 18 and 21 years (M = 18.38, SD = .92) and 42 females between the ages of 18 and 25 (M = 18.45, SD = 1.47). Racial/ethnic demographics are presented in Table 1. The education level (highest level completed) of the sample ranged from 12 to 18 years (M = 12.92, SD = 1.11). The education level of males ranged from 12 to 15 years (M = 12.43, SD = .98). The education level of females ranged from 12 to 18 years (M = 12.36, SD= 1.19). The sample consisted of 57 right-handed (male, n = 18; female, n = 39) and 6 left-handed (male, n = 3; female, n = 3) participants.

Materials and Apparatus

This study utilized the Grooved Pegboard Test (Klove, 1963; Lafayette Instruments, 1989). The Grooved Pegboard is a metal board consisting of 25 holes with randomly positioned slots. Pegs have a groove along one side that must be turned to match the hole before they can be inserted. Pegs to be used are placed in a depression at the top of the board and are drawn one at a time for placement. The objective is to place all 25 pegs as quickly as possible with both the dominant and non-dominant hands. The directions for the Grooved Pegboard are specific in the direction that the pegs should be placed in.

> For the right hand trial, the examiner demonstrates that the pegs are placed from subject's left to right, and from right to left for the left hand trial. The dominant hand trial is administered first, followed by the nondominant hand trial. The examiner encourages the subject to perform the task as quickly as possible, telling him or her to speed up if necessary. The pegs must be put in the board in the exact order and in the correct direction. (Lafayette Instrument, 1989, pp.4)

Speed of peg placement was assessed using an EAI T-80 dual-timer. A demographic questionnaire developed specifically for this study was employed to gather participant information.

Procedure

Following acquisition of informed consent, participants completed the Grooved Pegboard Test. Participants were timed in seconds. The study used time in seconds, as opposed to a scaled score. This was done to detect small differences between directions. These differences would be so small a scaled score would not be able to detect a difference in score. Participants began with the left hand and placed the pegs from right-to-left. The right hand was assessed with direction determined in accordance with the manual. The left hand was then assessed again using a left-to-right peg placement direction. Direction of the first and second trial for the left hand was counterbalanced to control for a possible order effect. The right hand was intentionally placed between the two left hand trials to control for a possible fatigue effect.

RESULTS

A 2 x 2 x 2 (gender [male, female] x handedness [right, left] x left hand placement direction [right-to-left, left-to-right]) mixed-design (between-between-within) Analysis of Variance (ANOVA) was employed to assess the independent measures' influence on left hand speed of performance on the Grooved Pegboard Test. The main effect for time to place all pegs as a function of the direction of placement (right-to-left [M = 68.71, SD 10.64]; left-to-right [M = 67.56, SD = 9.24]) was not significant, $F(1, 59) = .120$, $p = .731$, partial $\eta^2 = .002$. Examination of the gender main effect revealed that females (M = 66.34, SD = 10.07) were significantly faster than males (M = 71.74, SD = 8.82), $F(1, 59) = 5.215$, $p = .026$, partial $\eta^2 = .081$. Analysis of the handedness main effect revealed that left handed participants (M = 60.59, SD = 10.99) were significantly faster than right handed participants (M = 68.93, SD = 9.59), $F(1, 59) = 6.362$, $p = .014$, partial $\eta^2 = .097$. There was a non-significant interaction between direction and gender, $F(1, 59) = .280$, $p = .599$, partial $\eta^2 = .005$. The direction x handedness interaction was not significant, $F(1, 59) = .199$, $p = .657$, partial $\eta^2 = .003$. The interaction between gender and handedness was not significant, $F(1, 59) = .673$, $p = .415$, partial $\eta^2 = .011$. The direction x gender x handedness interaction was not significant, $F(1, 59) = .323$, $p = .572$, partial $\eta^2 = .005$.

DISCUSSION

The Grooved Pegboard Test is a widely used neuropsychological instrument to assess fine motor speed and dexterity. Clinical experience has shown that patients performing the Grooved Pegboard Test have difficulty maintaining the manualized right-to-left placement strategy with their left hand. This study sought to investigate possible differences in placement time on the Grooved Pegboard task between participants using the standardized left hand approach and a reversed manualized left hand placement strategy (i.e., left-to-right). It was hypothesized that participants would perform faster with their left hand when using the non-manualized, left-to-right, placement strategy. The data did not support this hypothesis. That is, there was no significant difference in speed for the left hand as a function of peg placement direction.

The direction of left hand peg placement has not been investigated prior to the present study. The absence of a significant time difference for the left hand noted in this study has practical significance in applied settings. Namely, a slight modification to the directions outlined in the test manual. For the left hand, the manual states that examinees are to place the pegs in a right-to-left direction. In the event that an examinee reverses the direction on the second or subsequent row, the examiner is to stop the examinee, point to the correct hole for the next peg, tell the examinee to place the next peg “here”, and remind them that they are to place the pegs from right-to-left. The present data suggest that if an examinee reverses the peg placement direction from the manualized instructions they should be allowed to continue without intervention from the examiner. This recommended change will control for the artificial inflation of an examinee’s time due to the examiner having to correct the examinee and estimating the time that elapsed while the behavior was being corrected and risk a flawed estimate of an examinee's ability.

The female participants in this study were, on average, faster at placing the pegs with their left hand than the male participants. This is consistent with past findings (Bornstein, 1985; Ruff & Parker, 1993; Schmidt et al., 2000). There was also a higher variance in the females' scores than males. This is also consistent with past findings (Rosselli, Ardila, Bateman, & Guzman, 2001; Thompson, Heaton, Matthews, & Grant, 1987). The presence of a gender effect is not surprising and consistent with prior studies, and is demographically controlled for in the norms tables (Heaton, Miller, Taylor, & Grant, 2004).

Handedness was noted to play a role in speed of performance, with left handed participants performing significantly faster than right handed participants. Again, this finding is consistent with prior research (e.g., Bryden & Roy, 2005). While speed of performance appears to favor left handed participants in this study, such a finding in the present study must be viewed with caution when attempting to generalize to the larger population. The main reason is from a statistical perspective. The present sample consisted of 57 right handed participants and 6 left handed participants. Thus, three statistical issues must be addressed. First, unequal sample sizes in ANOVA necessitate a different formula to calculate sum of squares. Second, a weighted mean must be used instead of the grand mean when unequal samples sizes are present. These two issues are not necessarily critical because statistical software (e.g., SPSS) will automatically control for the sum of squares and weighted mean concerns. However, a major problem not controlled for by SPSS is that unequal sample sizes effect the assumption of homogeneity of variance. While ANOVA is considered to be robust when moderate departures from the homogeneity of variance assumption is violated, the larger the discrepancy in sample size (as in this study) the heterogeneity of variance casts skepticism on the valid interpretation of the data.

A limitation is that the study used normal subjects. A differential effect might be found if a clinical population is tested.

In conclusion, it is recommended that examiners not correct an examinee if they reverse placement direction. The significance of this proposed change is that a single second may be the difference between a performance classification of impaired and not-impaired. Given that neuropsychological evaluations are often performed in medico-legal contexts, such a fine distinction could have profound implications.

APPENDIX A: IRB APPROVAL

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: UCF Institutional Review Board #1
FWA00000351, IRB00001138

To: Homer Edward Fouty and Co-PI: Ashley R. McWaters

Date: June 06, 2013

Dear Researcher:

On 6/6/2013, the IRB approved the following human participant research until 6/5/2014 inclusive:

Type of Review:	UCF Initial Review Submission Form
Project Title:	Psychometric differences in motor functioning
Investigator:	Homer Edward Fouty, Ph.D.
IRB Number:	SBE-13-09418
Funding Agency:	
Grant Title:	
Research ID:	N/A

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form cannot be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 6/5/2014, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 06/06/2013 01:52:24 PM EDT

IRB Coordinator

APPENDIX B: DEMOGRAPHIC QUESTIONAIRE

Age: _______

Gender:

___ Male

___ Female

Which hand do you write with?

___ Right

___ Left

Highest level of education COMPLETED:

___ I completed High School (or hold a GED)

College:

___ I have completed my Freshman year

___ I have completed my Sophomore year

___ I have completed my Junior year

___ I have received my Bachelor's degree

___ I have received my Master's degree

Race/Ethnicity

___ White (i.e., origins in any of the original peoples of Europe, the Middle East, or North Africa)

___ Black or African American

___ American Indian or Alaska Native

___ Asian

___ Native Hawaiian and other Pacific Islander

___ Hispanic/Latino

___ Two or more races (check the appropriate ones above)

Have you been diagnosed with neurological disease involving the brain?

___ Yes (Please explain ___________________________________)

___ No

APPENDIX C: RACIAL/ETHNIC FREQUENCY TABLE

TABLE 1

Participants' racial/ethnic demographics

Race/Ethnicity	*n*	%
Asian	5	7.9
Black or African American	6	9.5
Hispanic or Latino	17	27.0
Two or More Races	8	12.7
White	27	42.9

APPENDIX D: RAW DATA

SUB	AGE	GENDER	HAND	EDUC	RACE	LRLRAW	RRAW	LLRRAW
1	24	2	1	16	6	73	65	63
2	18	2	1	12	1	93	58	80
3	18	1	1	12	1	67	64	69
4	18	2	1	12	1	78	70	59
5	18	2	1	12	1	65	64	68
6	18	2	1	12	6	70	57	60
7	18	2	1	12	1	54	55	67
8	18	1	1	12	2	82	62	80
9	18	2	1	12	1	73	68	79
10	18	2	1	12	7	69	62	62
11	18	2	2	12	1	53	67	55
12	18	1	1	12	1	81	89	79
13	18	2	1	12	1	58	55	61
14	19	1	1	14	2	91	84	80
15	18	2	1	12	7	64	57	67
16	18	2	1	12	6	71	56	67
17	18	1	1	12	4	63	67	83
18	18	2	1	12	1	82	66	77
19	18	2	1	12	6	70	60	76
20	18	2	1	12	1	77	65	95
21	18	2	1	12	6	68	61	68
22	18	1	2	12	6	62	55	55
23	18	2	1	12	6	65	52	67
24	19	2	1	13	1	60	49	58
25	25	2	1	18	6	56	52	60
26	18	2	1	12	6	78	57	67
27	18	2	2	12	6	47	59	49
28	18	1	1	12	4	62	49	61
29	18	1	1	12	1	64	60	69
30	18	2	1	12	7	85	61	80
31	18	2	1	12	1	82	62	79
32	19	2	1	12	6	81	64	73
33	18	2	1	12	2	68	61	67
34	18	2	1	12	6	69	53	59
35	21	2	1	15	4	60	58	68
36	21	1	1	15	7	86	77	74
37	18	1	1	12	1	80	66	78
38	18	2	1	12	1	76	60	71
39	18	1	2	12	7	78	96	79

40	18	1	1	12	1	60	59	57
41	18	1	1	12	1	60	54	67
42	18	1	1	12	6	77	86	79
43	18	2	1	12	7	55	50	54
44	18	1	1	12	6	77	60	69
45	18	2	1	12	1	58	50	60
46	18	2	2	12	2	67	69	58
47	19	1	1	13	4	76	68	76
48	18	2	1	12	1	68	64	59
49	18	2	1	12	1	51	54	56
50	18	1	1	12	1	73	58	63
51	18	1	2	12	7	56	52	68
52	19	2	1	13	1	62	60	62
53	18	2	1	12	1	58	58	62
54	18	1	1	12	6	77	68	69
55	18	2	1	12	1	59	66	69
56	18	2	1	12	6	61	47	55
57	18	2	1	12	6	88	56	77
58	18	2	1	12	2	68	66	64
59	18	1	1	12	4	70	64	66
60	18	2	1	12	1	52	51	60
61	21	1	1	15	7	74	62	76
62	18	2	1	12	2	67	63	71
63	18	2	1	12	1	54	53	50

APPENDIX E: F TABLES

TABLE 2

ANOVA Summary Table: Tests of within-subjects effects

	SS	*df*	*MS*	*F*
Direction	3.574	1	3.574	.120
Direction x Gender	8.351	1	8.351	.280
Direction x Handedness	5.932	1	5.932	.199
Direction x Gender x Handedness	9.650	1	9.650	.323
Error	1762.190	59	29.868	

TABLE 3

ANOVA Summary Table: Tests of between-subjects effects

	SS	*df*	*MS*	*F*
Gender	765.697	1	765.697	5.215
Handedness	934.188	1	934.188	6.362
Gender x Handedness	98.828	1	98.828	.673
Error	8663.267	59	146.835	

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