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Relation of Personality Traits to Cognitive Impairments and Disease Severity in Parkinson's Disease

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Abstract

Parkinson's disease (PD) is the second most common neurodegenerative disorder with a prevalence rate ranging from 31 to 201 per 100,000 individuals. PD primarily affects individuals over the age of 65 years. Recently, researchers have recognized the importance that cognitive and other non-motor type deficits play in the lives of PD patients. Some speculate that PD patients even exhibit changes in certain personality traits. It is currently unclear, however, how these personality traits might relate to cognitive deficits and even disease severity. The current study examined this issue by administering a personality assessment and several cognitive (frontal-lobe) assessments to 27 non-demented PD participants and 23 normal control participants, matched on age and education. In contrast to previous literature, results revealed very few cognitive and personality differences between groups, and no significant relation between cognition, personality, and disease severity in the PD group. A biased PD sample may be responsible for this difference in findings. By examining the non-motor type deficits in PD, intervention strategies may be eventually developed that are aimed at improving the quality of life of these patients.

Relation of Personality Traits to Cognitive Impairments and Disease Severity in Parkinson's Disease

Parkinson's disease (PD) is one of the most common progressive neurodegenerative diseases. It affects 1% of the world's population over the age of 65, which is approximately six million people (Parkinson's Disease Overview, 2014). The prevalence of PD ranges from 31 to 201 per 100,000 individuals. This disease occurs in all ethnic groups, affects both genders, and becomes increasingly common with advancing age. The neuropathology of PD is complex and has been linked to a variety of motor and non-motor symptoms typically exhibited by PD patients.

Common motor symptoms of PD include a resting tremor, slowness of movement, motor rigidity, and postural instability. Some of the nonmotor symptoms of PD include cognitive deficits, including problems with learning and memory, visual-spatial processing, and executive function abilities (i.e., working memory, planning, inhibition, attention, and speed of processing [Uc et al., 2005]). Executive dysfunction affects roughly 30% of PD patients (Williams-Gray et al., 2009). Such deficits can occur early in the disease and involve impaired coordination of a range of cognitive processes required to achieve complex, goal-oriented, and novel cognitive operations (Jurado & Rosselli, 2007). Executive function deficits are primarily associated with frontal lobe pathology (specifically, a lack of dopamine) in PD (Lees & Smith, 1983; Taylor, Saint-Cry, & Lang, 1986). There is even evidence to support the idea that certain personality differences, also associated with frontal lobe functioning, are noted between PD patients and normal control participants. One question concerns whether these noted changes in personality directly relate to the observed cognitive changes noted in PD. Only two studies to date have examined this possibility (Koerts, Tucha, Leenders, & Tucha, 2013; McNamara, Durso & Harris,

2008). Another question, which is yet to be determined, concerns whether these noted personality changes coincide with disease severity. The primary purpose of the following project, therefore, is to further investigate these questions by examining the relationship between personality traits, cognitive impairments, and disease severity in PD patients. A review of the literature relevant to these issues is outlined below.

Neuropathology Associated with PD

PD has primarily been characterized neuropathologically by the progressive destruction of dopaminergic neurons and the accumulation of Lewy bodies (small, tightly packed granular structures with ring-like filaments) in a nucleus found in the midbrain, specifically, the substantia nigra (Gatto, 2011). More recent literature, however, demonstrates that damage also occurs in more primitive areas of the brain (e.g., the brainstem), as well as in more evolved areas of the brain (e.g., the cerebral cortex). Braak et al. (2003) developed a detailed set of six anatomical changes experienced by the majority of individuals with PD. These six stages are collectively known as the Braak Stages. Each stage is associated with the appearance of more symptoms; anatomical areas affected in earlier stages become progressively more affected with each additional stage. Stage one begins with pathology that is primarily located in the medulla in the brainstem. In Stage one, the PD patient is asymptomatic. Pathology expands from the brain stem in an upward course. Stage two includes pathology that proceeds to an area in the pons known as the pontine tegmentum, which has been implicated in sleep. The pathology also proceeds to an area called the anterior olfactory nucleus located in the frontal lobes, which plays a role in olfaction. In Stage two, symptoms may include loss of smell, sleep disturbances, constipation, and depression. During Stage three, the pathology proceeds to the substantia nigra in the tegmentum, a nucleus located in the midbrain. During Stage three, the motor symptoms of PD

first appear and it is typically in this stage when individuals receive a confirmed diagnosis of PD. The motor features include resting tremor, bradykinesia (slowness of movement), rigidity, changes in gait and balance, and postural instability (Taba & Asser, 2004). The first onset of motor symptoms is seen after almost 80% of neuronal death has occurred in the substantia nigra. During its course, the intraneuronal lesions increase steadily in a predictable distribution pattern (Braak, Ghebremedhin, Ru¨ b, Bratzke, & Del Tredici, 2004) causing more and more deficits to become evident in PD patients. In Stage four, the pathology proceeds to the temporal mesocortex (in the temporal lobe), the basal ganglia system, and the limbic system. Motor symptoms become progressively worse. Stage five includes pathology that proceeds to the prefrontal cortex and sensory association areas located throughout the neocortex. This is typically where cognitive impairments become apparent. In Stage six, pathology proceeds to the primary sensory and motor areas in the neocortex; cognitive impairments become fairly pronounced (Braak et al., 2003).

Studies of the neuronal connections between the basal ganglia, cerebral cortex, and thalamus have demonstrated that nuclei and cortical areas are interconnected via independent parallel loop circuits (Owen, 2004). This strong relationship between the frontal lobes, basal ganglia, and thalamus explains why cognitive dysfunction results from the initial loss of dopamine cells in the substaintia nigra. Cognitive dysfunction in PD is predominately linked to dopaminergic dysfunction within neural networks linking the dorsal striatum to the prefrontal cortex (Owen, 2004). A deficit in one area will be linked to the many neuronal connection areas and contribute to further deficits.

Motor Impairments and the Degree of PD Severity

PD is a progressive neurodegenerative condition that has historically been identified as a motor disorder (Marsden, 1982). The main features of PD (i.e., resting tremor, slowness of movement, motor rigidity, and postural instability) are mainly related to dysfunction of the motor circuit, involving the basal ganglia system (Rodriguez-Oroz et al., 2009). A diagnosis depends on identifying the physical cardinal signs of the disease including its core features as described years ago by James Parkinson.

The primary motor symptom of a resting tremor affects approximately 70% of PD patients in the early stages (Symptoms, 2014). Most individuals experience a slight tremor in their hand or foot on one side of their body, or less commonly in their jaw or face. A typical onset is the presence of tremor in one finger. The tremor consists of a shaking or oscillating movement, and usually appears when a person's muscles are relaxed or at rest. The tremor often spreads to the other side of the body as the disease progresses, but usually remains most apparent on the initially affected side.

Another primary motor symptom is bradykinesia, or slowness of movement (Symptoms, 2014). A defining feature of Parkinson's, bradykinesia also describes a general reduction of spontaneous movement, which can give the appearance of abnormal stillness and a decrease in facial expressivity. Bradykinesia also causes difficulty with repetitive movements, such as finger tapping.

The third primary motor symptom is motor rigidity (Symptoms, 2014). Motor rigidity causes stiffness and inflexibility of the limbs, neck and trunk. Muscles normally stretch when they move, and then relax when they are at rest. In Parkinson's rigidity, the muscle tone of an affected limb is always stiff and does not relax, sometimes contributing to a decreased range of motion.

The last primary motor symptom is postural instability, which is a tendency to be unstable when standing upright (Symptoms, 2014). A person with postural instability has lost some of the reflexes needed for maintaining an upright posture, and may topple backwards if jostled even slightly.

Secondary motor symptoms are also seen in PD and are just as important as the cardinal signs (Symptoms, 2014). Secondary motor symptoms include freezing gait, micrographia (small hand writing), mask-like expressions, and unwanted acceleration. Freezing of gait is an important sign of PD that is not explained by rigidity or bradykinesia. People who experience freezing will normally hesitate before stepping forward. They feel as if their feet are glued to the floor. Often, freezing is temporary, and a person can enter a normal stride once he or she gets past the first step. Freezing can occur in very specific situations, such as when starting to walk, when pivoting, when crossing a threshold or doorway, and when approaching a chair. Micrographia is the name for shrinkage in handwriting that progresses the more a person with Parkinson's writes. Mask-like expressions are when a person's face may appear less expressive than usual; it can occur because of decreased, unconscious facial movements. PD patients that experience unwanted accelerations experience movements that are too quick. These unwanted accelerations are especially troublesome in speech and movement.

Most individuals seek medical help because of changes they notice with their motor abilities. Although there is no definitive test to diagnose PD, physicians can use a variety of tools including blood work, brain scans, medication histories, etc., to aid in ruling out other medical conditions. As part of their diagnostic work-up, patients may be given the United Parkinson's Disease Rating Scale (UPDRS), a scale used to measure patients' performance on different physical tasks. This is a six-part scale with ratings from zero (normal) to four (severely affected;

Louis, Lynch, Marder, & Fahn, 1996). Two out of the four major motor symptoms (motor rigidity, slowness of movement, resting tremor, postural instability) of PD must be exhibited for a specified length of time before a probable diagnosis can be established (Symptoms, 2014). The UPDRS scale has been modified over the years by several medical organizations, and continues to be one of the bases of treatment and research in PD clinics. The UPDRS scale includes a series of ratings for typical Parkinson's symptoms that cover all of the movement hindrances of PD. It consists of the following four segments: 1) non-motor experiences of daily living, 2) motor experiences of daily living, 3) motor examination,and 4) motor complications (Goezt et al., 2008). Research on the UPDRS has examined its link to deficits in activities of daily living in PD patients, gender differences, and disease duration. In general, results suggest that PD patients who score higher on the scale, indicative of greater disability, have a lower quality of life (Rodriguez-Blazquez et al., 2013). Moreover, as PD progresses, gender differences emerge, with men exhibiting more severe parkinsonian motor features and women experiencing more medicine-induced dyskinesias (Lynos, Hubble, Troster, Pahwa, & Koller, 1998).

Frontal Dysfunction in PD

PD is associated with a wide variety of cognitive symptoms that significantly impair the quality of life of affected individuals. About 80% of patients develop cognitive changes detectable by clinical evaluation during the course of the disease. Cognitive changes in PD in the early stages include executive and visuo-spatial dysfunction and memory deficits. Executive dysfunction is the most frequently described cognitive change in patients with PD. These functions refer to principles of cognitive organization and mental processes involved in the changing situations of daily life (Bosboom, Stoffers, & Wolters, 2004). Frontal assessments often include tasks of executive functioning, attention, and verbal and nonverbal fluency.

Brown and Marsden (1988) used the Stroop Test to measure frontal lobe deficits in PD patients, specifically executive functioning. Participants were shown the words "red" and "green" written in their complementary color (for e.g., the word red was written in green ink). They were then required to say either the color of the printed words, or the actual word itself. However, the participants were not always told whether to specify either the color or the word before it was shown; in some conditions they had to remember, from previous instruction, which attribute was relevant. Results showed that the PD participants performed significantly worse than normal control participants only when they had to remember, from previous instruction, which attribute was relevant. Therefore, the attentional demands of this task most likely exceeded available resources, which lead to a hypothesis of reduced resources in the frontal lobes in PD participants.

To further support this theory, Woodward, Bud & Hunter (2002) used an updated version of the Stroop Test. Participants carried out both tasks that required them to repeat what they had learned. This included the color/word task above and a task that involved set-shifting. In the set-shifting task, a box split into two halves was shown on the computer screen. The participant was told to name the color when the stimulus appeared in the bottom half of the box, and to read the word when it appeared in the top half of the box. The results showed that the PD participants, when compared to normal control participants, only exhibited impairments when naming the colors during a required shift in attention. PD participants exhibit this same pattern of executive deficits on other cognitive assessments (Stravitsky, Neargarder, Bogdanova, McNamara, & Cronin-Golomb, 2012; Roca et al., 2012; Liozidou et al., 2012) that involve switching attention or set-shifting between two tasks.

These findings support the idea proposed by Brown and Marsden (1988) that PD participants lack sufficient attentional resources to adequately perform certain tasks. In other

words, due to executive dysfunction, PD participants find it difficult to ignore irrelevant stimuli while performing a task, which can lead to cognitive overload. As a result, cognitive processing speed can decrease, which often results in inefficient selection and execution of mental strategies (Zgaljardic, Borod, Foldi, & Mattis, 2003). This executive function impairment is thought to reflect a form of set-shifting that leads to difficulty in disengaging from one task and engaging in a new task, particularly while being distracted by a previously relevant dimension (Robbins, James, & Owen, 1994).

In addition to deficits in executive functioning, PD patients show impairments on simple tests of attention (i.e,.Trails A; Stravitsky et al., 2012), as well as on tests of verbal fluency (i.e., FAS; Stravitsky et al., 2012; Miller, Neargarder, Risi, & Cronin-Golomb, 2013) and nonverbal fluency (i.e., Ruff Figural Fluency Task; Stravitsky et al., 2012; Miller et al., 2013). These tests measure one's ability to attend to simple stimuli, generate words within a specified period of time, and create unique designs using basic stimuli, respectively. All are consistent with frontal lobe pathology, and are independent of other deficits such as rule-learning, working memory, or a general slowing of cognitive function. Because frontal lobe pathology is evident in PD, one question concerns whether other frontal lobe functions, such as personality traits, might also be affected by this disorder.

Personality Traits in PD

The Temperament and Character Inventory (TCI), a self-administered questioannaire developed by Cloninger, Svrakic, & Przybeck (1993) has been frequently used to assess personality characteristics in PD. It assesses seven dimensions of personality that are associated with two major components: temperament and character traits. Character traits are aspects of personality that involve individual differences in self-concepts about goals and value.

Temperament traits involve differences in automatic emotional reactions and habits. The three character traits are Self-Directedness (SD): where high SD individuals have personal integrity, honor, self-esteem, effectiveness, leadership, and hope; Cooperativeness (C): where high C individuals have concepts of community, compassion, conscience, and charity; and Self-Transcendence (ST): where high ST scores display feelings of mystical participation, religious faith, and unconditional equanimity and patience. The four temperament traits are Harm Avoidance (HA): high HA individuals are cautious, careful, fearful, tense, apprehensive, nervous, timid, doubtful, discouraged, insecure, passive, negativistic, or pessimistic and worriers; Novelty Seeking (NS): high NS individuals are quick-tempered, excitable, exploratory, curious, enthusiastic, impulsive, and disorderly; Reward Dependence (RD): high RD individuals are tender-hearted, loving and warm, sensitive, dedicated, dependent and sociable; and Persistence (P): high P individuals are industrious, hard-working, persistent, and stable (Cloninger et al., 1993).

The TCI is the preferred choice of personality assessment in PD patients because it was created based on a model relating personality traits to underlying neurobiological processes (Cloninger et al., 1993). For example, the temperament traits of NS has been shown to be directly related to dopamine levels, suggesting that damage to the mesolimbic dopaminergic system may result in low NS traits. Further, research suggests that serotonin is related to HA traits and norepinephrine to RD traits. These neurotransmitters have also been implicated in the manifestation of some of the symptoms of PD (Cloninger et al., 1993). The TCI scales exhibit satisfactory psychometric properties, are widely used in studies of clinical populations, and have been used successfully with PD patients (Menza et al., 1990; Cloninger et al., 1993; Fujii et al., 2000).

The majority of research examining personality characteristics in PD patients has found that, in general, PD patients exhibit low NS traits, high HA traits, and show less consistency in RD type-tasks than individuals without PD (Menza et al., 1990; Menza, Golbe, Cody, & Forman, 1993; Fujii et al., 2000). Poletti and Bonuccelli (2011) suggest that these noted changes, specifically the low NS and high HA traits noted in PD, are not present prior to disease onset. They believe that these personality changes are a direct result of having PD.

A question to consider is whether these noted changes in personality in PD are related to other changes manifested by the disorder. McNamara, Durso, and Harris (2008) conducted a study to examine personality, autobiographical memory, and executive cogntive function in patients with PD. Assessments used included the TCI, Stroop color-word interference, verbal fluency (FAS), and category fluency (animals). In general, they found that PD patients exhibited high HA traits when compared to normal control participants. They also reported a significant inverse correlation in their PD sample between verbal fluency scores and HA traits; the higher the HA score, the poorer the performance on the verbal fluency test.

Koerts et al. (2013) conducted a study to further investigate the relationships between executive functioning and personality traits in PD. PD and normal control participants were administered the TCI, the Stroop Color Word Test, Digit Span Backward, Zoo-Map, Frontal Assessment Battery, Trail Making Test, semantic and phonemic verbal fluency tests equivalent to the FAS test, and the Odd Man Out. Results showed that PD patients exhibited significantly higher scores on HA traits than normal control participants. However, contrary to previous literature, no differences between PD and normal control participants were noted for personality traits of NS, RD, or P. PD participants did significantly worse than normal control participants on measures of executive functioning including the Frontal Assessment Battery, semantic

fluency test, and the Odd Man Out. When comparing executive measures to personality measures, significant associations were found between some of the executive measures and P and RD, but not with HA and NS. Koerts et al., (2013) concluded that in general, cognition contributes to personality traits observed in patients with neurodegenerative disorders such as PD.

Present Project

The purpose of the present project is to evaluate personality traits in PD and normal control participants and to relate those findings to degree of PD severity and performance on frontal lobe assessments. It is fairly well established in the literature that cognition and degree of PD severity are related to one another. Multiple studies have shown that PD patients with more severe motor symptoms have a higher risk of developing more severe cognitive symptoms (Owen et al., 1992; Lees & Smith, 1983; Taylor et al., 1986; Beatty & Monson, 1990; Fama & Sullivan, 2002). It is currently uncertain, however, whether these cognitive deficits and disease severity relate to changes in personality noted in PD. This is the purpose of the current project. This study is designed to assess personality traits in PD and relate these findings to the degree of PD severity and cognition. We will administer a variety of cognitive assessments, a personality assessment, and a disease severity assessment to examine the hypotheses of this study, which include, 1) PD participants will perform more poorly than normal control participants on all five frontal lobe assessments administered; 2) PD participants, when compared to normal control participants, will exhibit lower Novelty Seeking traits and higher Harm Avoidance traits on a personality assessment; and 3) PD participants who show deficits in cognitive abilities will also show differences in personality traits compared to normal control participants. In addition, those with higher disease severity scores will exhibit more cognitve deficits and personality changes

than normal control participants.

Method

Participants

The study consisted of 50 participants: 27 non-demented PD participants (12 males and 15 females) with an average age of 64.52 years (SD = 6.24) and an average education level of 17.74 years (SD = 1.81), and 23 normal control participants (NC; 10 males and 13 females) with average age and education levels of 64.35 years (SD = 6.76) and 16.78 years (SD = 2.02). PD and NC participants did not significantly differ on age [t(48) = .09, p=.93] or education [t(48) = 1.77, p=.08]. All participants scored above 25 on the Modified Mini-Mental State Exam (mMMSE), indicating the absence of dementia. PD participants scored a 28.74 (SD = 0.75) and NC participants scored a 28.70 (SD = 1.00). The mean Hoehn & Yahr staging for PD participants was 2.15 (SD = .60). The Hoehn & Yahr assesses PD severity. The average duration of PD was 5.60 years (SD = 4.09).

PD and NC participants were referred from the Parkinson's Disease Center of Boston University Medical Center and local support groups, and included individuals who met the clinical criteria for mild to moderate PD as diagnosed by the patients' neurologists. NC participants were recruited from the community. Participants were required to have at least eight years of formal education, be native speakers of English, in good health, and living at home rather than in an institution. Exclusion criteria included co-existing serious chronic medical (including psychiatric or neurological) illness, mental retardation, use of psychoactive medications besides antidepressants and anxiolytics in the PD group, history of intracranial surgery, traumatic brain injury, alcoholism, or other drug abuse or treatment with electroshock therapy. On the modified Mini-Mental State Examination (mMMSE; Stern et al., 1987), the cut-

off score of 27 was used for NC participants and the cut-off score of 25 was used for PD participants, as this form of the MMSE is particularly sensitive to specific cognitive deficits found in PD without dementia. NC participants with a score above 17 for the Beck Depression Inventory-II (BDI; Beck et al., 1996) and a score of greater than 18 on the Beck Anxiety Inventory (BAI; Beck et al., 1988) were also excluded. Patients with PD were not excluded based on their scores on the BDI and BAI because depression and anxiety are common symptoms of PD (Aarsland et al., 1999). The study protocol was approved by the Boston University Institutional Review Board.

Measures and Procedures

After providing informed consent, participants received a comprehensive interview and assessment from a trained Ph.D. student. During the initial interview, historical and demographic information, such as education, age, and ethnicity were collected, and the inclusion and exclusion criteria and current medications reviewed. Participants were then given a battery of assessments. A Ph.D. student chose assessments based on literature supporting their utility in identifying deficits among PD patients. These assessments measured degree of PD severity, cognitive abilities, specifically executive functioning, attention, verbal and nonverbal fluency, and different personality traits. The Ph.D. student administered the assessments to the participants and I scored and entered the data into the database.

Degree of PD severity.

Movement Disorder Society-Unified Parkinson's Disease Rating Scale (MDS-UPDRS). PD participants were administered the Unified Parkinson's Disease Rating Scale (UPDRS; Fahn & Elton, 1987), a standard measure of symptom severity. The UPDRS has four-scales. The scales are (1) non-motor experiences of daily living (13 items), (2) motor experiences of daily

living (13 items), (3) motor examination (18 items) and (4) motor complications (6 items). Each subscale has 0-4 ratings, where 0 = normal, 1 = slight, 2 = mild, 3 = moderate, and 4 = severe. The total UPDRS score was used as the dependent measure. A score of zero indicates the absence of PD and a score of 400 indicates the greatest degree of PD disease severity.

Frontal dysfunction assessments.

Stroop Color-Word Task. The Stroop Color-Word Task (Stroop, 1935) is a test of executive functioning and measures selective attention, set-shifting, and processing speed. First, in the color naming condition, participants are presented with a series of "XXXXs" in five columns of 20 words. Each series is presented in one of three colors: green, blue, or red. Participants name the color of each series of "XXXXs" presented as quickly as possible. If the participant completes the list of words, they go back to the beginning to continue reading. The total number correct after 45 seconds is used as the dependent measure. Next, the assessment is presented in columns with the words "green," "blue," and "red," that appear in black (the word portion of the assessment). Their task is to read the words as quickly as possible within a 45-second time frame. The total number correct is used as the dependent measure Finally, the assessment is presented in columns with the words "green," "blue," and "red," except now the words are colored such that the color of the word is incongruent with what the word says (e.g., the word "blue" appears in the color red; the color-word portion of the assessment). Participants are asked to name the color in which the words appear (the correct response to the above example would be "red"). Participants are timed and the resulting score is equal to the number correct within a 45-second time frame, which is used as the dependent measure.

The Stroop color naming (reading the colors) and word portion (reading the color names in black ink) measures attention, while the color-word portion (the color names in incongruent

colors) measures executive functioning including set-shifting with lower scores indicating poorer performance.

The Delis-Kaplan Executive Functioning System (D-KEFS) Verbal Fluency Task. The D-KEFS Verbal Fluency task (Delis et al., 2001; Delis et al., 2004) measures verbal fluency, specifically, the ability to understand language rules and the ability to switch between rules. Participants were asked to generate as many words as possible that started with the letter F within a period of one minute. The number of words that were said in each 15-second interval was recorded. Proper nouns, non-english words, homophones, variations of the same word (e.g. long, longer, longest), and numbers were not counted toward the final score. Individual words that met the criteria were counted. This procedure was repeated for the letters A and S. The results from each portion (F, A, and S) were summed to generate a total score, which was used as the dependent measure.

For the category switching portion of the D-KEFS, participants were asked to name as many pieces of fruit and furniture as possible while alternating between categories (e.g., banana, chair, peach, table, etc.) for a period of 60 seconds. The number of words that qualify as fruit or furniture that are properly alternated are counted toward the final score, which is used as the dependent measure. Lower numbers indicate poorer performance.

For the category that measures semantic fluency, the participant demonstrates verbal fluency within a given category. Participants name as many animals as possible in one minute. The number of animals stated in 15-second intervals was recorded. Types of animals and specific species could be used. For example, a participant could say "dog," and "boxer." Individual words that met the criteria were counted resulting in a total score as the dependent measure, with lower scores indicating poorer performance.

The Ruff Figural Fluency Test. The Ruff Figural Fluency Test (RFFT) evaluates nonverbal fluency and mental flexibility in participants. The original assessment was a version with larger design patterns to minimize motor and visuo-spatial demands (Ruff et al., 1987). The test is made up of five pages, each consisting of 35 blocks of five-dot matrices, arranged in seven rows and five columns on an 8½ by 11 inch sheet of paper. Each page consists of a different stimulus pattern of dots. Pages 2 and 3 contain the dot pattern of Page 1 with various distracters (Page 2: triangles, Page 3: lines); Pages 4 and 5 contain variations of the original dot pattern (without distracting elements). Each stimulus sheet is preceded by a page containing three samples of the specific stimulus to allow the respondent an opportunity to practice. The task on each page is to draw as many unique designs as possible in a one-minute interval, by connecting the dots in different patterns. If the same design is repeated, then this is scored as a preservative error. The total number of unique designs, preservative errors, and an error ratio are recorded; all three scores were used as dependent measures. Lower scores indicate poorer performance.

The Trail Making Test. The Trail Making Test (Reitan, 1958) measures executive function, specifically attention and working memory (Trails A) and set-shifting or cognitive flexibility (Trails B). The Trail Making Test consists of two parts. Trails A has 25 circles with numbers (1-25) in them. Trails B has 25 circles with alternating letters and numbers (A-L, 1-13). The circles are scattered throughout the page in no discernible pattern. For Trails A, participants were asked to draw a line as quickly as they could, connecting all of the circles in numerical order without lifting the pen. The line was required to at least touch each circle. Participants were able to self-correct errors, but if the pen was lifted, the task was started from the first number. The amount of time it took to connect all of the circles was recorded and used as the dependent measure. For Trails B, participants were asked to connect the circles in order alternating between

letters and numbers (1, A, 2, B, etc) without picking up the pen and making sure the line touched each circle. The amount of time it took to connect all of the circles was recorded and used as the dependent measure. Lower time indicates better performance.

The Wisconsin Card Sorting Test (WCST) The Wisconsin Card Sorting Test was used to assess set-shifting and preservation (Kongs et al., 2000). The WCST version used for this study was the 64 Cards Computer Version. The purpose of this test is to assess the ability to form abstract concepts, to shift and maintain set, and to utilize feedback. The tests consists of four stimulus cards, placed in front of the participant, the first with a red triangle, the second with two green stars, the third with three yellow crosses, and the fourth with four blue circles. The participant is then given two decks each containing 64 response cards, which have designs similar to those on the stimulus cards, varying in color, geometric form, and number. The participant is told to match each of the cards in the decks to one of the four key cards and is given feedback after each trial. The computer assessment changes the sorting rules after a set number of trials and the participant needs to figure out that the rules have changed based upon the feedback he/she receives. No warning is provided that the sorting rule changes and there is no time limit to this test. Performance is scored on a number of variables (i.e., Number of Categories Completed, Trials to Complete First Category, Preservative Responses, Preservative Errors, Percent Preservative Errors, Failure to Maintain Set, Percent Conceptual, Level Responses, and Learning to Learn). Lower scores indicate poorer performance. For the purposes of this project, the number of categories completed was used as the dependent measure.

Personality assessment.

Temperament and Character Inventory (TCI). Participants were asked to complete the

Temperament and Character Inventory (TCI). This measure is a self-report questionnaire consisting of 240 items. As described earlier, the TCI examines seven different dimensions of personality traits: four so-called temperaments. Novelty Seeking (NS), Harm Avoidance (HA), Reward Dependence (RD), and Persistence (P), and three so-called characters: Self-Directedness (SD), Cooperativeness (CO), and Self-Transcendence (ST) (Cloninger et al., 1993). Each of these traits has a varying number of subscales. C and SD have 5 subscales. NS and HA have 4 subscales. RD and ST have 3 subscales. P has no subscales. Each item is rated with a two-point scale: "True" (1) or "False" (0). Each subscale assesses opposing qualities. For example, one subscale of NS is "Exploratory Excitability vs. Stoic Rigidity." All seven TCI trait scores were included as dependent measures.

Results

The results below are broken down by the three primary hypotheses outlined in the introduction.

Hypothesis 1

PD participants will perform more poorly than NC participants on all five frontal lobe assessments administered.

Stroop Color-Word Test. Independent samples t-tests were performed to examine group (PD, NC) differences on the 3 conditions of this assessment: color naming, word, and color-word. Results revealed a significant difference in the color naming condition, $t(48)= 2.09$, $p<.04$, and the word condition, $t(48)=2.82$, $p<.007$, but not in the color-word condition, $t(47)=1.87$, $p=.07$, although the result may be considered a trend. In each condition, the PD participants performed worse than the NC participants (see Figure 1).

D-KEFS. Independent samples t-tests were performed to examine group (PD, NC)

differences on the 3 conditions of this assessment: FAS total, switch fruit/furniture, and animals. Results revealed no significant group differences in the FAS total, $t(48)= .93$, $p=.36$, switch fruit/furniture, $t(48)=.74$, $p=.46$, or the animals condition, $t(48)=1.22$, $p=.23$. PD participants did not exhibit any deficits on this assessment.

RUFF. Independent samples t-tests were performed to examine group (PD, NC) differences on the 3 measures of this assessment: total number of unique designs, number of errors, and perseveration errors. Results revealed no significant difference in the total number of unique designs, $t(48)= .52$, $p=.61$, the number of errors, $t(48)=1.25$, $p=.22$, or in perseveration errors, $t(48)=1.24$, $p=.22$. PD participants exhibited no deficits on this assessment.

Trails A and B. Independent samples t-test were performed to examine group (PD, NC) differences on the two conditions of this assessment: Trails A and Trails B. Results revealed no significant difference on Trails A, $t(48)= 1.50$, $p=.14$. There was a significant difference on the Trails B condition, $t(46)=2.02$, $p<.05$. Here, PD participants performed worse than the NC participants (see Figure 2).

WCST. Independent samples t-test were performed to examine group (PD, NC) differences on the number of categories completed. Results revealed no significant difference in the number of categories completed, $t(48)= 1.25$, $p=.22$. PD participants exhibited no deficits on this assessment.

Hypothesis 2

PD participants, when compared to NC participants, will exhibit lower Novelty Seeking traits and higher Harm Avoidance traits on the TCI. Independent samples t-tests were performed to examine group (PD, NC) differences on the four temperament traits (NS, HA, RD, P) and the three character traits (SD, C, ST) of the TCI. There were no significant differences for any of the

temperament traits (NS: t[48]=.001, p=.99; HA: t[48]=.78, p=.44; RA: t[48]=.51, p=.62; P: t([48]=1.04, p=.31). For the character traits, there was a significant difference for Coorpertiveness: t(48)=2.16, p<.04, but not for SD: t(48)=1.09, p=.28, or ST: t(48)=.86, p=.40. PD participants scored higher in cooperativeness than NC participants (see figure 3).

Hypothesis 3

PD participants who show deficits in cognitive abilities will also show differences in personality traits compared to normal control participants. In addition, those with higher disease severity scores will exhibit more cognitive deficits and personality changes than normal control participants. In regards to disease severity, PD participants exhibited a mean of 30.08 (SD = 9.67) on the UPDRS. This value is consistent with mild severity PD impairments

NC correlations. Pearson correlations were performed to examine the relation between disease severity, cognitive variables, and personality traits. Alpha was set to .01 to account for the large number of correlations performed. Correlations for the NC group revealed significant relations between RD and color naming measures: r(23)=-.56, p<.006 and between NS and the number of errors on the RUFF: r(23)=.54, p<.007. Specifically, individuals who exhibited higher RD traits performed better on the color naming measure and individuals who exhibited higher NS traits exhibited more errors on the RUFF.

PD correlations. Pearson correlations were performed to examine the relation between disease severity, cognitive variables, and personality traits. Alpha was set to .01 to account for the large number of correlations performed. Correlations for the PD group revealed no significant relations between any of the dependent measures.

Discussion

Overall, the results of the current project do not reflect general findings demonstrated by

previous literature. Potential reasons for this discrepancy are discussed following a summary of the results for each of the three stated hypotheses.

The first hypothesis predicted that PD participants would perform more poorly than NC participants on all five frontal lobe assessments administered. Results demonstrated that PD participants, when compared to normal control participants, only exhibited deficits on the color naming and word conditions of the Stroop, and Trails B. No deficits were noted on the color-word condition of the Stroop, Trails A, the D-KEFS, the RUFF, or the WCST. Only some of these findings are consistent with previous literature. For example, Stravitsky et al. (2012) and Miller et al. (2013) found that PD participants performed poorly on Trails A and B, Verbal Fluency (FAS), and RUFF Figural Fluency when compared to normal control participants. Roca et al. (2012) and Liozidou et al. (2012) also found that PD participants performed significantly poorer when compared to normal control participants on the WCST. In sum, although PD participants in the current study did exhibit deficits consistent with previous literature (such as on the Stroop and Trails B), their impariments were not as extensive as those typically reported (i.e., showing deficits on most if not all of the frontal lobe type assessments).

The second hypothesis predicted that PD participants, when compared to normal control participants, would exhibit lower Novelty Seeking traits and higher Harm Avoidance traits on a personality assessment. Results demonstrated that PD participants did not exhibit lower Novelty Seeking traits nor higher Harm Avoidance traits, but they did exhibit higher scores in C traits. These findings are not consistent with previous literature. Specifically, Menza et al. (1990; 1993) and Fujii et al. (2000) found low Novelty Seeking and high Harm Avoidance traits in PD participants when compared to normal control participants on the TCI. Koerts et al. (2013) found that their PD sample only showed significantly higher scores on Harm Avoidance traits but not

Novelty Seeking traits when compared to normal control participants. McNamara et al. (2008) looked at Cooperativeness traits in PD participants. However, unlike the current study, PD participants did not show any significant results on Cooperativeness traits when compared to normal control partcipants. In sum, the results of the current study did not find the low Novelty Seeking and/or high Harm Avoidance trait pattern in PD patients noted in the literature.

According to the third hypothesis, it was predicted that PD participants who show frontal lobe dysfunction would also show differences in personality traits compared to normal control participants. In addition, PD participants with higher disease severity scores were expected to exhibit more cognitve deficits and personality changes. Correlations for the PD group revealed no significant relations between cognitive dysfunction, personality assessments, or degree of severity. This is inconsistent with the previous literature that has found significant correlations between executive function measures and Persistence and Reward Dependence personality traits in PD participants (Koerts et al., 2013).

Sample Characteristics

As demonstrated by the findings, many of the published cognitive deficits and personality changes observed in PD patients were not observed in the current study. One possible explanation relates to the characteristics of the participant sample used. Specifically, the sample of PD participants used in the current study is higher functioning in regards to PD severity than samples published in the literature and higher than those that have participated in previous research at the Vision and Cognition Laboratory at Boston University. Recruitment procedures biased the sample to only include the highest functioning PD participants, and those with the lowest disease severity. This most likely affected the findings of the current study. Once this bias was discovered, the method of recruitment was stopped. Had the normal routine recruitment

strategies been implemented, PD patients with a range of abilities and disease severities would have been recruited, which is more representative of the population, and different findings may have resulted.

General Limitations

There are some limitations to the current study. First, a relatively small sample size was used, and as noted above, the sample was most likely biased. Second, it is unclear whether the assessments used in the current study, both cognitive and personality, are the most sensitive to detecting impairments in PD patients. Other assessments may prove to be more useful and should be explored. For example, the Big Five Personality Test could be used. The third limitation is that this PD sample was highly educated. PD participants reported 17.74 years (SD=1.81) of education, which is equivalent to having a master's degree. Some of the participants even had doctoral degrees. This sample, therefore, may not be representative of the general PD population. An explanation as to why this pattern occurred is that highly educated PD participants may be more motivated than those who are less educated to participate in research studies. This observation may also relate to the current study's finding that PD participants reported more Cooperative traits. It would be interesting to see if Cooperative traits were evident in the general PD population and not just those individuals motivated to participate in research. The fourth limitation relates to the examination of gender differences. A preliminary analyses of the current data suggests that there may be gender differences in personality traits in PD participants. Specifically, PD females reported higher levels of Reward Dependence than did PD males or normal control females. PD females also reported higher levels of Cooperativeness than did normal control females. These findings extend the literature on personality in PD by documenting the relation of gender to temperament and character profiles. Future research

should therefore include gender as a variable of interest.

Conclusion

The current study examined the relationship between personality traits, cognitive impairments, and disease severity in PD. Although some impairments in cognitive performance were noted, and PD patients exhibited higher degrees of Cooperative personality traits than normal control participants, the results were not generally consistent with previous literature, most likely due to a biased PD sample. By continuing to examine the range of non-motor deficits associated with PD, we hope to aid in developing interventions aimed at improving the quality of life of these individuals.

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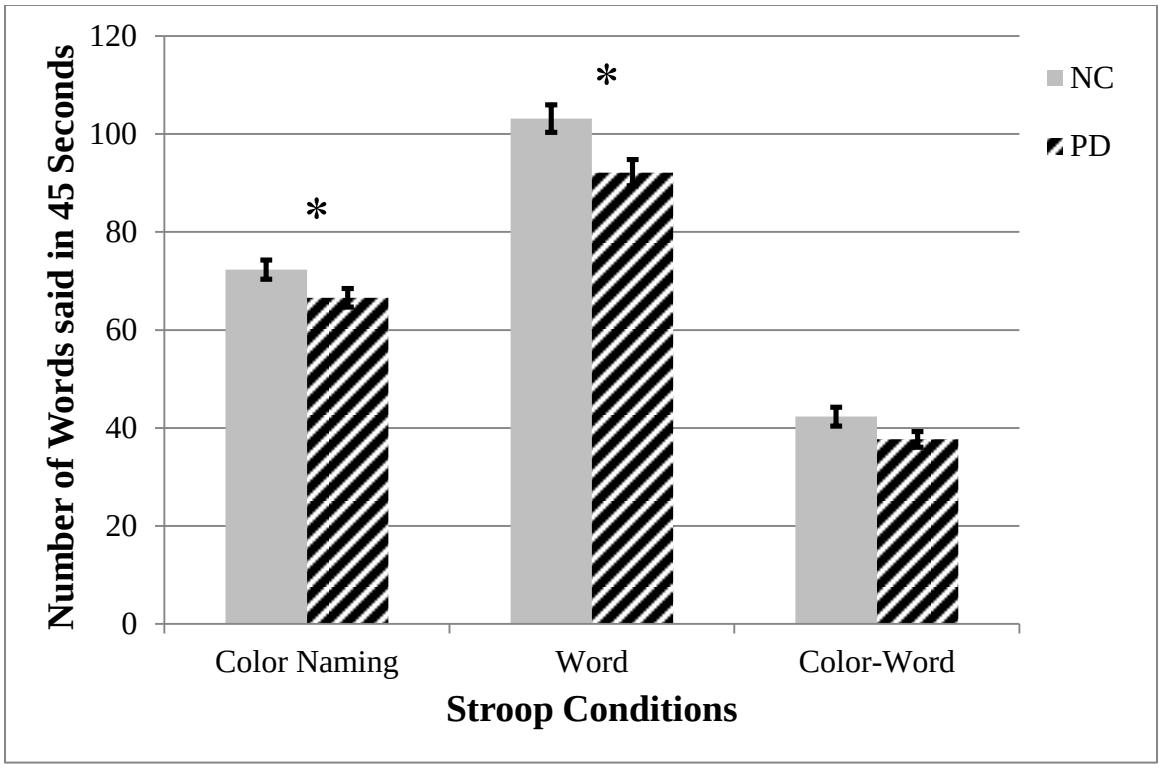

Figure 1. Stroop Color-Word Test. The number correct within a 45-second time frame is plotted as a function of the three Stroop conditions (Color Naming, Word, and Color-Word). Means and associated standard errors of the mean are plotted for both NC and PD participants. As shown, significant group differences were noted for the Color Naming condition and the Word condition (* = $p<.05$).

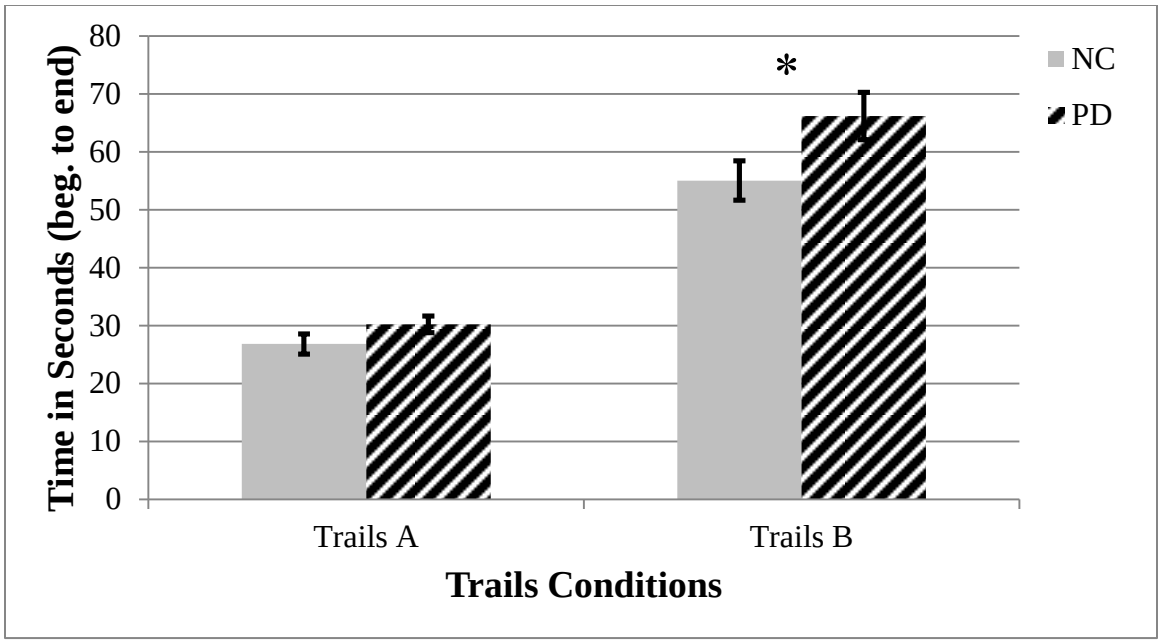

Figure 2. Trail MakingTest. The time in seconds from beginning to end of the test is plotted as a function of the two Trail conditions (Trails A and B). Means and associated standard errors of the mean are plotted for both NC and PD participants. As shown, significant group differences were noted for the Trails B condition (* = $p<.05$).

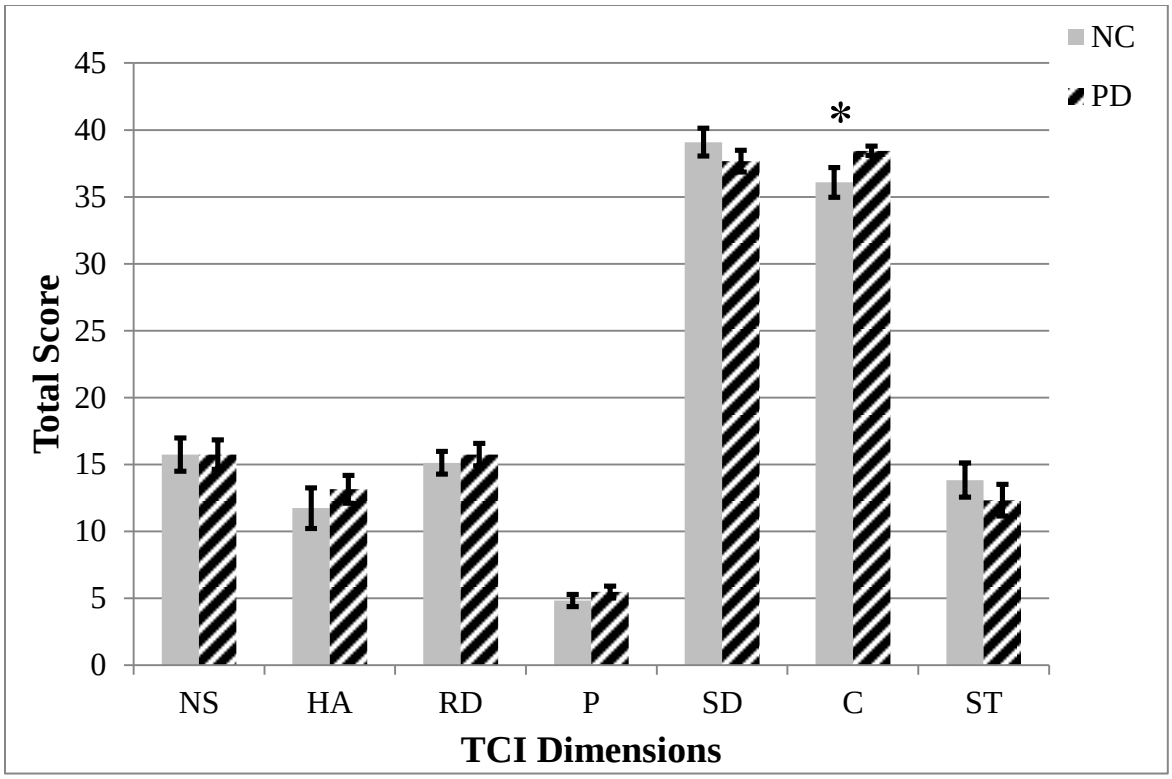

Figure 3. Tempermant and Character Inventory (TCI). The total number reported is plotted as a function of the four temperments (NS, HA, RD, and P) and three characters (SD, C, and ST). Means and associated standard errors of the mean are plotted for both NC and PD participants. As shown, significant group differences were noted for the C condition. Note: total scores are not the same for each dimension (* = $p<.05$).

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