SELF-RATINGS OF MEMORY IN PARKINSON'S DISEASE: RELATION TO DEPRESSIVE SYMPTOMS, PERSONALITY, AND EXECUTIVE FUNCTIONS

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Abstract

Accurate self-assessment of memory is important for everyday function. Self-rating accuracy may be affected by several factors in aging, and especially in Parkinson's disease (PD), but these putative influences have rarely been examined in the same study to determine their relative importance and the potential interactions among them. We examined self-ratings of memory in healthy older adults and people with PD. We used two metamemory scales: the relatively comprehensive Multifactorial Memory Questionnaire (MMQ) and the more brief Structured Telephone Interview for Dementia Assessment (STIDA). We took into account three key influencing variables: depression, personality variables (especially neuroticism and conscientiousness), and executive functions. The MMQ ability scale and the STIDA were moderately correlated for controls whereas this relationship failed to reach significance for patients after a Holm–Bonferroni correction. The difference between these correlations in the two groups was statistically significant. In both groups, objective memory performance and self-assessment of memory (assessed by MMQ ability, MMQ Satisfaction, and STIDA) were not significantly correlated. Conscientiousness and the interactions of group with conscientiousness and executive function were the strongest predictors of memory self-assessment as measured by MMQ ability. Our results suggest that memory self-assessment is not accurate, and is better predicted by conscientiousness and executive functions than by memory itself. Clinicians should know about the potential lack of accuracy of memory self-assessment when screening for memory impairment. Memory concerns reported by patients may not translate in objective memory impairment. At the opposite, confidence in memory may not reflect normal memory functioning.

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CHAPTER 1 – INTRODUCTION & LITERATURE REVIEW

Introduction and literature review

Parkinson's disease

Parkinson's disease (PD) is the second most common neurodegenerative disorder with a prevalence of 1–2% in the population aged over 65 years (Johns, 2014). Its distinctive features were first described by James Parkinson in his classic 1817 monograph, "An Essay on the Shaking Palsy". Parkinson had identified patients sharing similar involuntary tremulous motion as well as a propensity to bend the trunk forwards, and to pass from a walking to a running pace. Most of his initial clinical observations still stand today, and our understanding of the disease has deepened substantially. We now know that Parkinson's disease is a progressive neurodegenerative disease. The canonical view of its mechanisms focuses on the loss of dopamine-producing neurones in the substantia nigra and a widespread intracellular protein (α-synuclein) accumulation (Poewe et al., 2017). The disappearance of dopaminergic neurons causes, in turn, a deficiency of dopamine, a neurotransmitter essential for controlling body movements, learning, working memory, and emotion (Ayano, 2016). PD has a variable presentation consisting of motor and non-motor symptoms. The disorder presents itself slightly differently for each patient and so doctors assess the presence of a combination of symptoms in making a differential diagnosis of PD. The three cardinal features of PD are tremor, bradykinesia, and rigidity. The tremor in PD is a rest tremor that is most noticeable when the patient is not engaged in movement or a purposeful activity. Bradykinesia is defined by slow movement and an impaired ability to move the body swiftly on command. As for rigidity, it is the increased resistance to passive movement about a joint. A fourth feature, postural instability, is commonly mentioned in clinical papers, however, it should be noted this symptom generally occur later in the course of the disease (Gelb, Oliver, & Gilman, 1999; Poewe et al., 2017).

Despite the progress made so far in understanding the brain mechanisms of Parkinson's disease, no specific or unique trigger to Parkinson's disease has been discovered. Epidemiologists have rather identified protective and risk factors that combine genetic and environmental influences. For instance, being a man may increase the chances of developing the disease. Several epidemiologic studies indicate a greater percentage of men affected by PD (e.g. De Lau & Breteler, 2006; Moisan et al., 2016; Pringsheim, Jette, Frolkis, & Steeves, 2014; Quik, 2004). A family history of PD is also a risk factor for developing PD suggesting that PD may be partly hereditary for some patients (Noyce et al., 2012). PD patients also commonly develop depressive symptoms prior to their diagnosis. Researchers are attempting to clarify whether depression in PD is an epiphenomenon, a causal or risk factor, a separate etiology, or a consequence of the disease (Alonso, Rodriguez, Logroscino, & Hernan, 2009; Fang et al., 2010; Gustafsson, Nordström, & Nordström, 2015; Ishihara & Brayne, 2006; Jacob, Gatto, Thompson, Bordelon, & Ritz, 2010; Marsh, 2013; Shen, Tsai, Perng, Kuo, & Yang, 2013). Exposure to pesticides and a high consumption of dairy products are also risk factors for PD. Other risk factors previously investigated, but lacking strong scientific support at this time include: history of traumatic brain injury, reduced levels of dietary and sunlight-derived vitamin D, history of midlife migraine with aura, living in urban or industrial areas with high release of copper, manganese, or lead, exposure to hydrocarbon solvents (particularly trichloroethylene), living in rural areas, farming or agriculture work, the use of well water, high dietary intake of iron (especially in combination with high manganese intake), excess body weight, higher levels of education, history of anemia, and lower muscle strength in late adolescence (Chou, 2017). As for protective factors, smoking is correlated with a decreased risk of developing the disease (Chen et al., 2010; Kieburtz & Wunderle, 2013; Liu et al., 2012; Ritz, Ascherio, & Checkoway, 2007). Other protective factors include coffee and caffeine intake, ibuprofen, and statins.(Liu et al., 2012)

With researchers initially investing most of their efforts into studying the motor symptoms of PD, Parkinson's disease (PD) was first considered a motor disorder in which non-motor functions such as cognitive functions are relatively preserved. We now know that PD features many non-motor symptoms causing psychological distress and impairment, and so, those are important to investigate and manage clinically to improve patients' quality of life. Those include cognitive dysfunction, dementia, psychosis, and hallucinations, psychological disorders including major depression, anxiety, and apathy/abulia, sleep disturbances, fatigue, autonomic dysfunction, olfactory dysfunction, gastrointestinal dysfunction, pain, sensory disturbances, seborrhea, and rhinorrhea (Chou, 2017).

Cognitive Dysfunctions in PD

In recent years, cognitive dysfunctions in PD have gained increasing attention in the scientific literature and clinical practice (Connolly & Fox, 2014; Goldman et al., 2018; Litvan et al., 2011). This may be explained by their prevalence and troublesome nature. Indeed, cognitive dysfunctions are relatively frequent in PD patients. The risk of developing a cognitive dysfunction increases with the duration of the disorder with patients presenting different levels of severity ranging from subtle cognitive deficits, to mild cognitive impairment (MCI) and finally dementia (PDD) in its most impairing form.

Mild cognitive impairment affects approximately 20–50% of PD patients. As for dementia, longitudinal studies report a cumulative incidence of dementia as high as 80 percent. This is an important number especially when considering that dementia, in its severe form, often surpasses the motor symptoms as a major cause of disability and mortality in PD (Emre, 2004; Goldman et al., 2018; Hely, Reid, Adena, Halliday, & Morris, 2008).While most studies indicate that PD patients with MCI have an increased risk of developing dementia, the conversion from MCI to PPD is not systematic. Some PD patients with MCI will remain cognitively stable while others will revert to normal cognition (Broeders et al., 2013; Goldman et al., 2018; Hoogland et al., 2017; Lawson et al., 2017; Pedersen, Larsen, Tysnes, & Alves, 2017).

Cognitive impairment in PD may be heterogeneous in its affected cognitive domains. PD can coexist with other conditions also affecting cognitive health such as depression and vascular conditions (Hong, Hu, Chan, & Bai, 2018; Marsh, 2013). However, PD’s cognitive profile is distinguishable from that of Alzheimer’s disease. In PD, cognitive domains typically affected are executive functions, attention, visuospatial function, and processing speed. The general pattern is one of executive dysfunction and impaired visuospatial function, with, as opposed to AD, less prominent (but still existent) memory deficits and relatively preserved language function (Cahn-Weiner, Grace, Ott, Fernandez, & Friedman, 2002; Hildebrandt, Fink, Kastrup, Haupts, & Eling, 2013; Watson & Leverenz, 2010).

Executive function (EF) is an umbrella term that encompasses the set of cognitive processes that govern goal-directed action and adaptive responses to novel, complex, or ambiguous situations (Hughes et al., 2005). It allows the regulation and monitoring of behaviour and includes basic cognitive processes such as attentional control, cognitive inhibition, inhibitory control, working memory, and cognitive flexibility, but also higher-order processes that are more complex such as planning, reasoning and problem solving (Collins & Koechlin, 2012; Diamond, 2013). Executive dysfunctions are often present early in the course of PD with patients experiencing deficits in set-shifting, attention, and planning. Relative to intact, same-age peers, PD patients without dementia perform more poorly on measures of divided attention, planning, response inhibition, working memory, mental flexibility, and abstract reasoning (Dirnberger & Jahanshahi, 2013; Watson & Leverenz, 2010). Face recognition, one measure of visuospatial function, is also impaired early in the course of PD. While memory deficits are less prominent in PD than AD, studies do demonstrate that both verbal and nonverbal memory can be disrupted in PD patients without dementia (Watson & Leverenz, 2010).

Metamemory: an overview

Whereas memory serves the critical role of encoding, storing, retaining and subsequently recalling information and past experiences, this important cognitive ability could not function effectively without the executive roles of metamemory and memory self-assessment. Metamemory refers to the set of processes responsible for the monitoring and control of one’s own memory. It encompasses the knowledge and the beliefs that one has about memory but also the process of obtaining and using that information to make judgements about it and control it (Blake and Castel, 2015). Metamemory allows each of us to observe critically our memory, identify shortfalls, and, by the same token, ensure that our memory is functioning optimally. Indeed, being aware of shortfalls or deficits in our memory means that we can adjust our behavior if need be (e.g., by making a list, allocating more attentional resources or more time for studying, seeking professional help for assessment and treatment) (Perrotin & Isingrini, 2010). This has important implications for education as well as for the screening and management of memory disorders. By definition, metamemory is a broad concept. Oh-Lee and Otani (2014) have emphasized that it is not a unitary concept. Researchers have developed multiples measures to assess metamemory at various stages of memory function in clinical and experimental settings. Memory self-assessment (i.e., individuals' perceptions of their own memory) is one component of metamemory typically assessed by questionnaires or clinical interviews. Other tasks of metamemory include feeling of knowing (FOK), Ease of learning (EOL), Judgment of learning (JOL), Retrospective Confidence Rating (CR), Response to Feedback, Recall readiness, Ranking judgment, judgment of confidence (JOC) and Global Judgment of performance. Those correspond to experimental paradigms of metamemory.

Metamemory has been the subject of a significant amount of research most likely because of its important relation with memory. The first research study on metamemory can be traced back to 1965 when Joseph Hart, a graduate student at Stanford University, carried out and reported experiments of the tip-of-the-tongue effects, the phenomenon of failing to retrieve a word from memory, combined with partial recall and the feeling that retrieval is imminent. A useful framework for understanding where each metamemory phenomenon plays a role in the memory process (phases of acquisition, retention, and retrieval) was proposed by Nelson and Narens in 1990. At a time where researchers were studying paradigms of metamemory as if they were independent of one another, these two authors were the first to offer a model that unified research on metamemory (Dunlosky and Bjork, 2008).

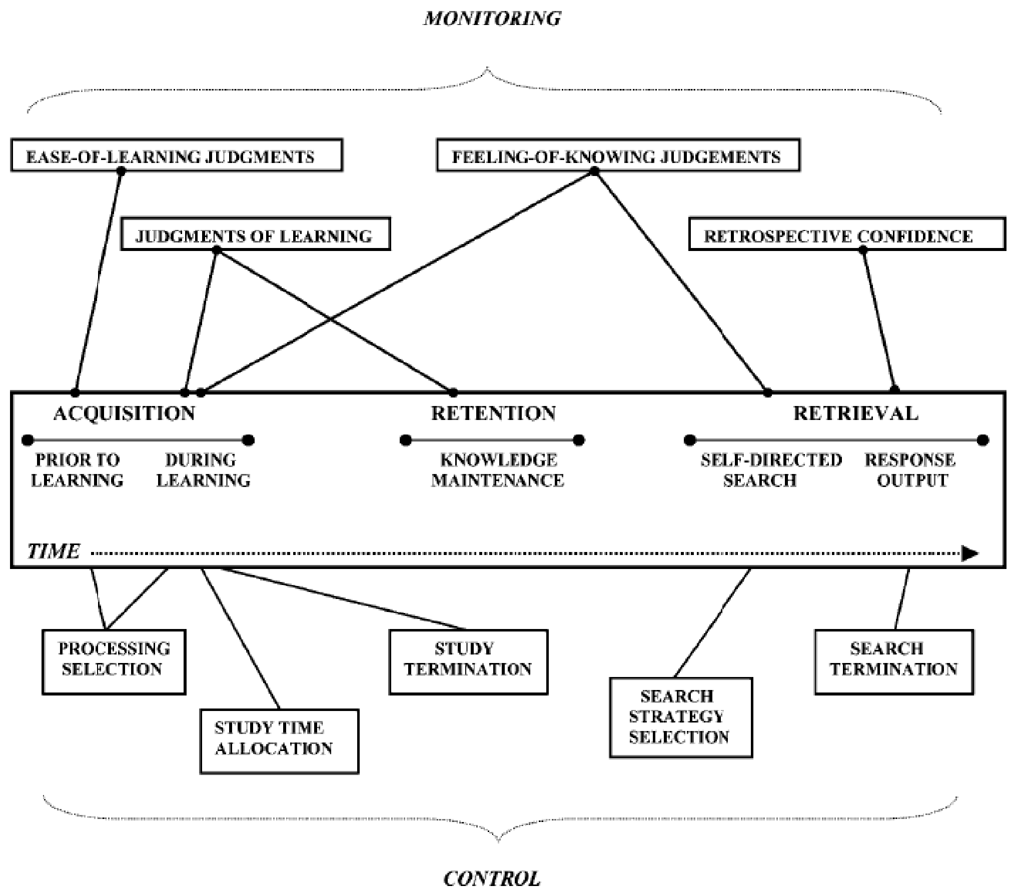

Figure 1. Illustration of monitoring and control processes in a theoretical framework. Adaption from Nelson and Narens (1990) as found in Pannu and Kaszniak (2005).

As showed in Figure 1, their framework highlighted the sequence during learning and retrieval of various monitoring and control processes. Monitoring is hypothesized to occur at all the memory phases; prior to a learning episode (EOL judgments), during and after acquisition (JOL and FOK judgments, respectively), and following attempted retrieval (retrospective confidence judgments). Similarly, control processes occur prior to a learning episode (processing selection), during learning (study time allocation and termination) and at retrieval (search strategy selection and search termination). The framework allowed an appreciation of the bidirectional interaction between monitoring and control processes as it demonstrated how they may influence each other over time during the different memory phases. For example, before learning, an individual may estimate the amount of time he will need to study based on his perceived complexity of the material to recall (monitoring informing control). Conversely, at retrieval, the time he allocated for studying may influence his feeling of knowing a specific answer (control informing monitoring).

Additionally, metamemory phenomena have been studied in clinical and non-clinical populations. Studying metamemory in patient populations is deemed key as "it can provide insight into the neural correlates of metamemory, and help to understand how people monitor memory and utilize strategies to retrieve memories by observing how such strategies are differentially affected by brain disease and damage" (Pannu & Kaszniak, 2005). In Parkinson's disease specifically, previous research on metamemory functioning has examined self-awareness ratings, global predictions, global postdictions, retrospective confidence judgments (RCJ), feelings of knowing (FOK), and the tip-of-the-tongue (TOT) phenomenon (Baran, Tekcan, Gürvit, & Boduroglu, 2009 ; Ivory et al., 1999 ; Koerts et al., 2011 ; Oh-Lee, Szymkowicz, Smith, & Otani, 2012 ; Sitek, Soltan, Wieczorek, Robowski, & Slawek, 2011 ; Smith, Souchay, & Moulin, 2011 ; Souchay et al., 2006 ; Yu, Wu,Tai, Lin, & Hua, 2010). A review of the literature was completed by Oh-Lee and Otani (2014) who summarized the results of 14 studies on metamemory in PD ranging from 1989 to 2012 (experimental and questionnaire designs combined). The authors concluded that out of 23 measures of metamemory, 9 showed metamemory impairments, whereas 14 did not. Those reports may initially seem simply to portray inconsistent results, however, the authors classified studies according to the methodology used. They considered the type of metamemory and memory measured by each study. This allowed them to acquire a potentially clearer picture of metamemory functioning in PD: FOK accuracy was impaired when PD patients made judgements based on their episodic memory. They did not show impaired FOK accuracy when FOK is based on semantic memory. Global predictions and global postdictions showed mixed results and TOT seemed to be unimpaired. Studies on metamemory questionnaires (mnesic self-assessment) showed no obvious impairments. The authors were also interested in the neural correlated of metamemory phenomena. They reviewed existing neuroimaging studies that revealed differences in neural substrates underlying TOT and other metamemory judgments such as FOK and RCJ. Globally, this review of the literature suggests that metamemory is a multifaceted concept and that the different metamemory tasks may activate different areas of the brain, perhaps with some overlap. This would partly explain the differences observed in metamemory performances in the parkinsonian population. Pannu and Kaszniak (2005) reviewed the results of metamemory experiments in numerous neurological populations and came to similar conclusions as Oh-Lee and Otani (2014), stating that research utilizing questionnaires and rating scales to assess metamemory (Danielczyk, 1983; Seltzer et al., 2001) did not show a difference between non-demented patients with PD and healthy control subjects. They added that the results from studies utilizing experimental tasks are consistent with the results from questionnaire and rating scale studies suggesting that PD patients do not have deficits in metamemory.

Although existing work has used experimental and questionnaire paradigms to better understand metamemory in PD, the literature on the relationship between memory and memory self-reports remains sparse and heterogeneous in its methods and results.. One must remain cautious in drawing conclusions. As a clinical neuropsychologist in training preoccupied by the application of theory and research to clinical settings, my interest led me to further investigate the potential gap between objective memory performance and questionnaires of memory. Clinical neuropsychologists are less likely to use experimental paradigms such as FOK and JOL, in part because of the demands on time (e.g., potentially hundreds of trials), and equipment (e.g., computer and perhaps response-box). Instead, they are more likely to rely on simple, efficient, face-valid measures such as questionnaires. Kessels (2018) discussed the importance as well as the numerous challenges of integrating experimental paradigms from cognitive neuroscience into the clinical practice of neuropsychologists. He stated that doing so would allow for a greater precision in neuropsychological assessment, but is often proven difficult because of (i) lengthy and overly specific experimental paradigms, (ii) technical limitations hampering their application in clinics; (iii) under-examined or poor psychometric properties of methods; (iv) paradigms that rely on reaction times rather than accuracy; (v) unclear predictive and ecological validity; (vi) technological progress that affects the continuous availability of experimental computerized assessment methods. Thus, in light of the constraints and particularities of clinical settings, dozens of questionnaires have been developed to evaluate self-assessment of memory (Berry, West, & Dennehey, 1989; Broadbent, Cooper, FitzGerald, & Parkes, 1982; Crook, Feher, & Larrabee, 1992; Crook & Larrabee, 1990; Dixon & Hultsch, 1983; Fort, Adoul, Holl, Kaddour, & Gana, 2004;

Gilewski, Zelinski, & Schaie, 1990; Go et al., 1997; Raimo et al., 2016; Royle & Lincoln, 2008; Shaikh et al., 2018; Simon, Ávila, Vieira, & Bottino, 2016; G. Smith, Del Sala, Logie, & Maylor, 2000; Squire, Wetzel, & Slater, 1979; Troyer & Rich, 2002; Van der Linden, Wijns, Von Frenkell, Coyette, & Seron, 1989; Youn et al., 2009). An empirical question that remains is whether we can use these questionnaires to gain insight into the memory of individuals with PD (and healthy individuals), going beyond the initial studies reviewed by Oh-Lee and Otani (2014).

SELF-RATINGS OF MEMORY IN PARKINSON'S DISEASE: RELATION TO DEPRESSIVE SYMPTOMS, PERSONALITY, AND EXECUTIVE FUNCTIONS

As mentioned above, accurate self-assessment of memory problems can help people make adjustments to their behaviours and their environments to provide support (Perrotin & Isingrini, 2010), and probably also influence their willingness to participate in cognitive rehabilitation. Among aging-related brain disorders, Alzheimer's disease has received considerable attention regarding memory self-assessment (Buckley et al., 2016; Fyock & Hampstead, 2015; Gambina et al., 2014; Gerretsen et al., 2017; Gilleen, Greenwood, Archer, Lovestone, & David, 2012; Kazui, 2006; Rueda et al., 2015; Vannini et al., 2017). In contrast, arguably less attention has been paid to Parkinson's disease (PD). Yet, because PD usually involves memory decline (Goldman et al., 2018; Watson & Leverenz, 2010), gaining a better understanding of patients' self-ratings of memory would be beneficial to both researchers and clinicians. Here we examined PD patients' self-evaluation of memory using two novel measures: the Multifactorial Memory Questionnaire (Troyer & Rich, 2002) and the Structured Telephone Interview for

Dementia Assessment (Go et al., 1997). Our first set of questions focused on the degree of correlation between these two measures and the degree to which each reflects actual memory abilities (because the relationship between memory self-assessment and objective memory performance is usually modest, at best) (Beaudoin & Desrichard, 2011; Crumley, Stetler, & Horhota, 2014). Comparing existing questionnaires is important to determine the most accurate, reliable, and efficient questionnaire for clinical use. Our second set of questions concerned whether the strength of the memory self-assessment—accuracy relationship is influenced by several potentially important variables: Mood, the personality traits of neuroticism and conscientiousness, and executive functions.

Self-ratings of memory in Parkinson's disease

PD presents an interesting paradox when it comes to the self-assessment of memory. On the one hand, even early in the disease problems with learning, memory, and forgetfulness are among patients' top complaints (Alcalay et al., 2010; Benito-León et al., 2011; Breen & Drutyte, 2013; Dupouy et al., 2018; Koster, Higginson, MacDougall, Wheelock, & Sigvardt, 2015; Mischley, Lau, & Weiss, 2017). Likewise, on cognitive testing PD patients often show objective memory impairments (Hurtado Gonzalez, Ladera, Perea, & García, 2017; Levy et al., 2002; Watson & Leverenz, 2010; Weintraub et al., 2015; Whittington, Podd, & Stewart-Williams, 2006; Yarnall et al., 2014). Yet, at the individual level PD patients may have difficulty gauging their own performance: Although several previous reports of memory self-assessment have argued that it is no less accurate than normal in PD (Alcalay et al., 2010; Copeland, Lieberman, Oravivattanakul, & Tröster, 2016; Dupouy et al., 2018; Erro et al., 2014; Hong, Lee, Sohn, & Lee, 2012; Hong, Lee, Sunwoo, Sohn, & Lee, 2018; Hong, Sunwoo, et al., 2014;

Hong, Yun, et al., 2014; Koster et al., 2015; Lehrner et al., 2015; Oh-Lee & Otani, 2014; Pannu & Kaszniak, 2005; Poliakoff & Smith-Spark, 2008; Sitek, Sołtan, Wieczorek, Robowski, & Sławek, 2011), as mentioned above even neurologically healthy people often lack clear insight into their memory (Beaudoin & Desrichard, 2011; Crumley et al., 2014; Rickenbach, Agrigoroaei, & Lachman, 2015). Others have suggested that PD patients over-report their memory problems (Poliakoff & Smith-Spark, 2008; G. Santangelo et al., 2014; Woods & Kneebone, 2017) or that they under-report them (Lehrner et al., 2015; Leritz, Loftis, Crucian, Friedman, & Bowers, 2004; Seltzer, Vasterling, Mathias, & Brennan, 2001). One reason for the inconsistency observed in previous reports of memory self-awareness in PD may be that accuracy of self-assessment is measured in different ways. For example, informants' (e.g., family members) assessments sometimes serve as the comparator for patients' self-assessment, whereas others times objective performance on neuropsychological tests is the comparator. Another reason for inconsistency may be that some studies boil self-evaluation down to a single question such as "Do you have any memory-related problems?" or "Have you experienced changes in your memory?" (Copeland et al., 2016; Erro et al., 2014; Hong, Sunwoo, et al., 2014; Hong, Yun, et al., 2014; Hong et al., 2012) Although such an approach is parsimonious, it may be overly so.

To address this last problem, several questionnaires about memory have been developed to more fully assess the wide range of memory problems that people can experience (Hopp, 1999; Ivory, Knight, Longmore, & Caradoc-Davies, 1999; Johnson, Pollard, Vernon, Tomes, & Jog, 2005; Lehrner et al., 2015; Poliakoff & Smith-Spark, 2008; Sitek et al., 2011; S. J. Smith, Souchay, & Moulin, 2011; Woods & Kneebone, 2017). Some questionnaires (such as the Multifactorial Memory Questionnaire used in this study) also assess feelings about memory and mnesic strategies. Our aim was to explore and compare two relatively new, and potentially useful, memory questionnaires: the Multifactorial Memory Questionnaire (MMQ) and Structured Telephone Interview for Dementia Assessment (STIDA). In both questionnaires, most of the questions assess complaints about episodic memory that is to say recollection about failed attempts to remember in everyday life.

Multifactorial Memory Questionnaire (MMQ). The MMQ is concise enough to be administered in under 15 minutes. Yet, it covers three domains of memory functioning –*Satisfaction* with one's current memory, *Ability* self-appraisal, and *Strategy* use—and has the additional advantage of focusing on clinical and real-world functioning. It has already been used in healthy aging (Burmester, Leathem, & Merrick, 2015; Troyer & Rich, 2002), Alzheimer-type MCI (Chung & Man, 2009; Hutchens et al., 2012; Kinsella et al., 2009; Lenehan, Klekociuk, & Summers, 2012; Troyer, Murphy, Anderson, Moscovitch, & Craik, 2008) and subjective cognitive impairment (Chin, Oh, Seo, & Na, 2014) but not in PD yet. Given arguments that memory changes in PD may resemble an exaggeration of those seen in normal aging (Braver & Barch, 2002; Li, Shu-Chen, Lindenberger, Ulman, & Frensch, Peter A., 2000; Rubin, 1999), we expected this questionnaire might be sensitive to these changes. More specifically, we included it in the present study because it is one of the most exhaustive questionnaires on memory while remaining easy to complete. The MMQ also has been validated in several languages (Fort et al., 2004; Raimo et al., 2016; Simon et al., 2016) and both the French and English versions have demonstrated good psychometric proprieties. (More detailed information on psychometric proprieties of the MMQ is provided in Appendix A.) Given the limitations often associated with recruiting clinical populations, the availability of the questionnaire in French and English was an advantage. We had planned to recruit French and English-speaking PD patients to expand our pool of potential participants.

Structured Telephone Interview for Dementia Assessment (STIDA). The STIDA comprises 7 questions to assess subjective cognitive complaints. It is intended to be a very brief screener for self-reported changes in cognition and daily functioning suggestive of early dementia, particularly of AD type (Go et al., 1997). Higher STIDA scores are correlated with poorer cognitive function (Amariglio, Townsend, Grodstein, Sperling, & Rentz, 2011). We included it for two reasons. First, it is even shorter than the MMQ, and thus could be administered and scored more rapidly. Second, it focuses on dementia, and a significant number of PD patients develop dementia (Emre, 2004; Vasconcellos & Pereira, 2015).

Influences on memory self-assessment accuracy

Even when one uses relatively sensitive and psychometrically sound self-assessment questionnaires, the actual relationship between self-assessment and objective memory performance can be surprisingly weak (Beaudoin & Desrichard, 2011). Previous research in healthy older adults has pointed to several potential moderators, including mood, personality traits (e.g., neuroticism, conscientiousness), and executive functions (Colvin, Malgaroli, Chapman, MacKay-Brandt, & Cosentino, 2018; Jorm et al., 2004; Weaver Cargin, Collie, Masters, & Maruff, 2008; Zelinski & Gilewski, 2004; Zlatar, Moore, Palmer, Thompson, & Jeste, 2014). PD may significantly affect each of these domains.

Mood. Depression is more common than normal in PD (Marsh, 2013; Pocklington, 2017; Reijnders, Ehrt, Weber, Aarsland, & Leentjens, 2008). Partly because of the nature of the population and heterogeneity in the methods of assessment, the prevalence estimates for depression in PD vary across studies, ranging from 2.7% to more than 90% (Cummings, 1992; Marsh, 2013) but, a recent systematic review determined that "the weighted prevalence of major depressive disorder was 17% of PD patients, that of minor depression 22% and dysthymia 13%. Clinically significant depressive symptoms, irrespective of the presence of a DSM defined depressive disorder, were present in 35%" (Reijnders et al., 2008). Depressive symptoms can cause or exacerbate deficits in memory, executive functions, and attention in non-PD (Rock, Roiser, Riedel, & Blackwell, 2014) and PD groups (Marsh, 2013). How depression might affect the self-assessment of memory remains to be clarified, however. On the one hand, some researchers have found that depressive symptomatology causes individuals to overestimate their memory problems (Kahn, Zarit, Hilbert, & Niederehe, 1975; Marino et al., 2009; Sitek et al., 2011; Weaver Cargin et al., 2008; Zlatar et al., 2014) On the other hand, consistent with the theory of "depressive realism" (Alloy & Abramson, 1979), others have suggested that a certain level of depression can have a positive effect on self-assessment (Moore & Fresco, 2012; Soderstrom, Davalos, & Vázquez, 2011). It may be that the level of depression accounts for accuracy. For example, Soderstrom, Davalos & Vázquez (2011), found that mild depression was associated with better calibration of metamemory in undergraduate students; students with mild depression made judgments of learning that were more accurate than students with moderate depression or those without depression.

In PD, although many studies of self-assessment of memory have included mood/depression questionnaires, only a minority have assessed the relation between depression and patients' self-rating accuracy (Dujardin et al., 2010; Erro et al., 2014; Lehrner et al., 2014; Lehrner et al., 2015; Marino et al., 2009; Santangelo et al., 2014; Sitek, Sołtan, Wieczorek, Robowski, & Sławek, 2011). Many have reported that depressive symptoms lead to an increase in subjective memory complaints (Dujardin et al., 2010; Lehrner et al., 2014; Santangelo et al., 2014; Sitek, Sołtan, Wieczorek, Robowski, & Sławek, 2011). Sitek et al. (2011) reported that PD patients with depressive symptoms overestimated their memory deficits adding that self-awareness of memory function is relatively well preserved in PD, but is negatively affected by depressive symptoms. Lehrner et al. (2015) came to a different conclusion observing that poor awareness of memory deficits seemed to be associated with lower levels of depression rather than higher level of depressive symptomatology.

Neuroticism and conscientiousness. To the best of our knowledge, no studies of memory self-assessment in PD have investigated personality as a potential influence. Yet, studies of healthy older adults have suggested that personality traits of higher neuroticism but lower conscientiousness are related to increased cognitive complaints (Pearman & Storandt, 2004, 2005; Ponds & Jolles, 1996; Zelinski & Gilewski, 2004). For example, in a study of self-assessment of memory in older adults, almost one third of the variance in subjective memory complaints was explained by a combination of personality measures (Conscientiousness, self-esteem, Neuroticism) compared with only 4% unique variance associated with the objective memory measure. Correlation of the objective measure of memory with subjective evaluation was only modest ($r = .23$) (Pearman & Storandt,

2005) (for similar findings, see Zelinski & Gilewski, 2004). We thought that the influence of personality on memory self-assessment in PD was especially important to investigate given the literature that highlights that PD may be associated with a particular cluster of personality characteristics (Bower et al., 2010; Buchman et al., 2014; Cerasa, 2018; Heberlein, Ludin, Scholz, & Vieregge, 1998; Kaasinen et al., 2001; M. Menza, 2000; M. A. Menza, Golbe, Cody, & Forman, 1993; Poletti & Bonuccelli, 2012; Santangelo et al., 2018; Sieurin et al., 2016). Indeed, it is hypothesized that PD patients present with distinct premorbid personality features that may be behavioural manifestations of their damaged dopaminergic systems. Although the idea of a distinctive premorbid personality profile in PD remains controversial (Arabia et al., 2010; Glosser et al., 1995; Ishihara & Brayne, 2006), a recent review by Cerasa (2018) suggests that personality profile in PD is characterized by low novelty seeking, high introversion, neuroticism, and harm avoidance. The author emphasized four recent long-term prospective studies investigating premorbid personality in PD (Arabia et al., 2010; Bower et al., 2010; Buchman et al., 2014; Sieurin et al., 2016). He discussed how these studies added to existing retrospective works and provided new impetus to the field of study. Supporting the idea that personality is linked with dopaminergic activity, he also discussed evidence that novelty seeking may change dynamically during the course of PD as a function of dopaminergic treatment or dysfunctions (Bódi et al., 2009; Harris et al., 2015; Piacentini et al., 2011; Tomer & Aharon-Peretz, 2004). Santalegelo (2018) came to similar conclusions about personality and PD in his meta-analysis. He reported that higher levels of neuroticism but lower levels of openness and extraversion were associated with PD. In short, neuroticism may be elevated in PD and conscientiousness, less frequently discussed, may be lower (Bower et al., 2010; Damholdt, Callesen, & Møller, 2014; Menza, 2000; Gabriella Santangelo et al., 2018a; Sieurin et al., 2016; Volpato, Signorini, Meneghello, & Semenza, 2009), but see (Glosser et al., 1995). If many people with PD are high on neuroticism, then this may explain (in part) why they complain about memory problems.

Executive functions. These functions are generally impaired in PD (Dirnberger & Jahanshahi, 2013; Kudlicka, Clare, & Hindle, 2011). Whereas it is postulated that metacognition is a form of executive control, it is surprising that only a few studies have looked at the correlation between self-assessment of memory and executive functions in PD. In young and middle-aged healthy adults, Mäntylä, Rönnlund, & Kliegel, (2010) examined metamemory in relation to three basic executive functions (set shifting, working memory updating, and response inhibition). Self-reported memory problems showed low predictive validity, but self-reported memory and objective memory performance were related to different components of executive functioning. In both age groups, set shifting, but not updating and inhibition, was related to the Prospective and Retrospective Memory Questionnaire. In PD, Hopp (1999) found support for the theoretical relation between executive functioning and metamemory: Memory prediction and postdiction accuracy (i.e., CVLT) were correlated with verbal fluency.

Despite the importance of understanding memory self-assessment accuracy in PD, relatively few studies have looked at depression, personality, and executive functions as predictors on their own and no study has combined all of them in healthy aging and PD. Comparing these predictors together will help us to assess each’s respective influence on self-assessment of memory and determine their relative importance.

CHAPTER 2 – THE PRESENT STUDY'S GOALS AND METHOD

The Present Study

Given the landscape outlined in the introduction, we had two sets of goals.

First Set of Goals and Hypotheses. Neither the MMQ nor the STIDA has been used in PD so far, and never have they been examined together in any population. Our first goal therefore was to characterize PD patients' responses on each questionnaire. Given the literature outlined above, we expected that PD patients' mean response patterns would look different from those of healthy comparison participants, with PD patients possibly showing lower self-evaluation ratings on the MMQ-Ability and the STIDA (Koster et al., 2015). The MMQ can be broken into three subdomains –*Satisfaction* with one's current memory, *Ability* self-appraisal, and *Strategy* use. We focused on MMQ-Ability because it is highly correlated with MMQ-Satisfaction (Troyer & Rich, 2002), and because the MMQ-Ability questions are most conceptually similar to those in the STIDA. Both the MMQ-Ability and the STIDA list everyday memory problems. We predicted that given this similarity, MMQ-Ability and STIDA would be positively correlated with one another.

We hypothesized that the PD patients would show significantly impaired performance on the objective memory measures (California Verbal Learning Test long delay cued recall and Logical Memory delayed recall units), as established by neuropsychological testing (Watson & Leverenz, 2010). We also expected that both the MMQ and STIDA self-ratings would be positively correlated, albeit modestly, with objective memory (Alcalay et al., 2010; Copeland, Lieberman, Oravivattanakul, & Tröster, 2016; Erro et al., 2014; Hong, Lee, Sohn, & Lee, 2012; Hong, Lee, Sunwoo, Sohn, & Lee, 2018; Hong, Sunwoo, et al., 2014; Hong, Yun, et al., 2014; Lehrner et al., 2015; Oh-Lee & Otani, 2014; Pannu & Kaszniak, 2005; Poliakoff & Smith-Spark, 2008; Sitek, Sołtan, Wieczorek, Robowski, & Sławek, 2011). We planned to compare the correlation magnitude (using Fisher's exact test) for MMQ and STIDA in relation to the objective memory scores – a significantly higher correlation for one of the self-assessment measures would mean that it was doing a better job of reflecting actual performance. We expected that the MMQ (because it is more comprehensive and uses a finer-grained scale) would be a better predictor of actual memory performance than the STIDA (which only ranges from 0 to 7). Nevertheless, if these two questionnaires are equally predictive of actual performance, the more concise STIDA would be preferable for clinical practice. We also planned to compare the PD patients and controls on correlation strength, to learn whether the self-assessment questionnaires better reflect actual performance in one group compared to another.

Second Set of Goals and Hypotheses. We anticipated that we might find only a modest relationship between self-assessment of memory and actual performance (consistent with the scientific literature; Beaudoin & Desrichard, 2011; Crumley et al., 2014; Rickenbach et al., 2015). Thus, our second objective was to examine three psychological domains that can influence memory self-evaluation ratings: mood, personality traits (e.g., neuroticism, conscientiousness), and executive functions. We expected that patients with idiopathic PD would have significantly higher scores on the depression scale than controls (Marsh, 2013; Pocklington, 2017; Reijnders, Ehrt, Weber, Aarsland, & Leentjens, 2008). As for personality variables, we predicted that PD patients would obtain higher neuroticism and lower conscientiousness scores in comparison with controls (Gabriella Santangelo et al., 2018b; Sieurin et al., 2016; Volpato et al., 2009) We also expected PD patients to perform significantly worse on our three measures of executive functions (Dirnberger & Jahanshahi, 2013). Globally, we expected that these four psychological factors would influence self-ratings of memory and significantly predict some of the variance in self-ratings of memory that is not explained by objective memory. We predicted that self-ratings of memory would be correlated with depression (negatively), executive functions (positively), the Conscientiousness dimension (positively) and the Neurotic dimension (negatively) in both patients and controls.

Method

Participants

Sixty-three people with PD and 70 community dwelling older adults (i.e., the control group) participated. Five individuals with PD were excluded prior to running analyses. One person with PD was excluded from the study because he/she failed to complete most of the testing session due to severe chronic pain. Another was excluded as a result of receiving a diagnosis of Lewy body dementia shortly after the date of the testing. As per his/her diagnosis, he/she had performed poorly on measures of objective memory and executive functions. Finally, three individuals with PD were excluded because they had undergone deep brain stimulation surgery. Those participants described having an aggressive/younger onset form of the disease, different from most people with PD who develop the disease later in life (Lewis, 2005; Poewe et al., 2017; Selikhova et al., 2009). They were younger (38, 47 and 50 years old) compared to our pool of PD patients.

People with PD were recruited mainly through two local support agencies, which distributed information to members via email and a website and allowed the first author to give brief presentations to members. Others came via word-of-mouth and an advertisement in a local clinic specialized in the treatment of neurological diseases. Although we did not have access to medical records to confirm the participants' clinical diagnoses of PD, we did systematically ask the participants if they had formally diagnosed with PD by a physician, and, if so, when. Older adults in the comparison group were recruited through a local newspaper advertisement and by word-of-mouth.

All participants were required to have a good understanding of, and ability to express themselves in French or English. All reported being free of current substance abuse disorders, current psychiatric and neurological illness other than PD. In addition, all patients and controls were assessed on their regular medication. Fifty-five of the 58 PD patients included in our correlational analyses were taking dopamine replacement drugs at the time of testing. These patients underwent neuropsychological testing in their ‘‘on’’ state. Participation was voluntary and confidential, and the study was approved by the University's Research Ethics Board. Participants' demographic information is presented in Table 1.

Table 1.

Participants Demographic Information

	Controls (n=70)		PD patients (n=58)					
	M	*SD*	*M*	*SD*	*t*	*df*	*p*	*Cohen d*
Age	70.50	5.28	66.57	8.64	3.16	126	.002	.56
Education years	17.32	2.68	16.86	3.39	.86	126	.39	.15
Sex	33M 37F		37M 21F					
Tested in English	100%		51.7%					
Tested at home	0%		58.6%					
MoCA total score (18CO and 58PD) [a]	26.28	2.52	26.52	2.27	-.38	74	.70	.10

[a]The MOCA was administered to all of the PD patients compared to 18 of the 70 controls. Controls were tested firsts and this screener test wasn't part of the initial testing battery. The MoCA was added after the student's thesis proposal defence following feedback from the committee members.

Required Sample Size and Statistical Power

Using the G*power computer program, we performed an a priori power analysis to determine the minimum number of participants required to conduct correlations, t-tests and a multiple regression (G*Power 3: Faul, Erdfelder, Lang & Buchner, 2007). G*power analysis indicated that a total sample of 102 individuals (51 in each group) would be needed to detect medium effects (d=.5) with 80% power using a t-test between two independent means with alpha at .05. These numbers support that the size of our two groups allows for sufficient statistical power to assess for differences between them. The size of our groups was also deemed adequate to assess the presence of 1-tailed/directional correlations within them. A G*power analysis indicated that a sample size of 50 participants was required to detect a small to medium effect size (d=.4) with 90% power and an alpha of .05. As for the multiple regression, numerous rules-of-thumb have been suggested for determining the minimum number of subjects required (Green, 1991). Tabachnick and Fidell (2007) suggest that one should aim to have 20 times more cases than IVs when performing a standard multiple or hierarchical regression, a recommendation that could not be met given our number of predictors. More realistically, the power analysis ran in G*power suggested that a total sample size of 127 participants would be sufficient to detect a medium effect (f2=.15) with a power of 80%, an alpha of .05 and 12 predictors. We fall slightly short of this recommended sample size with a total of 124 participants, after deleting 9 PD patients for the purpose of running the multiple regression.

Measures

Self-assessment of memory was assessed by both the MMQ and seven questions from the STIDA, objective memory performance by the California Verbal Learning Test-II (CVLT) and (WMS-III) Logical Memory, depression by the Center for Epidemiologic Studies Depression Scale, personality by the 50-item IPIP questionnaire (to assess the "Big Five" factors)(Gow, Whiteman, Pattie, & Deary, 2005), and executive functions by the Brixton Spatial Anticipation Test, the Stroop and the verbal fluency test. Detailed information for each measure is provided in Appendix A. We chose to combine our two objective measures of memory into a single composite score to obtain a more stable and robust score of participants' performance. We also combined our three measures of executive functions for the purpose of running multiple regressions. We constructed composite scores by converting the original variable scores to z scores and combining them. We opted for this technique because it is efficient and preserves the distribution of the raw scores. On top of producing more stable scores, combining tests that measure the same cognitive skill also presents the advantage of reducing the number of predictors included in the multiple regression. Given the limitations in recruiting a clinical population and statistical power considerations, we purposely aimed to decrease our number of predictors when possible.

In addition to tests and questionnaires measuring our variables of interest, all participants completed a general demographic questionnaire and a health screening questionnaire for data screening purposes and to help interpret the data. The severity of motor symptoms was assessed for all PD patients using the Motor Examination subscale of the Unified Parkinson's Disease Rating Scale. PD duration was calculated from age at disease diagnosis. A measure of general cognitive functioning and screener for mild cognitive impairment, the Montreal Cognitive Assessment, was also administered to all the patients and control 53 and up.

Testing Protocol

All participants chose the time of their testing and were tested individually. For older adults, participation invariably required one testing session in the neuropsychology laboratory. Individuals with PD had the option of completing testing in two sessions as well as being tested at home to ensure that challenges related to mobility and transportation did not interfere with their participation. As reported in Table 1, 58.6% of individuals with PD chose to be tested at home. Two required testing to be completed in two separate sessions. The severity of their impairment was greater making it difficult for them to sustain their attention and their energy for the full duration of the testing session. All participants were offered $35 for expenses (e.g. transportation). Participants firstly read the consent form and were given the opportunity to ask questions to the experimenter. They were also reminded that they could choose to stop testing at any time. After consenting, participants completed the demographic questionnaire and the health questionnaire. The remaining testing was divided into four testing blocks:

A. the two memory self-assessment questionnaires (the MMQ and the seven memory complaint questions from the STIDA) and the MoCA

B. the two tasks of objective memory performance (the California Verbal Learning Test-II and the Wechsler's memory scale, 3rd edition)

C. the 50-item version of the International Personality Item Pool questionnaire and the Center for Epidemiologic Studies Depression Scale

D. the three tests of executive functions (the Stroop test, verbal fluency and the Brixton)

The two memory self-assessment questionnaires (i.e., MMQ and STIDA) were always administered first, to ensure that the participants answered these questionnaires without being influenced by their performance on the cognitive tests. To prevent the order of the tests from influencing our results, we partially counterbalanced their order (refer to Counterbalanced testing orders in Appendix B).

To ensure reliability, we double-scored all questionnaires and neuropsychological tests. For most of the differences that were found in scoring, the first and second independent scorers were able to reach a consensus after re-examining the participants' answers. For the Verbal fluency test and the Logical Memory that required more time for scoring and involved an element of judgment because of the complexities and subtleties of the French and English languages, we computed an average score of the two scorers. The scores of the two independent scorers were highly correlated with one another with Pearson correlations over 97%, indicating a high level of inter-rater consistency. Kappa coefficients were lower, however, ranging from as low of 14% to 75%. The first author double-checked the data entry as a final verification step.

Statistical analysis

We firstly performed t-tests and chi-square tests to control for potential differences in demographic characteristics between our two groups. Subsequently, we investigated group differences as we performed a MANOVA on the memory self-ratings, cognitive performance, and emotion/personality ratings. Because of a significant group difference observed in age, this variable was used as a second independent variable in the MANOVA. PD patients and controls were divided into subgroups using the median age of our sample. Correlation analyses were used to assess the strength of the relations between our variables such as the strength of the relation between objective memory performance and self-ratings of memory. We also planned to compare the correlation magnitude (using Fisher's exact test) for MMQ and STIDA in relation to the objective memory scores – a significantly higher correlation for one of the self-assessment measures would mean that it was better reflecting actual performance. Finally, we performed a stepwise multiple regression with age, group, objective memory, depression, personality variables, executive functions and interactions with group as predictors of self-assessment of memory. To investigate memory self-assessment accuracy, we could have chosen to divide our two groups into high versus low cognitive functioning (subgrouping). We opted for a multiple regression because this statistical test is more sensitive. Furthermore, we choose to use MMQ-Ability in our multiple regression instead of the STIDA because we considered the MMQ more sensitive. As compared to the STIDA, more variability can be observed in the MMQ scores. Furthermore, we observed a loss of variance with the STIDA in our sample. This measure was found to be positively skewed especially in the control group (floor effect).

CHAPTER 3 – RESULTS

Demographics characteristics of patients and controls

Demographic characteristics of patients and controls are presented in Table 1. An independent-samples t-test indicated that the number of years of education completed did not differ significantly for controls (M =17.3, SD =2.68) and PD patients (M =16.9, SD =3.39), t(126) = 0.855, p = 0.394, d = 0.15. Age at time of testing, however, was significantly older for controls (M =70.5, SD =5.28) than PD patients (M =66.6, SD =8.64), t(126) = 3.16, p = .002, d = 0.56. This group difference was present even though we had excluded the three younger PD patients that had undergone deep brain stimulation surgery prior to running our statistical analyses. Because only 18 of the 70 control participants completed the MoCA compared to 100% of the patients, we choose not to compare results. A chi-square test was performed to examine whether sex ratio differed between our two groups. The difference was nonsignificant, χ^2(N = 128) = 3.55, p = 0.06. Given the study conception, the two groups differed in testing location and language of testing. We compared Francophones and Anglophones PD patients to ensure that the two subgroups were similar prior to combining them. These comparative analyses and their results are detailed in Appendix C and D.

Differences in Performance and Self-assessment between Patients and Controls

Based on the literature, we had postulated that PD patients would show lower self-evaluation ratings on the MMQ-Ability and the STIDA, lower performance on the objective memory and executive function measures, higher depression, higher neuroticism, and lower conscientiousness scores. Participants' self-ratings and cognitive scores are presented in Table 2 as we compare PD patients and controls' results side by

Table 2.

Participants Self-ratings and Cognitive Scores (MANOVA with age group and group as independent variables)

	Controls			PD patients					
	M	*SD*	*min/ max*	*M*	*SD*	*min/ max*	*F*	*p*	*Partial eta squared*
MMQ satisfaction (out of 72)	50.11	14.04	13/72	46.48	13.19	4/68	1.932	.167	.016
MMQ ability (out of 80)	54.36	10.74	31/74	50.24	10.73	19/72	2.971	.087	.024
STIDA memory scale (out of 7)	1.50	1.68	0/7	2.41	1.70	0/6	7.695	.006	.061
Memory composite	.58	1.34	-2.53/ 3.12	-.70	1.75	-4.73/ 2.75	**20.379***	**<.001**	.146
Depression (CES-D, out of 60)	6.46	6.21	0/27	11.34	7.81	0/39	**15.477***	**<.001**	.115
Conscientiousness (IPIP-50, out of 50)	38.57	6.82	20/50	36.34	7.40	15/48	3.978	.048	.032
Neuroticism (IPIP-50, out of 50)**	34.67	7.37	19/50	34.26	6.10	17/45	.139	.710	.001
Brixton mistakes	16.94	5.92	9/33	22.70	9.10	4/44	**17.190***	**<.001**	.126
Stroop interference	-63.70	13.51	-89/-18	-77.28	13.89	- 106/-47	**27.804***	**<.001**	.189
Verbal fluency FAS	47.66	12.59	19/76	38.43	14.91	8.50/74	**12.203***	**.001**	.093
Verbal fluency animals	43.54	12.17	20/73	19.46	5.01	4.50/33.50	**169.447***	**<.001**	.587

*** = significant differences between the two groups after applying Holm-Bonferroni correction**

****=Neuroticism is reversed in all tables. A greater score equals more emotional stability.**

side. A Multivariate Analysis of Variance (MANOVA) was performed in SPSS to assess for statistical differences between the two groups. Eleven dependent variables were investigated in total: MMQ satisfaction, MMQ ability, STIDA memory scale, Memory composite, Depression, Conscientiousness, Neuroticism, Brixton mistakes, Stroop interference, Verbal fluency FAS and Verbal fluency animals. Independent variables were group (PD patients and controls) and age group (youngest and oldest PD patients and controls). Order of entry of IVs was age group, then group. Because PD patients were significantly younger than controls, age was used as a second independent variable. PD patients and controls were first divided into four subgroups using the median age of 69 years old for patients and controls combined. Table 3 shows the cross-tabulation that resulted from the subgrouping.

Table 3. Group * Age group Crosstabulation

		Age group		
		Under 69 years old	Above 69 years old	Total
Group	Controls	22	48	70
	PD patients	32	26	58
Total		54	74	128

The required minimum of 20 participants in each subgroup was obtained. Five patients were excluded from the MANOVA because they had a missing score on the Stroop test. These participants were color blind. Thus, 70 controls and 53 PD patients were included in the MANOVA. With the use of Wilks' criterion, the combined DVs were significantly affected by group $F(11, 109) = 22.71$, $p < .001$ but not by age group $F(11, 109) = 1.59$, $p = .113$ or the interaction of age group with group $F(11, 109) = 1.06$, $p = .397$. Six of our

11 dependent variables were found to differ significantly between our two groups after controlling for the family-wise error rate using a Holm–Bonferroni correction. Contrary to our hypothesis, the PD patients did not report significantly more memory complaints on the STIDA and the MMQ ability than the controls after applying the Holm–Bonferroni correction. As for cognitive performance, PD patients' overall memory performance (indicated by our memory composite) was significantly inferior to that of controls, as it was on our three measures of executive functions. Furthermore, PD patients endorsed significantly higher scores on the depression scale than the controls, but conscientiousness and neuroticism scores did not differ significantly between the two groups.

The relationship between Objective Memory Performance and Self-assessment of Memory

Although we expected that the MMQ would be a better predictor of objective memory performance than the STIDA, we predicted that both of the scales would be positively correlated, albeit modestly, with objective memory. We also expected that the two memory self-assessment scales would be positively correlated with one another given their similarity. To test those hypotheses, but also to explore the various relationships between our variables of interest and how the strength of those relationships might differ for patients and controls, we performed multiples Pearson correlations that are presented in the correlation matrices (Tables 4 and 5). In Table 5, age at the time of testing was used as a covariate given the age difference found between the two groups. Also, to control for the family-wise error rate associated with the problem of multiple correlations, we applied a Holm-Bonferroni correction for each group separately in both sets of correlations. Only one correlation that had reached significance in Table 4 (the correlation between the Brixton and Verbal fluency animals in patients), was no longer significant when age was used as a covariate. The other 18 significant correlations remained. In both PD patients and controls, objective memory performance and self-assessment of memory (assessed by MMQ ability, MMQ Satisfaction, and STIDA) were not significantly correlated. Furthermore, the strength of the linear relationships was either null or poor at the most. The strongest relationship in PD patients that was revealed between MMQ Satisfaction and memory performance failed to reach significance after the Holm-Bonferroni correction. Figures 2, 3, and 4 provide scatter plots illustrating the weak relationships between objective memory performance and our self-assessment measures. Figure 5 provides the scatter plot to illustrate the relationship between our two measures of objective memory that we combined. For both PD patients and controls, the California Verbal Learning Test long delay cued recall and the Logical Memory delayed recall units were moderately correlated (patients $r=.43$, $p=0.001$, controls $r=.44$, $p<.001$).

Table 4.

Pearson Correlations Among the Study Variables and Divided by PD Patients (above the diagonal) Versus Controls (below the diagonal) (p values are reported in parentheses)

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. MMQ Satisfaction		**.61***	**-.46***	.08	**-.56***	.27	**.48***	.21	-.09	-.18	-.09
		(<.001)	**(<.001)**	(.278)	**(<.001)**	(.022)	**(<.001)**	(.058)	(.260)	(.089)	(.253)
2. MMQ ability	**.58***		-.34	-.17	**-.41***	.14	**.41***	.15	-.37	-.37	-.11
	(<.001)		(.005)	(.106)	**(.001)**	(.151)	**(.001)**	(.132)	(.003)	(.002)	(.201)
3. STIDA memory	**-.60***	**-.58***		.09	.28	-.08	-.24	.02	-.04	.25	.12
scale	**(<.001)**	**(<.001)**		(.243)	(.017)	(.279)	(.033)	(.439)	(.379)	(.028)	(.193)
4. Memory composite	-.09	.04	-.07		-.14	.22	.04	**-.50***	.06	.30	**.58***
	(.233)	(.373)	(.293)		(.149)	(.046)	(.395)	**(<.001)**	(.332)	(.012)	**(<.001)**
5. Depression (CES-D)	**-.47***	**-.38***	.31	-.02		-.36	**-.60***	.22	.22	.03	-.14
	(<.001)	**(.001)**	(.005)	(.435)		(.003)	**(<.001)**	(.048)	(.059)	(.403)	(.145)
6. Conscientiousness	.20	**.43***	-.21	-.04	-.24		.18	-.17	-.05	.05	.03
(IPIP-50)	(.053)	**(<.001)**	(.044)	(.379)	(.025)		(.084)	(.107)	(.352)	(.366)	(.408)
7. Neuroticism (IPIP-	.35	.24	-.33	.04	**-.59***	-.03		-.06	.01	.01	.13
50)	(.002)	(.024)	(.003)	(.366)	**(<.001)**	(.414)		(.338)	(.477)	(.480)	(.170)
8. Brixton mistakes	-.18	-.09	.10	-.18	.10	.11	.04		-.07	-.15	**-.47***
	(.071)	(.231)	(.201)	(.063)	(.212)	(.179)	(.368)		(.309)	(.130)	**(<.001)**
9. Stroop interference	-.07	-.17	.18	-.01	.06	-.13	.04	-.20		-.09	-.20
	(.294)	(.085)	(.066)	(.478)	(.312)	(.140)	(.378)	(.053)		(.266)	(.070)
10. Verbal fluency FAS	-.12	-.05	.08	.18	.02	-.09	-.15	<.00	-.23		**.48***
	(.160)	(.333)	(.258)	(.070)	(.434)	(.222)	(.110)	(.495)	(.030)		**(<.001)**
11. Verbal fluency	-.06	.01	.11	.33	.12	-.13	-.16	-.25	-.09	**.53***	
animals	(.310)	(.471)	(.183)	(.002)	(.160)	(.149)	(.100)	(.020)	(.227)	**(<.001)**	

*** = Significant Pearson correlations after applying Holm-Bonferroni correction for each group separately**

Table 5.

Partial Correlations Divided by PD patients (above the diagonal) Versus Controls (below the diagonal) Age as a Covariate (p values are reported in parentheses)

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. MMQ Satisfaction		**.60***	**-.41***	.26	**-.59***	.31	**.49***	.09	-.10	-.17	.11
		(<.001)	**(.001)**	(.027)	**(<.001)**	(.010)	**(<.001)**	(.252)	(.241)	(.098)	(.209)
2. MMQ ability	**.58***		-.31	-.11	**-.41***	.15	**.41***	.10	-.38	-.37	-.04
	(<.001)		(.009)	(.203)	**(.001)**	(.136)	**(.001)**	(.235)	(.002)	(.003)	(.391)
3. STIDA memory scale	**-.60***	**-.58***		.01	.28	-.09	-.23	.11	-.04	.25	.01
	(<.001)	**(<.001)**		(.463)	(.019)	(.250)	(.040)	(.220)	(.379)	(.031)	(.459)
4. Memory composite	-.08	.06	-.08		-.17	.22	.07	**-.43***	.07	.30	**.51***
	(.246)	(.322)	(.263)		(.106)	(.049)	(.315)	**(<.001)**	(.320)	(.012)	**(<.001)**
5. Depression (CES-D)	**-.47***	**-.39***	.31	-.01		-.37	**-.60***	.25	.22	.03	-.18
	(<.001)	**(.001)**	(.005)	(.456)		(.003)	**(<.001)**	(.030)	(.061)	(.411)	(.086)
6. Conscientiousness (IPIP-50)	.20	**.43***	-.21	-.04	-.24		.19	-.16	-.05	.04	.01
	(.054)	**(<.001)**	(.045)	(.383)	(.026)		(.081)	(.117)	(.354)	(.373)	(.462)
7. Neuroticism (IPIP-50)	.35	.24	-.33	.04	**-.59***	-.03		-.08	.01	.01	.18
	(.002)	(.024)	(.003)	(.375)	**(<.001)**	(.415)		(.268)	(.478)	(.469)	(.092)
8. Brixton mistakes	-.18	-.10	.11	-.17	.09	.11	.04		-.08	-.14	-.38
	(.066)	(.202)	(.184)	(.088)	(.223)	(.182)	(.361)		(.298)	(.146)	(.002)
9. Stroop interference	-.07	-.17	.18	-.01	.06	-.13	.04	-.20		-.09	-.23
	(.296)	(.087)	(.068)	(.472)	(.312)	(.142)	(.379)	(.054)		(.268)	(.052)
10. Verbal fluency FAS	-.12	-.04	.07	.16	.03	-.09	-.15	.02	-.23		**.51***
	(.169)	(.368)	(.278)	(.096)	(.419)	(.225)	(.106)	(.448)	(.030)		**(<.001)**
11. Verbal fluency animals	-.05	.04	.10	.30	.14	-.13	-.17	-.22	-.10	**.51***	
	(.333)	(.384)	(.212)	(.006)	(.131)	(.145)	(.084)	(.035)	(.212)	**(<.001)**	

*** = Significant Pearson correlations after applying Holm-Bonferroni correction for each group separately**

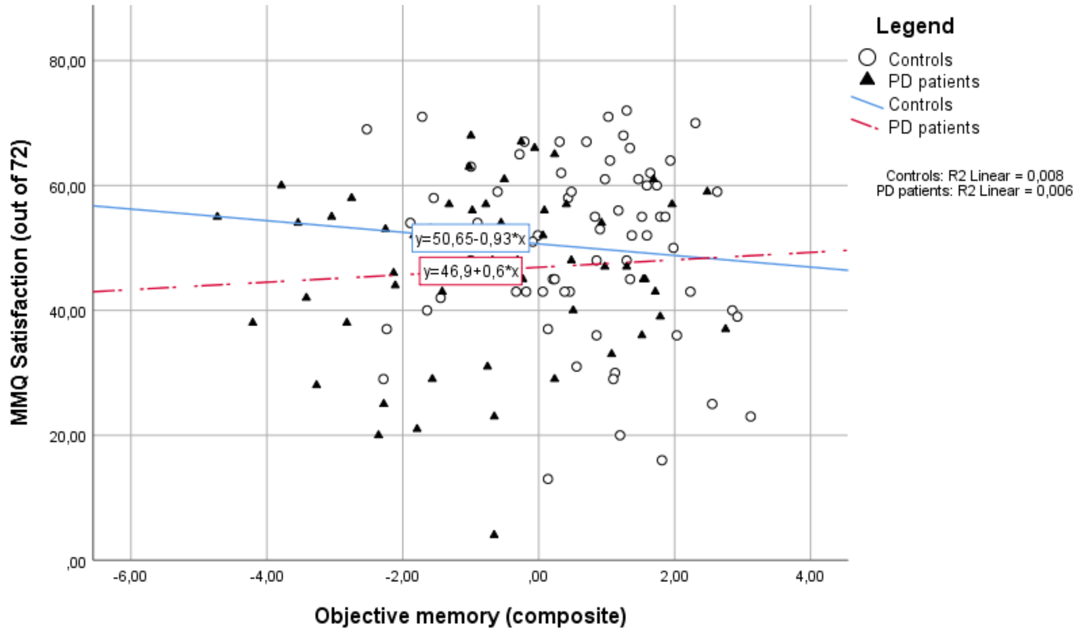

Figure 2. Correlation between objective memory and the MMQ satisfaction scale

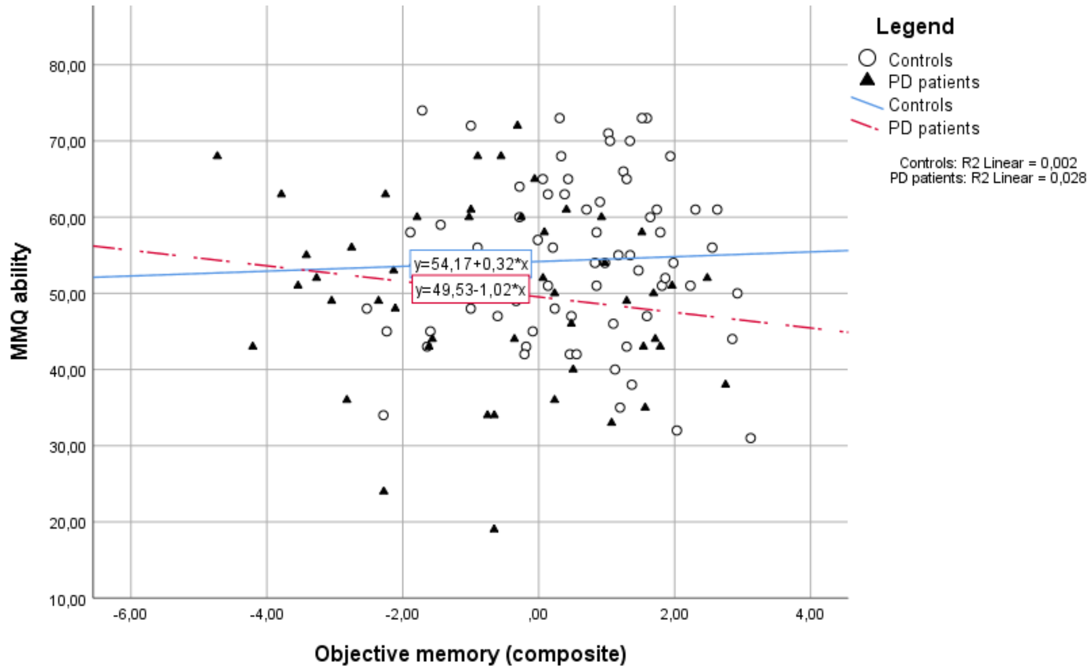

Figure 3. Correlation between objective memory and the MMQ ability scale

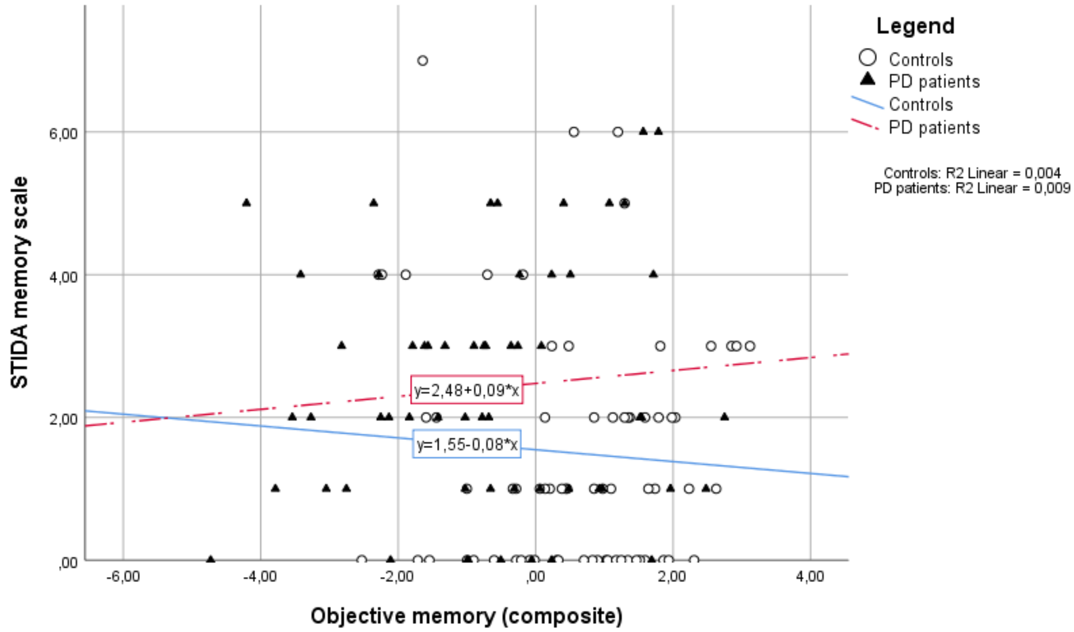

Figure 4. Correlation between objective memory and the STIDA memory scale

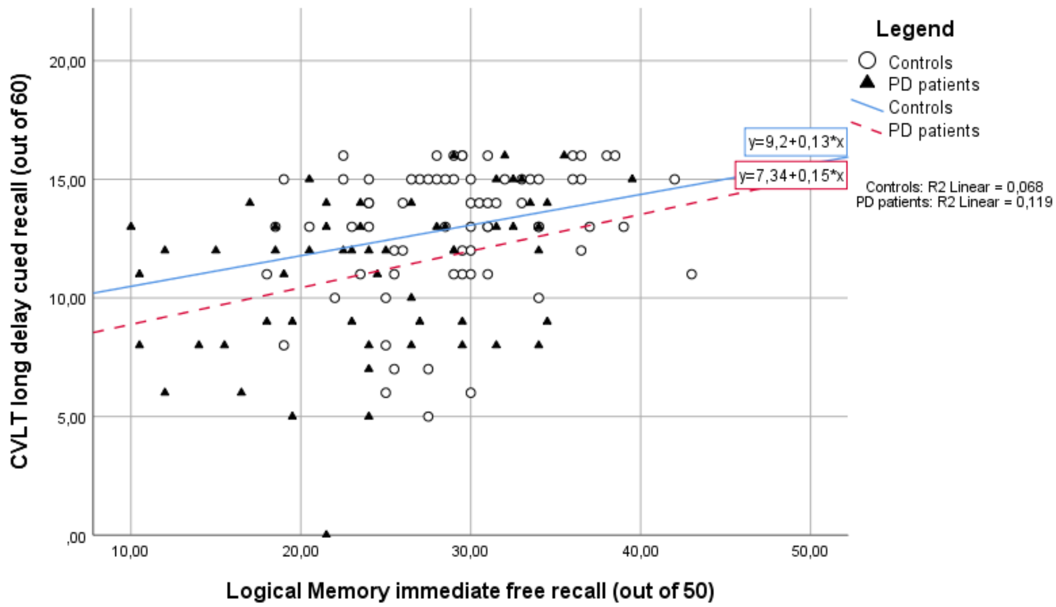

Figure 5. Correlation between the CVLT and the Logical Memory

As for the relationship between our two memory self-assessment questionnaires, MMQ ability was negatively correlated to STIDA for controls, whereas the correlation between the two scales failed to reach significance for patients after applying the Holm-Bonferroni correction. A one-tail Fisher test supported that the difference between these correlations was statistically significant, $Z = -1.69$, $p = 0.046$. Figures 6 and 7 provide scatter plots of the relationships between our two measures of memory self-assessment. They illustrate the modest correlations between the scales of the MMQ and the STIDA. It is also interesting to note, that both in the PD patients and the controls, depression was negatively correlated with MMQ scales, but not significantly correlated with the STIDA. In both groups, depression was also negatively correlated with emotional stability (inverse of neuroticism). In PD patients, but not controls, emotional stability was additionally positively correlated with MMQ ability and MMQ Satisfaction. Whereas, memory performance was not correlated with any predictive variables in controls, it was correlated with two measures of executive function in patients, negatively correlated with Brixton errors as well as positively correlated with Verbal fluency (animals).

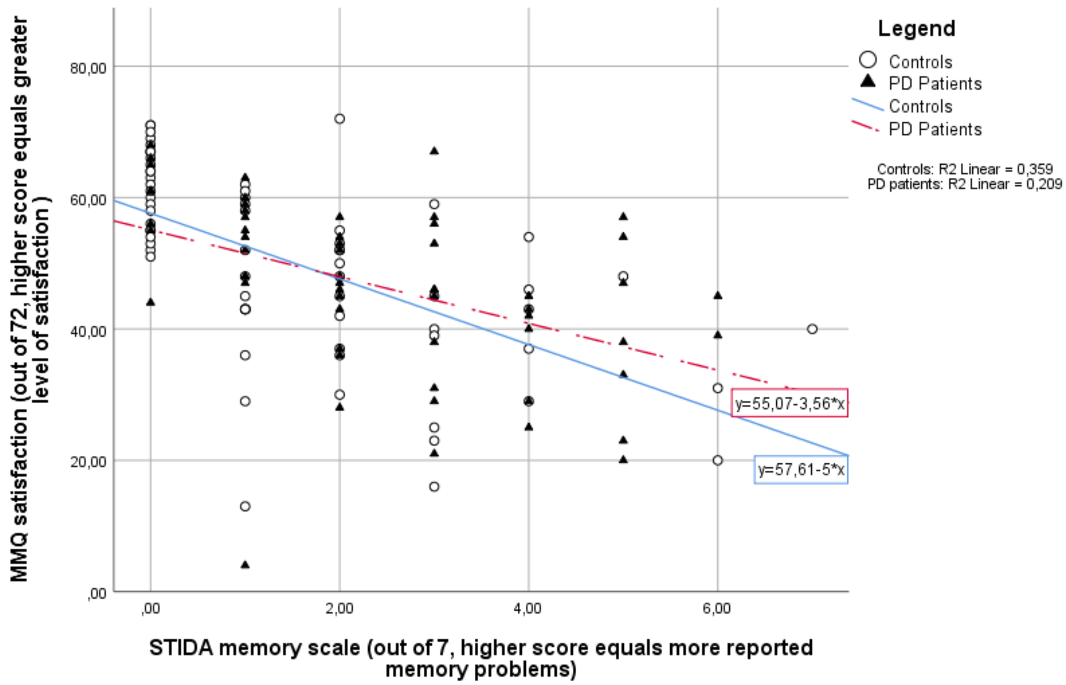

Figure 6. Correlation between the STIDA memory scale and the MMQ satisfaction scale

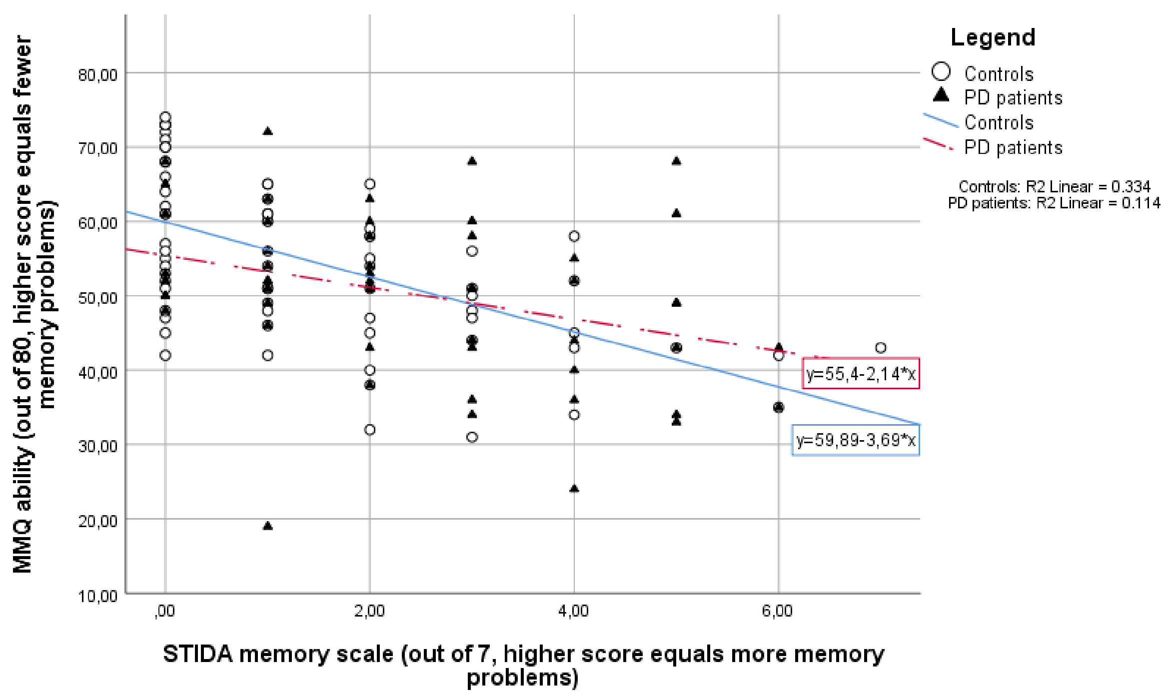

Figure 7. Correlation between the STIDA memory scale and the MMQ ability scale

Predictors of Memory Self-ratings

Insofar as memory self-assessment showed little relation to objective memory performance, we had postulated that depressive symptoms, personality traits (conscientiousness and neuroticism), and executive function would be three psychological domains that influence or predict memory self-ratings. A stepwise multiple regression was then conducted to evaluate whether memory performance (average of our two memory scores), depression, conscientiousness, neuroticism, and executive functions predict MMQ ability. Controls and patients were first combined into a single group to obtain sufficient statistical power. The assumptions for the statistical test were violated, namely normality. As such, the data was subjected to a transformation to reduce skewness, reduce the number of outliers, and improve the normality, linearity, and homoscedasticity of residuals. Two of our variables, Age at testing and Depression, were initially skewed. We normalized Age at testing by excluding two younger PD patients aged 42 and 47 years old respectively (M =68.5, SD =7.15 prior to deletion; M =69,24, SD =6,56 after deletion;). Depression that was positively skewed was normalized by excluding one highly depressed patient (39/60 on the CESD, highest depressive score in our sample) and subsequently using the Templeton method. The Templeton method is a straightforward and efficient statistical approach to transform a non-normally distributed continuous variable into normally distributed z-scores in two steps (Templeton, 2011). Finally, a patient was excluded from the regression as their data was found to be an outlier because the regression standardized predicted value was lower than minus 3. The patient reported a very low level of Satisfaction with memory as well as low memory ability. In total, 9 patients (and no control) were excluded from the multiple regression. That number includes the 5 patients previously excluded for correlational analyses. Thus, the sample size for this analysis was N = 124. Using a threshold of 0.7, we also screened for multicollinearity between the twelve predictor variables. Executive functions and group as well as some interactions terms were found to be multicollinear which is to be expected. Importantly, none of our main predictors were. At step 1 of the analysis, Age was entered into the regression model followed by group at step 2, memory performance, depression, conscientiousness, neuroticism, and executive functions (main predictors) at step 3 and finally the interactions of memory performance, depression, conscientiousness, neuroticism, and executive functions with group at step 4. Altogether, 26.8% of the variability in MMQ ability was predicted by our twelve variables. After step 1, with age in the equation, adjusted R2 = 0.039, F inc (1, 122) = 6.02, p = 0.016. After step 2, with group added to prediction of MMQ ability, adjusted R2 = 0.048, F inc (1, 121) = 2.18, p = 0.14. Addition of group to the equation did not reliably improve R. After step 3, with memory performance, depression, conscientiousness, neuroticism, and executive functions added to prediction of MMQ ability, adjusted R2 = 0.205, F inc (5, 116) = 5.78, p < 0.001. The addition of these main variables to the equation with age and group results in a significant increment in R2. Finally, after step 4, with interaction terms added to predict MMQ ability, adjusted R2 = 0.268, F inc (5, 111) = 3.00, p = .014. The addition of interaction terms to the equation resulted in a significant increment in R2. This pattern of results suggests that the main predictors and the interactions terms take the largest part of the variance explained whereas age contributes modestly to that prediction and group independently of the main predictors adds no further prediction. The final hierarchical regression model is presented in Table 6. When we look more closely at the contribution of each variable at step 4, only conscientiousness, conscientiousness interaction with group and executive function's interaction with group significantly contributed to the variance explained. The distribution of conscientiousness and executive functions scores by group are presented in Figures 8 and 9. PD patients report an average level of conscientiousness that is similar to controls, but display inferior executive functions. Figure 10 shows the interaction effect between MMQ ability and conscientiousness and Figure 11 the interaction effect between MMQ ability and executive functions. In the healthy older adults, we observed a positive correlation between conscientiousness and MMQ ability (r2=0,182) suggesting that healthy individuals with greater conscientiousness report fewer memory complaints. In contrast, the PD patients showed no correlation between the two variables (r2=0.006). The positive correlation between conscientiousness and MMQ ability we observed in healthy older adults replicates the findings of Pearman & Storandt (2004). As for the interaction between group and executive functions, controls showed no correlation between executive functions and memory self-assessment (r2=.004) whereas PD patients' executive functions were negatively correlated with MMQ ability (r2=.23). This suggests that PD patients with lower executive functions report fewer memory complaints.

Table 6.
Final hierarchical regression model (step 4, 12 predictors of MMQ ability)

Source	*B*	*SE B*	β	*t*	*p*
Age	0.22	0.13	0.14	1.63	0.11
Group	4.46	15.87	0.21	0.28	0.78
Objective memory performance (composite score)	0.71	1.69	0.06	0.42	0.68
Depression	-2.36	1.58	-0.22	-1.49	0.14
Conscientiousness	0.62	0.17	0.43	3.64	< 0.01*
Neuroticism	0.19	0.19	0.12	1.01	0.32
Executive functions (composite score)	1.47	2.50	0.10	0.59	0.56
Group* Objective memory performance	0.01	2.40	0.00	0.01	1.00
Group* Depression	1.18	2.26	0.07	0.52	0.60
Group* Conscientiousness	-0.49	0.25	-0.90	-2.01	0.05*
Group* Neuroticism	0.25	0.32	0.42	0.78	0.44
Group* Executive functions	-10.93	3.78	-0.46	-2.89	0.01*

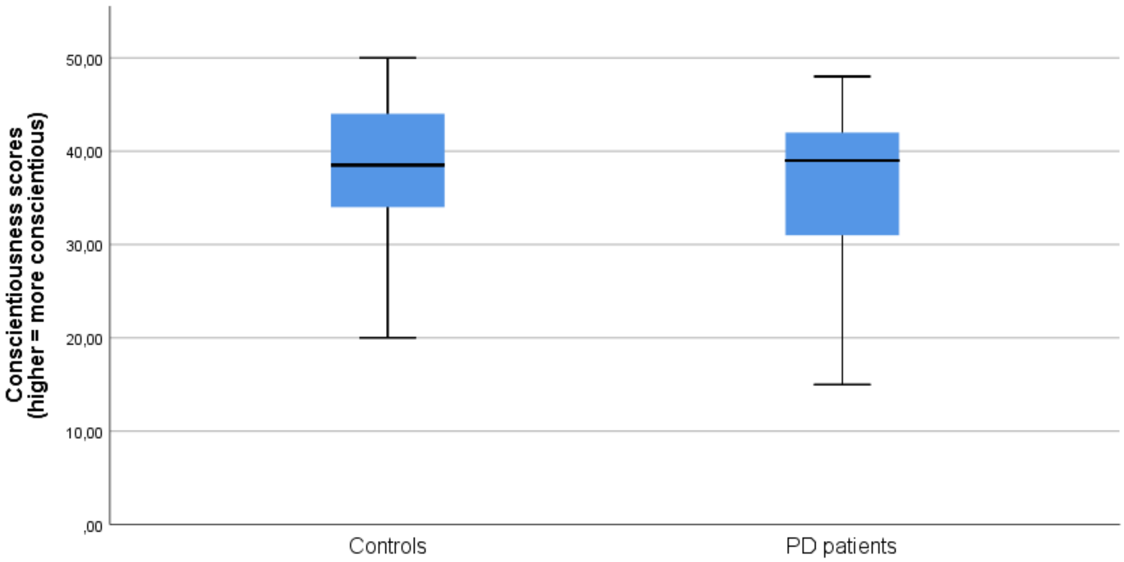

Figure 8. Distribution of conscientiousness scores for controls and PD patients

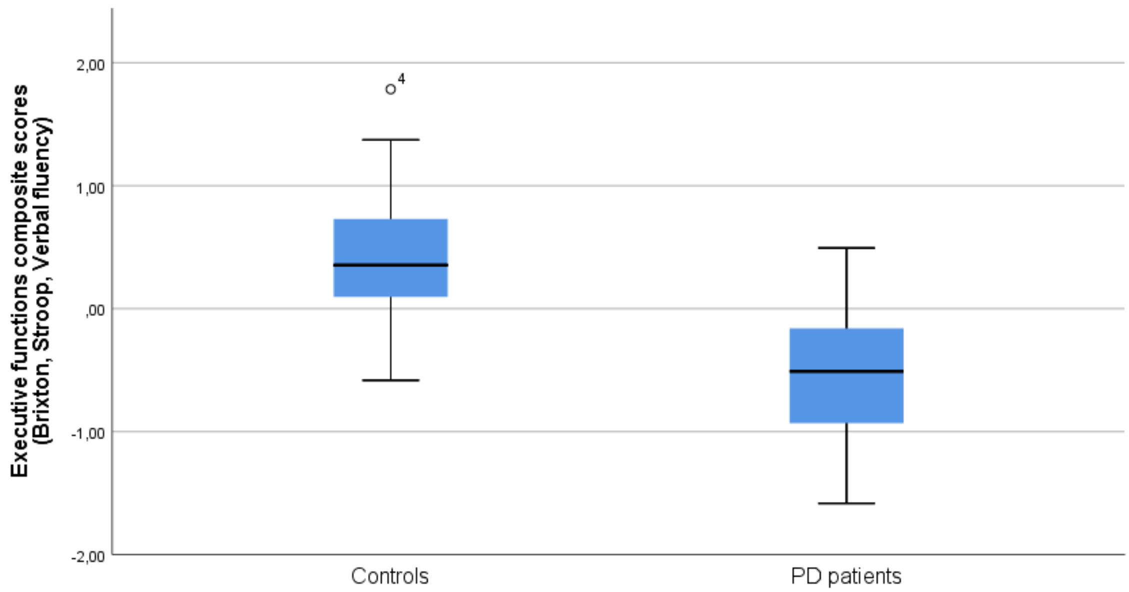

Figure 9. Distribution of executive functions composite scores for controls and PD patients

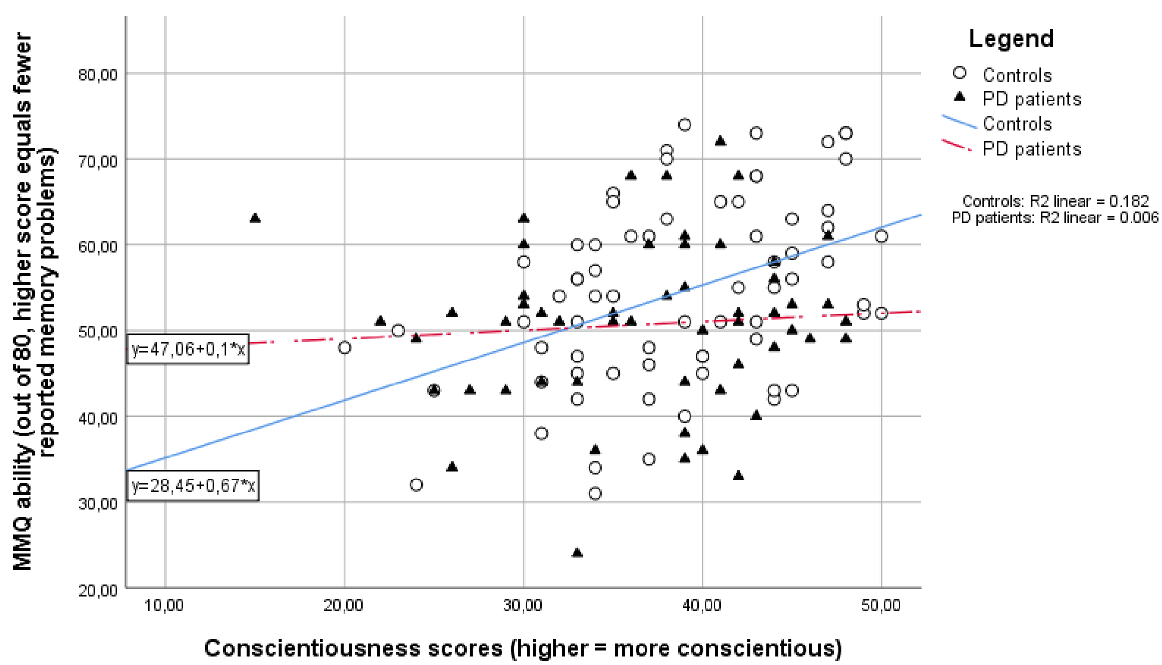

Figure 10. Relationship between MMQ ability and conscientiousness for each group (interaction effect)

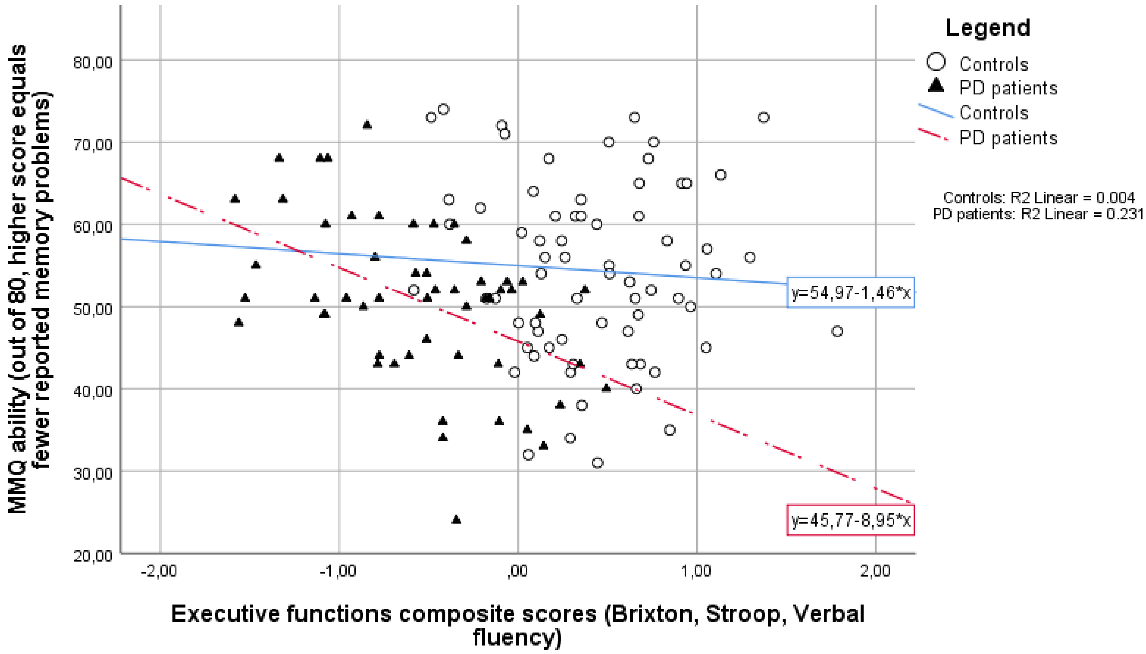

Figure 11. Relationship between MMQ ability and executive functions for each group (interaction effect)

CHAPTER 4 – DISCUSSION AND CONCLUSION

Discussion

In this study, we examined memory self-assessment in PD patients compared to healthy older adults, the relationship between self-assessment of memory and objective memory performance, and potential influences on this relationship. We also compared two questionnaires of memory that had never been used in PD or examined together in any population: the MMQ and the STIDA. PD patients and controls did not differ significantly on MMQ ability and the STIDA after a Holm–Bonferroni correction. Moreover, the two memory self-assessment scales were moderately correlated for controls whereas this relationship failed to reach significance for patients. The difference between these correlations in the two groups was statistically significant. In both groups, objective memory performance and self-assessment of memory (assessed by MMQ ability, MMQ Satisfaction, and STIDA) were not significantly correlated suggesting that individuals with or without PD cannot accurately assess their memory functioning relative to that of others. A multiple regression combining PD patients and controls revealed that the personality construct of conscientiousness as well as the interactions of group with conscientiousness and group with executive function were the strongest predictors of memory self-assessment as measured by MMQ ability.

Modest Correlation Between the Two Self-Assessment Measures (MMQ & STIDA)

On the face of it, the MMQ and STIDA look relatively similar. They both inquire about everyday memory mistakes, but to what extent do they tell us the same thing about participants' self-assessment of memory? Our results suggest some level of agreement between the measures while raising interesting differences between the two. First of all, both measures yielded lower memory self-ratings in the PD patients than in the controls.

These group differences did not reach significance in the STIDA, nor the MMQ ability and satisfaction scales, however. In addition, supporting that the two measures differ to some extent, the MMQ and the STIDA were only moderately correlated in controls (i.e., r = -.60 for MMQ-Satisfaction and r = -.58 for MMQ-Ability).For patients, STIDA and MMQ-Satisfaction were also moderately correlated (r=-.41, p <.001) and the relationship between STIDA and MMQ-Ability was not significant after a Holm–Bonferroni correction (r =-.31 p=.009).

The present report is one of the few studies to compare questionnaires of memory self-assessment. Jackson et al. (2017) combined the 7 questions from the STIDA with the self-rated version of the Everyday Cognition scale and the Memory Functioning Questionnaire to create a composite score of subjective cognitive complaints. They found that the STIDA was moderately correlated with the Memory Functioning Questionnaire in both African-Americans and Caucasians (r=.48 to .54). As for the MMQ, it *has* shown correlations with other self-assessment questionnaires in previous work with healthy older adults. For example, Troyer & Rich (2002) found agreement between the MMQ and subscales of the MIA (Dixon et al., 1988) and the MFQ (Gilewski et al., 1990) in their validation study. For MMQ-Satisfaction, correlations were large with both the Anxiety and Change subscales of the MIA, rs(50) = -.57 and .61, respectively, ps < .001, and medium-sized with the Seriousness of Forgetting subscale of the MFQ, r(51) = .45, p = .001. For MMQ-Ability, correlations were large with the Capacity subscale of the MIA, r(50) = .60, p < .001, and the General Frequency of Forgetting subscale of the MFQ, r(51) = .70, p < .001.

The lower-than-expected/moderate correlations between the MMQ and STIDA suggest that the areas probed by the two may overlap less than one might initially think. Comparison of specific questions suggests conceptual overlap, which was the basis for creating a comparison table where we attempted to match the STIDA questions with the MMQ questions (see Appendix E). For example, the STIDA question #1 "Have you recently experienced any change in your ability to remember things?" is conceptually similar to the MMQ-Satisfaction Q.11 "My memory is really going downhill lately." While they are not identical, both capture an element of change in memory. The MMQ implies memory deterioration whereas the nature of the change in memory could be either positive or negative in the STIDA. The STIDA question #3 "Do you have trouble remembering things from one second to the next?" is conceptually similar to 4 questions of the MMQ that we combined into a composite score (i.e. MMQ-Ability Q.3 Have trouble remembering a telephone number you just looked up, MMQ-Ability Q.4 Not recall the name of someone you just met, MMQ-Ability Q.7 Forget what you were just about to do; for example, walk into a room and forget what you went there to do, and MMQ-Ability Q.14 Forget what you were going to say in conversation). As for the remaining of the STIDA questions, there appears to be no clear equivalent in the MMQ questionnaire.

To test the similarity of the MMQ and the STIDA questions, we performed t-tests where we divided controls and patients by whether they said yes or no on the STIDA question and observed whether the means of the MMQ question differed significantly. Healthy older adults who said they had noticed a change in their memory on the STIDA expressed significantly greater concern about their memory on the relevant MMQ question (M= 2.36/4, SD= 1.03 where 0= Strongly agree and 4= Strongly disagree) than those who had not reported a memory change on the STIDA (M=3.54/4, SD=.61), t(50.64)=5.76, p<.001. A similar pattern occurred in the PD patients. Additionally, healthy older adults who said they had trouble remembering things from one second to the next on the STIDA expressed significantly greater concern about their memory on the four relevant MMQ questions that we combined (M=10.6/16 where for each question 0= All the time and 4= Never, SD= 2.09) compared to those who had not reported trouble remembering things (M=6.77/16, SD= 2.18), t(39.25)= 5.94, p<.001. For PD patients, we did not obtain a significant difference on the 4 MMQ questions between those who said they had trouble remembering things from one second to the next on the STIDA (M= 7.62, SD= 3.12) and those who said they did not (M= 8.86, SD=2.51), t(53.24)= 1.65, p=.104. The reason of this difference between PD patients and controls is unclear.

In light our comparisons and statistical analyses, we would argue that the STIDA and the MMQ share some similarities in their questions, but that they may also be tapping different sets of memory concerns. On close examination of each, the STIDA that was developed to screen for dementia by phone appears to be asking about memory concerns that are much more severe and impairing whereas the MMQ that focuses on memory abilities and strategies that are applicable to everyday life has more questions about commonly reported memory concerns in the population. Questions 4, 5, 6 and 7 of the STIDA are memory problems that would most likely not be endorsed by individuals with normal memory functions. The severity of the STIDA items could partly explain our floor effect on that measure especially amongst healthy controls (i.e., 37.1% of controls versus 13.8% of PD patients reported no complaints on it). The MMQ did not present with this problem. To this extent, our hope for using the STIDA as a shorter substitute for the MMQ was not supported by these data. A clinician or researcher who wants to use one of these two questionnaires should think carefully about what they want to assess before opting for one over the other.

Neither of the two Memory Self-Assessment measures (MMQ and STIDA) Strongly Reflect Actual Episodic Memory Performance

One of our goals was to determine which of the STIDA or the MMQ is the most accurate, reliable, and efficient questionnaire of memory self-assessment. Our findings suggest that neither is fit or preferable to estimate actual episodic memory. Indeed, regardless of whether one used the STIDA or the MMQ and in both patients and controls, self-assessment of memory was not significantly correlated with objective performance (on the CVLT-Logical Memory composite). For the STIDA, this could be partly caused by the floor effect we mentioned earlier. Yet several reports from the literature are consistent with this finding (for reviews, Beaudoin & Desrichard, 2011; Crumley, Stetler, & Horhota, 2014). The ways in which objective memory performance and self-assessment of memory are measured could partially explain the variability reported in their correlation. Many studies have examined individuals’ memory self-assessment in relation to the performance obtained on a single memory task (Beaudoin & Desrichard, 2011). One of the strengths of our study is that memory performance was obtained by combining two validated tests of memory, giving us a robust score. Nonetheless, one may wonder to what extent we can expect questionnaires about everyday memory mistakes to correlate with experimental tasks of memory. In other words, is it surprising that we observed a weak correlation between the two? First, it should be noted that both the

STIDA and the MMQ ask about global aspects of functional memory whereas objective measures tend to assess specific aspects of memory. In their meta-analysis, Beaudoin & Desrichard (2011) reported that memory performance is more strongly related to concurrent memory self-assessment (perceived current ability to perform a given task) than it is to global memory self-assessment (perceived usual memory ability in general). This suggests that we may have obtained better metamemory accuracy if we had inquire about feeling-of-knowing for example and asked participants to think about how well they would be able to remember a list of new words and compared their predictions to objective measures of list learning. Following that thinking, it is legitimate to ask whether subjective measures and objective measures of memory tap in to the same constructs. In the context of our study, both the memory questionnaires and the objective measures of memory, the long delay free recall from the California Verbal Learning Test-II and the recall of the details of the Wechsler Memory Scale-III Logical Memory stories, measured episodic memory. The majority of the questions in the MMQ and the STIDA ask respondents to think back on their daily lives and recollect previous memory experiences such as memory failures and successes. In that way, we could expect some recoupment between our objective and subjective measures of memory. Futhermore, the CVLT and the Logical memory that are commonly used by neuropsychologists have also been shown to have reasonable ecological validity, at least in people with cognitive impairment (Davidson, Cooper, & Taler, 2016). When considering the relationship between objective and subjective memory, one could argue that it is important to use memory tests that have good ecological validity. For one, it seems plausible that ecologically valid questionnaires promote participants’ motivation and effort. Individuals may provide better effort if they perceive a test as being relevant and indicative of their good cognitive functioning. Second, since memory questionnaires ask about everyday memory mistakes, it appears only logical that the test of objective memory performance to which they are compared should be ecologically valid.

In PD, more specifically, it remains to be clarified whether patients' memory self-assessment accuracy is impaired in comparison to controls or proxies. So far, studies seem to suggest that patients provide memory self-ratings that are just as accurate as healthy individuals (Copeland, Lieberman, Oravivattanakul, & Tröster, 2016; Ivory, Knight, Longmore, & Caradoc-Davies, 1999; Sitek, Sołtan, Wieczorek, Robowski, & Sławek, 2011). One potential problem with these reports is that the accuracy of memory assessment is often low in the control group. For example, in Ivory and colleagues (1999), the degree of association between responses on individual items of the memory questionnaire and the different verbal memory tests tended to be low for both patients as well as medical control patients with similar levels of physical disability. In Copeland (2016), both patients' and care partners' accuracy in observing objectively identified deficits were poor across all cognitive domains. When the correlation between performance and self-assessment is already low in healthy individuals, there is little room for patients to demonstrate lower self-assessment accuracy. Notwithstanding, when compared to patients with Alzheimer's disease, PD patients have showed better accuracy in memory self-assessment with some nuances. Lehrner et al. (2015) reported that memory deficits awareness significantly decreased along the continuum from non-amnestic subtypes of mild cognitive impairment to amnestic subtypes of mild cognitive impairment and finally Alzheimer's disease (naMCI→aMCI→AD). Interestingly, they found that PD patients showed accurate self-appraisals as long as memory function was largely unaffected making a distinction between PD with memory impairments and those without. Seltzer, Vasterling, Mathias, & Brennan (2001) came to a similar conclusion. In their study, they assessed impairment of awareness by measuring the difference between patient self-report and caregiver ratings of patient abilities on questionnaires tapping cognitive, emotional/social interaction, self-care, and motor function. They then compared these “discrepancy scores” between the two diagnostic groups and examined them in relation to selected neuropsychological test data. They found that both the AD and PD patients rated themselves as being less impaired than do their caregivers. Furthermore, impaired awareness in PD but not in AD was associated with poorer overall cognitive function and performance on tests measuring memory, attention, and constructional ability. Parkinson’s disease patients with comparatively intact cognitive function display relatively preserved awareness of motor and other deficits. Supporting that PD patients have good accuracy, some studies also found that patients with greater subjective memory complaints performed worse on objective memory tests or were at greater risk of developing MCI. (Erro et al., 2014; Lehrner et al., 2014; Woods & Kneebone, 2017) Others, on the other hand, reported evidence of anosognosia in PD (Orfei et al., 2018; Pillai, Bonner-Jackson, Floden, & Leverenz, 2016). To reconcile the findings on impaired memory self-assessment with those on no-worse-than normal insight, we suggest that many complicating/mediating/moderating variables must be considered.

Influences on Memory Self-assessment Accuracy : Mood, Personality, and Executive Functions

As reviewed above, many studies (including ours) have found a modest relation between self-assessment of memory and actual performance in healthy older adults and Parkinson's patients, but others have reported some correspondence. What explains the difference? The literature has suggested that several other variables must be taken into account to understand this relationship. For example, Niederehe (1998) suggested a theoretical model that considers a number of potential contributors to subjective memory complaints, including physiological disorders, state variables, trait variables, and contextual variables as well as objective memory impairment. Indeed, variables such as depression, anxiety, health, personality, and self-efficacy seem to be related to memory complaints (e.g., Comijs, Deeg, Dik, Twisk, & Jonker, 2002; Kahn, Zarit, Hilbert, & Niederehe, 1975; Levy-Cushman & Abeles, 1998). Much of this research, however, has examined only one or a few of the candidate predictors at a time without considering their combined effects. In the present study, we examined several of these variables together (i.e., depression, neuroticism, conscientiousness and executive functions) with the aim to explain the variance in PD patients and controls' MMQ-Ability self-ratings. Altogether, 26.8% of the variability in MMQ-Ability was predicted by our twelve variables. Conscientiousness, the interaction between group and conscientiousness, and the interaction between group and executive functions were the strongest predictors of memory self-assessment in our sample whereas group and age showed little influence. Our findings are consistent with previous studies that supported the significant influence of conscientiousness on memory self-ratings in different populations (Akbar, Honarmand,

& Feinstein, 2011; Hülür, Hertzog, Pearman, & Gerstorf, 2015; Pearman & Storandt, 2004, 2005; Seiffer, Clare, & Harvey, 2005). In their study examining subjective memory evaluations in 283 older adults, Pearman & Storandt (2004) also found that conscientiousness (adjusted R^2 =.21) was the strongest predictor of the variance in memory complaints followed by self-esteem (.08), Logical Memory (.04), and neuroticism (.03). Individuals low in conscientiousness had more memory complaints. Akbar, Honarmand, & Feinstein (2011) also found greater reported cognitive dysfunction in MS patients with lower conscientiousness. A similar relationship was also found between conscientiousness and subjective executive functioning. Meltzer et al. (2017) reported that lower conscientiousness was related to increased self-reported EF difficulties on five BRIEF-A clinical scales, suggesting that older adults who perceive more EF difficulties tend to view themselves as less conscientious. Whether greater or lower conscientiousness is associated with increased accuracy of memory self-assessment remains to be clarified, however. Seiffer, Clare, & Harvey (2005) found that greater conscientiousness was associated with reduced awareness of memory functioning in individuals with early-stage dementia. In contrast, (Hülür, Hertzog, Pearman, & Gerstorf, 2015) found that persons high in conscientiousness were more accurate in monitoring their memory successes and failures.

Despite previous research findings supporting that depression can influence memory self-assessment (Dujardin et al., 2010; Kahn et al., 1975; Lehrner et al., 2014; Lehrner et al., 2015; Marino et al., 2009; G. Santangelo et al., 2014; Sitek et al., 2011; Soderstrom et al., 2011; Weaver Cargin et al., 2008; Zlatar et al., 2014), depression was not a consistent predictor of memory self-assessment in our patient or control samples.

More precisely, the initial correlational analyses revealed significant relationships between depression and memory self-assessment with more depressive symptoms endorsed on the CES-D being correlated with lower satisfaction with memory on the MMQ-Satisfaction scale as well as with more memory complaints/worse self-reported memory ability on the MMQ-Ability scale. These relationships were present in both our groups (refer to Table 4). The magnitude of the relationship we found between the MMQ-Satisfaction and the CES-D is commensurate with Troyer and Rich's original report of a significant correlation between MMQ-Satisfaction and the Geriatric Depression Scale, $r(43) = -.41$, $p. = 007$ in healthy older adults. Yet, in the multiple regression, depression did not reveal itself as a significant predictor of memory self-assessment. One possible explanation for depression that failed as a predictor of memory self-assessment is that the participants of this study (and the PD sample, in particular) did not endorse severe levels of depression. CESD scores can range from 0 to 60. Scores of 16 to 26 are typically considered indicative of mild depression and scores of 27 or more indicative of major depression (Zich et al. 1990, Ensel 1986). The majority of patients gave CES-D scores that would qualify as "not depressed" or "mildly depressed", and in fact the participant with the highest level of depression was excluded from the multiple regression for the sake of normalization. The low level of depressive symptomatology in our sample could be partly explained by the convenience sampling methods. All of our participants volunteered for the study. PD patients who sought testing were part of associations and both PD patients and controls reported being active within the community. More variability in the depressive scores may have been obtained if participants were recruited randomly from hospital settings. In future work, actively recruiting participants with higher levels of depression (both moderate and severe levels) may make for a more representative sample and may yield more obvious relationships with memory self-assessment. Recruiting participants who endorse greater depressive symptoms may also influence the other predictors included in this study. Depression, personality and executive functions can be correlated with one another. For example, it has been reported that neuroticism is linked to a greater risk to develop depression (Angst & Clayton, 1986; Hirschfeld et al., 1989; Kendell & DiScipio, 1968; Kendler, Neale, Kessler, Heath, & Eaves, 1993; Wetzel, Cloninger, Hong, & Reich, 1980; Xia et al., 2011). Depression can in turn negatively impact performance on tasks of executive functioning (Channon & Green, 1999; Fossati, Ergis, & Allilaire, 2002; Snyder, 2013).

In this study, group taken on its own did not significantly add to the predicted variance in memory self-assessment. However, interaction effects were found between group and conscientiousness as well as group and executive functions. Why greater conscientiousness is correlated with fewer memory complains in healthy older adults but not PD patients is puzzling. Could it be that Parkinson's disease suppressed the influences of conscientiousness on memory self-assessment? Further studies would be needed to clarify the question. As for the interaction between group and executive functions, it appears that PD patients with lower executive functions (but not healthy older adults) report fewer memory complaints. These self-reports are not supported by our data. In PD patients, objective memory performance was negatively correlated with the number of mistakes on the Brixton and positively correlated with the Verbal fluency animals. It may be that PD patients with impaired executive functions lack accuracy in the assessment of their memory functioning. This would add evidence that support the hypothesis that metamemory is a form of executive functions.

Potential Limitations and Future Directions

Aside from further exploration of depression, other potential predictors of memory self-assessment could be combined and investigated in future studies. Our interest led us to study depression, personality and executive functions, but variables such as education, anxiety, and sleep impairments have also been found to influence memory self-assessment. Anxious symptomatology and poor sleep quality appear to be associated with an overestimation of memory dysfunction/greater memory complaints (Akbar, Honarmand, & Feinstein, 2011; Clarnette, Almeida, Forstl, Paton, & Martins, 2001; Comijs, Deeg, Dik, Twisk, & Jonker, 2002; Dux et al., 2008; Hänninen et al., 1994; Koster, Higginson, MacDougall, Wheelock, & Sigvardt, 2015; Tardy, Gonthier, Barthelemy, Roche, & Crawford-Achour, 2015). While the role of mood on memory self-assessment is commonly studied, Akbar, Honarmand, & Feinstein (2011) suggested that anxiety may be a more accurate predictor of cognitive self-assessment than depression, at least in patients with multiple sclerosis. Greater reported cognitive dysfunction was significantly correlated with lower scores on the Paced Auditory Serial Addition Test, increased depression and anxiety, higher neuroticism, and lower conscientiousness, but the authors reported that depression and neuroticism did not contribute significant variance in comparison to anxiety. With regard to the influence of sleep on memory self-assessment, Tardy and colleagues (2015) reported that healthy older adults with a subjective cognitive complaint were 2.1 times more likely to have poor sleep quality. Greater subjective cognitive complaints were also associated with daytime sleepiness.

We would argue that the influences of anxiety and sleep on memory self-assessment are especially important to investigate in PD. Both are frequently reported non-motor symptoms of the disease. A recent meta-analysis concluded that the weighted point prevalence of anxiety disorders in PD averages 31% (Broen et al., 2018) while it is reported that complaints of sleep and wake are present in 74 to 98% of patients (Oerlemans, 2002). As for education, an interesting study by van Oijen, de Jong, Hofman, Koudstaal, & Breteler (2007) found an interaction effect between memory complaints and education. They reported that the risk of Alzheimer's disease associated with subjective memory complaints was higher in highly educated persons than in persons with a low education. Although the role of education in relation to the association between subjective memory complaints and risk of dementia is inconsistent in the literature (Geerlings, Jonker, Bouter, Adèr, & Schmand, 1999; van Oijen, de Jong, Hofman, Koudstaal, & Breteler, 2007), evidence of an interaction suggests that the phenomenon of cognitive reserve is operating. The cognitive reserve hypothesis postulates that people with a high level of education or high IQ are less likely of developing dementia. Those that do will exhibit greater brain pathology before the clinical symptoms of the disease manifest themselves because of their high level of functioning, cognitive flexibility, and use of compensation mechanisms. Also, individuals who have greater initial cognitive reserve will typically experience a faster decline in cognition and function following the onset of the disease. The greater association between subjective memory complaints and Alzheimer's disease in highly educated persons may reflect that more aggressive pattern of cognitive decline. These findings emphasize the importance of self-perceived cognitive deterioration when screening for dementia (Meng & D’Arcy, 2012). One wonders if a similar relationship between education and memory self-assessment accuracy could be found in PD? Given statistical power limitations, the present study did not investigate the influences of education on memory complaints. It is to be noted, however, that our sample was highly educated with most participants having a postsecondary degree.

Apathy, a variable less commonly studied, would also be interesting to compare to depression as a predictor of memory self-assessment in PD. Current estimates of the prevalence of apathy in PD fluctuate between 16.5% and 42%, depending upon the assessment instruments and samples (Pluck & Brown, 2002). Varanese, Perfetti, Ghilardi, and Di Rocco (2011) reported that apathy, but not depression, is associated with deficit in implementing efficient cognitive strategies in PD patients. Specifically, they compared the performance of PD patients with and without apathy on measures of memory, attention, processing speed and executive functions. Their findings revealed that PD patients with apathy performed significantly worse on 9 of the 20 measures including recall and recognition. Depression and apathy revealed a weak correlation and, unlike apathy, depression did not predict cognitive performance. When the authors compared the depressed and non-depressed PD patients within the non-apathetic group, no difference was found for all cognitive measures.

Although it would have been interesting to add those variables to our multiple regression to compare them to our predictors and investigate each unique contribution, it was not possible given the modest size of our sample. We were already stretching our number of predictors and having a ratio of subjects- to-predictors that is too low would have caused our study to have insufficient statistical power (Green, 1991).

In our study, we also choose to look at the PD patients as a single group. This is a limitation to the extent that PD is not a homogenous diagnostic category, and that a distinction between the clinical presentations of our patients may have been preferable (Oh-Lee & Otani, 2014). The clinical heterogeneity of PD is well acknowledged (Hoehn & Yahr, 1967). Various proposals have been advanced to classify patients into subtypes using criteria such as disease onset, disease progression, predominant motor symptoms and presence of depression (Burn, 2006; Gibb & Lees, 1988; Graham & Sagar, 1999; Lewis, 2005; Louis et al., 1999; Paulus & Jelliger, 1991; Rajput, Pahwa, Pahwa, & Rajput, 1993; Schiess, Zheng, Soukup, Bonnen, & Nauta, 2000; Selikhova et al., 2009; Spiegel et al., 2007; Zetusky, Jankovic, & Pirozzolo, 1985). Whereas most studies used methodologies that divide patients according to predetermined notions, some have used a cluster analysis of clinical data to segregate patients into subtypes (Selikhova et al., 2009). In all cases, developing and validating PD's subtypes and their motor and cognitive progression is judged important because it could allow a more accurate prognosis and better clinical management of patients' symptoms. A recent study suggests that treatment needs vary between Parkinson's disease subtypes (Chase, 2015; Erro et al., 2015). In light of PD's heterogeneity of cognitive deficits and different rates of progression, there is new evidence that PD may present in different neuropsychological subtypes. The CamPaIGN, a longitudinal study, suggested there are two distinct cognitive subtypes in PD 1) a frontostriatal/executive function profile associated with dopamine depletion interacting with the COMT genotype and not necessarily progressing to dementia and (2) a posterior cortical dysfunction profile with deficits in impaired language/semantic fluency and visuospatial orientation/pentagon copying, and this second subtype is more likely to progress to dementia (Williams-Gray et al., 2009). Comparing the memory self-ratings of those two groups would be quite interesting. Could it be that PD's subtypes influence the frequency of memory complaints or memory self-assessment accuracy? A study by Yu, Wu, Tai, Lin, & Hua (2010) suggest that it could be the case. Using an episodic paradigm of FOK, Yu and colleagues compared two subgroups of PD patients, one exhibiting tremor-dominant symptoms and the other exhibiting akinetic and rigidity dominant symptoms. They found that FOK accuracy was only impaired in the second group. In sum, PD’s subtypes differences in self-assessment of memory remain to be clarified and explored in future studies.

Given their age, most of the participants in our study were taking prescription medications regularly. Cognitive deficits are relatively common side effects of pharmacological therapy especially in at-risk populations such as older adults and patients with dementia or metabolic abnormalities. Deficits may range from gross encephalopathy with delirium to subtle subjective alterations (e.g., mood and perception of well-being) (Meador, 1998). Another potential limitation of this study is that the cognitive burden of each medication wasn’t considered when investigating objective memory and executive functions. In our PD patients, 43% of were taking medications linked with anticholinergic effects. 93% of patients were taking dopamine replacement drugs. This being said, we did investigate the cognitive burden of anticholinergic drugs in our PD patients as part of an explorative study conducted by Élisabeth Cyr. Using the Anticholinergic Cognitive Burden Scale, all patients were given a cognitive burden score based on their list of medications. Cognitive burden score were low for most of our patients and we decided to divide the PD patients into two groups to run comparison. The patients were divided as taking "no acetylcholine medication" with a score of 0 or taking "acetylcholine medication" with a score of 1, 2, 3 or more. Each group was relatively comparable in terms of their age mean (group 1 having an age mean of 65.91 and group 2 having an age mean of 65.44), their education levels (group 1 having a mean of 17.11 years of education, and group 2 having 16.59 years of education). Additionally, the number of participants in each group was relatively comparable with 35 participants in group 1 and 27 participants in group 2. T tests did not reveal significant difference between groups on memory performance and executive functions as we failed to observe acetylcholine burden effect on memory and executive performance.

Despite our efforts to prevent confounding variables related to experimental design, PD patients were significantly younger than the control group. This difference in the demographic characteristics of the two groups is important to acknowledge. However, because performance in memory and executive functions typically declines with increasing age, the age difference is working against our hypothesis of cognitive superiority of the control group. The ageing literature suggests that if age was considered independently from Parkinson's, patients would outperform controls. By the same premise, we would expect patients' memory and executive functions performance to be further impaired if they were older (Anderson & Craik, 2017; Salthouse, 2010). Supporting our initial hypotheses, however, our results revealed that PD patients performed significantly worse on the CVLT, Logical Memory and measures of executive functions. This suggests that the performance differences we observed between the two groups are valid, but also that we may have observed bigger effects if the two groups were equal in age. In future studies, recruiting younger controls would be an easy solution to investigate the full extent of these effects.

Other possible confounding variables related to experimental design to consider are differences between the testing conditions of our two groups. All 63 PD patients completed the MoCA compared to 18 of the 70 controls. Being tested at home, tested in French and dividing testing into two sessions were options made available only to PD patients. Furthermore, PD patients and controls were rarely tested by the same experimenter. Patients were strictly tested by the graduate student conducting this study whereas controls were tested by a team of graduate and undergraduate students. These methodological differences decrease the consistency of the testing conditions. Ideally, one would want to provide testing conditions that are identical for all participants where the only variables that fluctuate are the one manipulated/studied by the experimenter. Differences in testing conditions introduce potential sources of variance and provide alternative explanations for the results. In our study, although we used standardized tests and questionnaires, it would have been preferable to have the same experimenter test all participants. One experimenter might encourage participants to give their best effort while another could accept «I don't know» for an answer more easily. Such differences in the experimenter behaviour are susceptible to affect participants' behaviour and performance (Price, Jhangiani &Chiang, 2015). It is also possible that the experimenter bias influenced the research outcomes. This bias can be introduced by the experimenter when he communicates subtly and perhaps unconsciously his expectations on the outcome of the experiment to the participants. In this study, experimenters were not blind to the group they were testing and they knew the study experimental hypotheses. Expecting poorer performance in PD patients may have, for example, influenced the experimenter unconsciously despite efforts to remain impartial.

It would also have been preferable for the controls to be offered the same testing options than the controls whether it is to be tested in French or at home. As mentioned previously, recruiting Anglophone controls was easier as compared to recruiting PD patients. With controls tested exclusively in English and patients tested either in French or in English, language adds a level of complexity to the interpretation of our results. Differences between Francophones and Anglophones PD patients are discussed in Appendix C. It should also be noted that participants presented with different levels of bilingualism, a variable that was not assessed by our team. Whereas the effect of bilingualism on cognitive functioning has been the object of many studies, its influence on metamemory has never been studied so far. "Cognitive advantages for bilinguals have inconsistently been observed in different populations, with different operationalisations of bilingualism, cognitive performance, and the process by which language control transfers to cognitive control"(Pot, Keijzer, & Bot, 2018). Traditional research on bilingualism initially suggested that bilingualism fostered executive control advantages due to the frequent use of control mechanisms in language switching. However, new evidence by Blanco-Elorrieta and Pylkkänen (2018) suggest that this advantage is present only in bilinguals who frequently switch languages based on external constraints as compared to those who switch languages freely.

Additionally, we do not believe that the testing location favored one group over the other. Both our laboratory and the houses of our patients offered conditions conducive to concentration and performance. Patients who chose to be tested at home were asked to pick a silent room with a table, no distraction such as a television, background noise or music.

The limited sample size of this doctoral study also represents a limitation. Although we included 124 participants in our multiple regression, this sample size is inferior to the number of subjects recommended by some authors. Tabachnick and Fidell (2007), for example, suggest that the minimum number of subjects for each predictor or independent variable (IV) in a regression analysis should be 5-to-1. One would then need 20 times more cases than IVs. They add that a bare minimum requirement is to have at least 5 times more cases than IVs and at least 25 cases if 5 IVs are used. Following their recommendations and given our number of predictors (i.e. twelve including our five interaction terms), 240 participants should have been recruited for adequate statistical power. While this recommendation was not met, the sample size respected the minimum requirement suggested by Tabachnick and Fidell of at least 5 times more cases than IVs which would be 60 participants. Green (1991) argues that effect size should be considered when estimating the minimum number of subjects needed. Repeating our study with a bigger sample size would allow us to potentially detect smaller effects, investigate other potentially important predictors of memory self-assessment as well as look at the contribution of each executive test separately, rather than combining them into a composite score as we did.

Another limitation of this study is that its design does not allow us to draw conclusions about the causal links between our variables. Not only are the majority of our analyses correlations, we only compared controls and patients at one point in time. While costly and with greater risk of attrition, longitudinal designs are generally considered "superior" to cross-sectional designs. Their observations taken at different moment in time provide information on the time ordering of the variables and, consequently, tentatively suggest the direction of the causality link. This is not the case in a cross-sectional data set where the time ordering of the variables is not explicitly given, except if detailed retrospective information is gathered at the time (Wunsch, Russo, & Mouchart, 2010). Thus, following our participants over time would allow us to track participants' trajectory of cognitive performance, assess the stability of their memory complaints and ultimately make clearer inferences about causality. For example, one may wonder if depression follows or precedes memory complaints. A longitudinal design would also allow us to investigate whether memory complaints predict future cognitive decline, objective that was outside of the scope of this study. While having important memory complaints, some people may perform well compared to the group but still be experiencing memory decline as observed in people with cognitive reserve. Finally, given that PD is a degenerative disease, it would be of special interest to assess memory self-assessment accuracy at different stages of the illness for the same participants (Mulligan, Smart, Segalowitz, & MacDonald, 2017). Variability in memory self-assessment studies results could be partly explained by the disease stage at which patients were tested. Our own study can only make claims about people in the mild/moderate stage of the illness.

Conclusion

To conclude, the results of this doctoral thesis add to the body of scientific evidence supporting that self-assessment of memory is poorly correlated with objective memory performance and better predicted by psychological variables such as conscientiousness. One may ask if questionnaires assessing self-perception of memory such as the MMQ and the STIDA should be used in clinical contexts. Although this study doesn’t support the predictive validity of memory self-assessment questionnaires, we believe that these questionnaires remain valuable sources of information. They may or may not accurately portray the memory performance of the self-respondent; however, they can capture discontentment and distress about memory. These concerns should not be ignored by the medical system. Indeed, distress about memory functions warrants an intervention by the medical team. Firstly, clinicians should clarify by screening and/or objective testing whether the patient’ memory complaints translate in objective impairment. If not, they should provide reassurance, information about memory functioning in aging or PD, and recommendations to promote a healthy cognitive life such as remaining active socially, physically and cognitively. In the same line of thought, memory questionnaires can also be useful tools for reflection for patients and their family. They can help spur discussion about memory functioning. Cognitive decline can be easily overlooked in aging as we tend to focus our attention on physical disabilities that are more apparent. Memory self-assessment questionnaires can serve as tools to increase awareness of memory functioning/deficits for patients and their family.

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APPENDICES

Appendix A. Description and psychometric properties of our testing measures

The measures used in this study include self-administered questionnaires combined with neuropsychological tests assessing memory and executive functions. In this section, I will describe our measures and discuss their psychometric properties.

The Multifactorial Memory Questionnaire (MMQ)

The Multifactorial Memory Questionnaire by Troyer and Rich (2002) includes 57 items divided into three scales: satisfaction, ability and strategy. The satisfaction scale measures satisfaction, concern, and overall appraisal of one's own memory. It also assesses affects that one may have about his memory such as embarrassment, fear and frustration (e.g. I am embarrassed about my memory ability or I get annoyed or irritated with myself when I am forgetful). The scale includes 18 five-point Likert items ranging from strongly agree to strongly disagree, with a higher score on the scale indicating a greater level of satisfaction with memory. The ability scale evaluates the frequency of occurrence of memory mistakes in everyday situations (e.g. Do you forget to pay a bill on time or misplace something you use daily, like your keys or glasses?). The scale includes 20 items and refers to the two weeks preceding the completion of the questionnaire. The five-point Likert items range from never to always and a higher score on the scale indicates less memory problems. Finally, the strategy scale measures the frequency of use of strategies in the last two weeks to facilitate the storage and recall of information (e.g. Do you ever use a timer or alarm to remind you when to do something or write things on a calendar, such as appointments or things you need to do?)The scale includes 19 five points Likert items also ranging from never to always, with a higher score on the scale indicating a greater propensity to use mnemonic strategies.

The validation of the psychometric properties of the English and original version of the MMQ was carried out on a sample of 130 adults. Cronbach's alpha scores were 0.95 for the satisfaction scale, 0.93 for the ability scale and 0.83 for the strategy scale. The test-retest reliability for the three scales at a four-week interval is excellent, ranging from 0.86 to 0.93 (N = 24). The convergent validity of the MMQ scales has been demonstrated by their correlations with the Memory Functioning Questionnaire (MFQ), the Memory in Adulthood Questionnaire (MIA) and objective memory tasks. Divergent validity was demonstrated by the lack of a correlation between MMQ scales and attention tests. A principal component analysis with orthogonal rotation (varimax) identified three factors corresponding to the scales proposed by the authors (Troyer & Rich, 2002).

A French version of the MMQ was validated by Fort and colleagues (2004) who administered this version of the questionnaire to 294 adult participants. The reliability of the French questionnaire is good with Cronbach alpha coefficients ranging from 0.79 to 0.88 for the different scales. In addition, the convergent validity of the MMQ scores was evidenced by significant positive correlations with several subscales of the Metamemory in Adulthood (MIA), namely the anxiety, change, capacity and strategy subscales. An important difference between the English MMQ and the French MMQ is that the French version has four scales, not three. Indeed, the three-factor solution obtained in the original validation study was not validated in the study by Fort et al. (2004). An exploratory factor analysis has shown that a four-factor solution allows for a better interpretation of the scores. Two of the dimensions proposed by Troyer and Rich (2002) have been replicated namely the satisfaction and ability dimensions. The strategy scale has been subdivided into two factors: internal strategies and external strategies. It should be noted that in this study, we use the French version as if it included three scales in order to facilitate the comparisons between Francophone and Anglophone participants.

Finally, the MMQ was chosen for this study because it is relatively exhaustive.

The seven questions from the STIDA that assess memory complaints

The memory complaints subscale from the STIDA developed by Go, Duke, Harrell et al. (1997) includes seven yes or no questions. This is a one-dimensional scale that measures various memory complaints that can be endorsed by older adults (e.g. Do you have trouble remembering things from one second to the next or do you have much more trouble than usual remembering recent events?) Although the use of this subscale by itself has not been validated, Go, Duke, Harrell et al. (1997) report that it is highly correlated with the overall STIDA questionnaire (r = .902). In addition, the seven questions were found to be useful in screening for patients with possible cognitive impairment (Go, Duke, Harrell et al., 1997, Amariglio et al., 2011).

To our knowledge, no French version if the STIDA was ever validated. For the purpose of this study, the seven memory complaints questions were translated by the doctoral student using a double translation method.

For its part, the STIDA complaint subscale was chosen because it is easy to use and quick to administer.

The California Verbal Learning Test-II

The California Verbal Learning Test-II is a measure of episodic verbal learning and memory. It uses a learning paradigm in which participants are exposed to two recall lists with 16 words each and words corresponding to four semantic categories (e.g. animals, vegetables, and musical instruments). First, participants are presented with the first word list five times in the context of a free recall trial. A second list (list B or interfering list) is administered immediately after followed by a free recall. Following the free recall of the second list, the participant is asked to recall the first list in a short-delay free recall followed by a short-delay cued recall where the semantic categories are provided to the participant. Approximately 20 minutes later, whilst the participant was not told that he will have to recite those words again, he is asked to recall the first list in a long-delay free recall, a long-delay cued recall and finally a recognition task. In the recognition task, the examinator reads a list of words including 16 targets and 28 distracters to the participant. One of the great strengths of this measure is that it allows the clinician to assess many characteristics of learning such as recency and primacy effects and learning curve. It also provides the clinician with rich information on the functioning of all three memory phases (encoding, storage, and retrieval) given the different types of recall and delays before recalls.

The (WMS-III) Logical Memory

This sub-test of the Wechsler Memory Scale-III assesses narrative memory. Two short stories are read to a participant who is asked to recite what he remembers immediately after hearing them but also after a 20-minute delay. For older adults, story A is read twice. In the deferred recall phase, the candidate must tell the stories without them being read first. Finally, the participant is asked questions about the two stories as part as a recognition task.

The Montreal Cognitive Assessment

The Montreal cognitive assessment (MoCA) was developed as a screening measure for the assessment of mild cognitive impairment and dementia. As such, it is quick and easy to administer, taking approximately ten minutes to complete under the instructions of a trained professional. The test assesses a range of cognitive functions that is to say attention, executive functions, memory, language, visuoconstructive abilities, abstraction abilities, calculation and orientation. Participants can obtain a maximum of 30 points where a score of 26 and above is considered normal.

The Center for Epidemiological Studies Depression Scale (CES-D)

Depressive symptomatology was measured by the Center for Epidemiological Studies Depression Scale (CES-D) of the National Institute of Mental Health Center for Epidemiological Studies (Radloff, 1977). This scale is brief and was designed to measure self-reported symptoms of depression experienced in the past week. The scale can be self-administered and it includes a total of 20 items that are grouped into four subscales: depressed affect (e.g. I had crying spells.), positive affect (e.g. I enjoyed life.), somatic complaints (e.g. I felt that everything I did was an effort.) and interpersonal relations (e.g. People were unfriendly.). Participants are asked to rate the frequency at which they experienced each symptom on a 4-point Likert scale where 0” is “rarely or none of the time (less than 1 day)”, and “4” is “almost or all of the time (5-7 days)”. Of the 20 items, four are reversed and total scores can range from 0 to 60 with higher scores indicating more severe depressive symptomatology.

Radloff (1977) performed the first systematic evaluations of the psychometric properties of the CES-D on three samples from the community. Using principal component analyzes, he confirmed the four-fold structure of the scale. Additional analyses also demonstrated that the entire scale presented: (i) acceptable internal consistency coefficients (α) ranging from 0.85 to 0.90 in clinical and non-clinical samples, (ii) a moderate test-retest reliability ranging from 0.51 to 0.32 for time intervals ranging from 2 weeks to 12 months; and (iii) moderate correlations with several convergent measures of depressive symptoms, general psychopathology, positive and negative affects, and social desirability.

The psychometric properties of the French version were validated with a sample of 469 participants, including 163 depressed adult patients and 306 adults from the general population (Morin et al, 2011). The factorial validity, and the measurement and latent mean invariance of the CES-D across gender and clinical status, were verified through CFAs based on ordered-categorical items. In addition, the reliability of the questionnaire is considered adequate with the Cronbach α coefficients that vary from 0.83 to 0.96 for the different subscales. The concomitant validity of the CES-D with measures of depression, self-esteem, anxiety and hopelessness was also confirmed in this study.

Finally, this scale was chosen because it has a small number of questions about the physical symptoms of depression, physical symptoms that could be endorsed by patients because of their Parkinson's disease and not because they are depressed per se.

The 50-item version of the International Personality Item Pool questionnaire

Personality variables were measured by the 50-item version of the International Personality Item Pool questionnaire (IPIP, Goldberg, 1999). The IPIP questionnaire assesses the “Big Five” personality factors which include neuroticism/emotional stability, extraversion, openness, agreeableness and conscientiousness. In our study, only the dimensions of conscientiousness and neuroticism were considered as they were judged to be most important in predicting self-assessment of memory after considering the existing scientific literature. Both the conscientiousness and neuroticism scales have 10 five-point Likert items ranging from strongly disagree to strongly agree. The neuroticism scale measures one’s tendency to experience "negative" emotions such as anger, worry, depression, or vulnerability (e.g. I get stressed out easily.) As for the conscientiousness scale, it measures the propensity of one individual towards self-discipline, loyalty, respect of obligations and planning rather than toward spontaneous acts (e.g. I am always prepared.)

Gow, Whiteman, Pattie, and Deary (2005) examined the structure of the 50-item IPIP version in three different samples for a total of 906 adult participants. In all three samples, the 5-factor structure proposed by Goldberg was confirmed, with minor deviations only. The concurrent validity of the scale was also demonstrated with strong correlations between the 5 IPIP factors and the corresponding scales of the NEO Five-Factor Inventory and the Eysenck Personality Questionnaire-Revised Short. In addition, the internal coherence coefficients were all acceptable or high with the lowest coefficient at 0.72.

The French version of the IPIP-50 was available on the internet (Morizot, 2011) but, to my knowledge, it has not yet been validated.

The Stroop test

The Word-Color test created by Stroop (1935) assesses the ability to inhibit an automatic response (read "red") when facing a visuoperceptive incongruity (e.g. "red" written in green ink). Simply, it is a cognitive task that consists of naming the color of the ink in which different color words are printed in. In order to be able to do this, the individual must constantly focus on the color of the ink at the expense of the name of the color (obvious answer) which involves an inhibitory process, but also selective attention that is to say the ability to maintain one’s attention on a stimulus despite the presence of distractors and to put aside one dimension of a stimulus in order to privilege another. The color of the ink may or may not be the same as the name of the color so that "Blue" may sometimes be written in blue ink and on other occasions be written in red, green or yellow ink.

It should be noted that although several versions of the Stroop test exist, the general principle of the test always remains the same. The first task is to read color names printed in black as quickly as possible. The second to identify colors and finally, the third and last task, to present the participant with color words written with different color inks. In this study, we used the version of Golden (1978) which is standardized. Franzen, Tishelman, Sharp, and Friedman (1987) examined the test-retest reliability of this version on 62 participants and obtained coefficients of 0.83 for color names printed in black, 0.738 for color rectangles to be named, and 0.671 for color names written with different color inks whose ink color was to be given. They concluded that there was an improvement in performance at the second attempt followed by a stabilization after three trials.

The Lexical and Categorical Verbal Fluency Test

The lexical and categorical verbal fluency test is a cognitive task that consists of naming the largest number of words beginning with the same letter or belonging to the same semantic category within a predetermined time interval (one minute was given to participants in this study). For example, the participant is asked to say all the words he/she can recall starting with the letter "T" or all the words corresponding to animals or musical instruments. As far as lexical verbal fluency, "F", "A", and "S" are the most commonly used letters and those used in this study. For semantic categories, only the animal category was used. Obviously, the lexical frequency of each letter can fluctuate depending on the language of testing. This is why we will assess for difference between the Francophone and Anglophone patients.

In adults, the test-retest reliability for lexical and categorical verbal fluency at a one-week interval as well as a five-year interval is typically greater than 0.70 (Basso et al., 1999, Dikmen et al. 1999, Harrison et al.2000; Levine et al, 2004; Ross, 2003). This being said, as one might expect, there is an increase in the performance of participants when the interval between the passing of the test is short. As such, Wilson et al. (2000) reported a small but steady increase in performance when the same letter or category is tested in 20 successive administrations of the verbal fluency test over a four-week period.

The Brixton Spatial Anticipation Test

The Brixton Spatial Anticipation Test, which was developed by Burgess and Shallice in 1996, is a visuospatial sequencing task with rule changes that assesses deduction capabilities, an important aspect of executive functioning. The goal of the task is for the participant to discover and follow logical rules, but more specifically, to detect patterns of presentation of visual stimuli. In this task, the experimenter presents the participant with 56 pictures. On each of them are 10 circles arranged in 2 lines of 5 circles with one circle that is always blackened. On each picture, the position of the black circle varies, obeying four simple logical rules. The participant has the concrete task of accurately predicting the position of the black circle on the following sheet. An interesting aspect of this executive function test is that it does not require language skills. It allows the solicitation of a different sensory modality than the Stroop and the verbal fluency test. As for its psychometric properties, the reliability of Brixton has been shown to be acceptable (.71).

Appendix B. Counterbalanced testing orders

ORDER 1

	Completed ✓	Comments
Consent form (2 copies)		
Money and receipt (15$)		
Health questionnaire (Review current medication list + ask for dosage)		
Personal data		
Metamemory • *7 du STIDA* • *MMQ*		
Motor Examination to assess severity of the PD (for patients only)		
MoCA		
CVLT 1		**Time after completion : Must wait 20 min before recall**
• Stroop • BRIXTON		
CVLT 2		
END OF SESSION 1 – Ask the participant whether he would like to continue with the testing or if he would prefer to schedule a second session to finish the battery.		
Logical memory 1		**Time after completion : Must wait 20 min before recall**
Perso and Depression • *IPIP questionnaire* • *CES-D Scale*		
Logical memory 2		
Verbal fluency		
Remaining tests if that is the case		
Debriefing		

ORDER 2

	Completed ✓	Comments
Consent form (2 copies)		
Money and receipt (15$)		
Health questionnaire (Review current medication list + ask for dosage)		
Personal data		
Metamemory • *7 du STIDA* • *MMQ*		
Motor Examination to assess severity of the PD (for patients only)		
MoCA		
CVLT 1		**Time after completion :** **Must wait 20 min before recall**
Perso and Depression • *IPIP questionnaire* • *CES-D Scale*		
CVLT 2		
END OF SESSION 1 – Ask the participant whether he would like to continue with the testing or if he would prefer to schedule a second session to finish the battery.		
Logical memory 1		**Time after completion :** **Must wait 20 min before recall**
• Stroop • BRIXTON		
Logical memory 2		
Verbal fluency		
Remaining tests (if that is the case)		
Debriefing		

ORDER 3

	Completed ✓	Comments
Consent form (2 copies)		
Money and receipt (15$)		
Health questionnaire (Review current medication list + ask for dosage)		
Personal data		
Metamemory • *7 du STIDA* • *MMQ*		
Motor Examination to assess severity of the PD (for patients only)		
MoCA		
Logical memory 1		**Time after completion :** **Must wait 20 min before recall**
• Stroop • BRIXTON		
Logical memory 2		
END OF SESSION 1 – Ask the participant whether he would like to continue with the testing or if he would prefer to schedule a second session to finish the battery.		
CVLT 1		**Time after completion :** **Must wait 20 min before recall**
Perso and Depression • *IPIP questionnaire* • *CES-D Scale*		
CVLT 2		
Verbal fluency		
Remaining tests if that is the case		
Debriefing		

ORDER 4

	Completed ✓	Comments
Consent form (2 copies)		
Money and receipt (15$)		
Health questionnaire (Review current medication list + ask for dosage)		
Personal data		
Metamemory • *7 du STIDA* • *MMQ*		
Motor Examination to assess severity of the PD (for patients only)		
MoCA		
Logical memory 1		**Time after completion :** **Must wait 20 min before recall**
Perso and Depression • *IPIP questionnaire* • *CES-D Scale*		
Logical memory 2		
END OF SESSION 1 – Ask the participant whether he would like to continue with the testing or if he would prefer to schedule a second session to finish the battery.		
CVLT 1		**Time after completion :** **Must wait 20 min before recall**
• Stroop • BRIXTON		
CVLT 2		
Verbal fluency		
Remaining tests (if that is the case)		
Debriefing		

Appendix C. Investigating language differences in PD patients: Francophones versus Anglophones

To maximize the number of PD patients that could participate in testing, we offered individuals with PD the opportunity to be tested either in French or in English. We compiled the French version of all our tests and questionnaires prior to the recruitment of patients. We planned to combine into one group the patients tested in French and in English into one group after screening for group differences. We verified that the two subgroups were similar on demographic characteristics, global cognitive performance, and self-rated measures.

Regarding demographic characteristics, statistical analyses revealed that patients tested in French and those in English did not differ significantly on age at testing, sex ratio, education years, testing location, and disease duration (see Supplementary table 1). Only motor symptoms' severity was proven to be significantly higher for PD patients tested in English. We can only attribute this significant difference to chance given that all patients were tested by the same experimenter and that they all volunteered to take part in the study.

Controlling for the motor symptoms' severity difference, we had found previously, a MANCOVA on the self-ratings, cognitive performance, and emotion/personality ratings was performed to assess potential differences between the two subgroups. As demonstrated in the Supplementary table 2, the single significant difference between the two groups that remained after applying the Holm-Bonferroni correction was on memory composite. Patients tested in English proved to perform significantly better on measures of memory despite using French tests that were validated. It is to be noted that the difference on memory performance doesn’t remain when a simple MANOVA is performed. As shown in the Supplementary table 3, when differences on motor symptoms severity are not taken into account, we find no significant difference between the two groups on cognitive performance, self-ratings, and personality.

In terms of correlations between our different variables (Supplementary table 4), we note that, after applying the Bonferroni correction, no correlation remains in the patients tested in French. In patients tested in English, however, we find that the two MoCA scores are positively correlated together so is MMQ Satisfaction and MMQ ability (positively), MMQ Satisfaction and depression (negatively), depression and neuroticism (negatively), memory composite and Brixton errors (negatively), and finally memory composite and verbal fluency animal (positively).

Appendix D. Supplementary Tables

Supplementary table 1.

Demographic Characteristics of PD Patients (Patients tested in French versus those tested in English)

	Patients tested in French n=28		Patients tested in English n=30				
	M	*SD*	*M*	*SD*	*t*	*p (2-tailed)*	*Cohen's d*
Age	67.39	7.88	65.80	9.36	-.699	.488	.18
Education years	16.75	3.71	16.97	3.13	.241	.811	.06
Sex	17M 11F		20M 10F				
Tested at home	67.9%		50%				
Motor symptoms' severity (Unified Parkinson's Disease Rating Scale, out of 56)	13.22	7.78	20.30	5.79	3.922	<.001	1.04
Number of years since PD diagnosis (best estimate given by patients)	6.71	6.01	6.30	3.76	.317	.752	.08

Supplementary table 2.

Self-ratings and Cognitive Scores of PD patients (Patients tested in French versus those tested in English) MANCOVA

	Patients tested in French			Patients tested in English					
	M	*SD*	*min/ max*	*M*	*SD*	*min/ max*	*F*	*p*	*Partial eta squared*
MoCA total score (out of 30)	26.39	2.50	20/30	26.63	2.06	22/29	3.40	.041508	.122
MoCA memory score (out of 5)	4.11	0.99	2/5	3.73	1.08	0/5	1.27	.288958	.049
MMQ Satisfaction (out of 72)	48.00	12.63	21/68	45.07	13.74	4/66	0.30	.742271	.012
MMQ ability (out of 80)	52.82	9.24	33/68	47.83	11.59	19/72	1.39	.257843	.054
STIDA memory scale (out of 7)	2.64	1.68	0/6	2.20	1.71	0/6	0.56	.572573	.023
Memory composite (z score)	-.23	1.70	-3.82/ 2.50	.22	1.58	-2.89/ 3.22	**7.82**	**.001129***	.242
Depression (CES-D, out of 60)	10.89	6.78	0/25	11.77	8.76	0/39	0.91	.409079	.036
Conscientiousness (IPIP-50, out of 50)	37.00	7.09	22/48	35.73	7.75	15/48	1.73	.188031	.066
Neuroticism (IPIP-50, out of 50)	34.64	4.48	25/43	33.90	7.35	17/45	0.28	.758595	.011
Brixton mistakes	22.11	10.07	4/44	23.23	8.27	9/35	2.91	.063697	.106
Stroop interference	-77.52	11.93	-97/-56	-77.07	15.59	-106/-47	0.08	.920713	.003
Verbal fluency FAS	37.59	15.04	8.50/74	39.22	15.00	11/69.5	2.38	.103167	.089
Verbal fluency animals	19.50	5.40	4.50/ 30.5	19.42	4.70	8/33.5	5.55	.006696	.185

* = only significant difference between the two groups after applying the Holm-Bonferroni correction

Supplementary table 3.

Self-ratings and Cognitive Scores of PD patients (Patients tested in French versus those tested in English) MANOVA

	Patients tested in French			Patients tested in English					
	M	*SD*	*min/ max*	*M*	*SD*	*min/ max*	*F*	*p*	*Partial eta squared*
MoCA total score (out of 30)	26.39	2.50	20/30	26.63	2.06	22/29	0.106	0.746	0.002
MoCA memory score (out of 5)	4.11	0.99	2/5	3.73	1.08	0/5	2.379	0.129	0.045
MMQ Satisfaction (out of 72)	48.00	12.63	21/68	45.07	13.74	4/66	0.393	0.533	0.008
MMQ ability (out of 80)	52.82	9.24	33/68	47.83	11.59	19/72	3.305	0.075	0.061
STIDA memory scale (out of 7)	2.64	1.68	0/6	2.20	1.71	0/6	1.622	0.209	0.031
Memory composite (z score)	-.23	1.70	-3.82/ 2.50	.22	1.58	-2.89/ 3.22	0.668	0.418	0.013
Depression (CES-D, out of 60)	10.89	6.78	0/25	11.77	8.76	0/39	0.033	0.856	0.001
Conscientiousness (IPIP-50, out of 50)	37.00	7.09	22/48	35.73	7.75	15/48	0.992	0.324	0.019
Neuroticism (IPIP-50, out of 50)	34.64	4.48	25/43	33.90	7.35	17/45	0.373	0.544	0.007
Brixton mistakes	22.11	10.07	4/44	23.23	8.27	9/35	0.236	0.629	0.005
Stroop interference	-77.52	11.93	-97/-56	-77.07	15.59	-106/-47	0.102	0.751	0.002
Verbal fluency FAS	37.59	15.04	8.50/74	39.22	15.00	11/69.5	0.011	0.917	0.000
Verbal fluency animals	19.50	5.40	4.50/ 30.5	19.42	4.70	8/33.5	0.310	0.580	0.006

Supplementary table 4.

Pearson correlations among the study variables divided by patients tested in English (above the diagonal) versus patients tested in French (below the diagonal) (p values are reported in parentheses)

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. MoCA total score		**.64***	-.05	-.23	.08	.49	.13	.14	.00	-.34	.11	.36	.44
		(<.001)	(.389)	(.113)	(.337)	(.003)	(.242)	(.226)	(.500)	(.032)	(.288)	(.026)	(.008)
2. MoCA memory	.45		-.04	-.32	.01	.21	.17	.02	-.16	-.17	.33	.10	.15
score	(.009)		(.411)	(.042)	(.477)	(.134)	(.187)	(.458)	(.193)	(.184)	(.039)	(.293)	(.212)
3. MMQ Satisfaction	-.22	.21		**.70***	-.53	.09	**-.64***	.17	.50	-.08	-.03	-.24	<.01
	(.136)	(.139)		**(<.001)**	(.001)	(.315)	**(<.001)**	(.190)	(.003)	(.332)	(.433)	(.101)	(.493)
4. MMQ ability	-.05	.23	.48		-.41	-.18	-.42	.11	.40	.14	-.33	-.41	-.26
	(.404)	(.117)	(.005)		(.012)	(.175)	(.011)	(.282)	(.014)	(.230)	(.039)	(.013)	(.086)
5. STIDA memory	.10	-.04	-.42	-.35		-.03	.39	-.10	-.19	.26	.09	.18	-.05
scale	(.313)	(.415)	(.013)	(.035)		(.446)	(.017)	(.295)	(.157)	(.087)	(.319)	(.174)	(.407)
6. Memory composite	.51	.34	.10	-.09	.26		-.06	.12	.04	**-.59***	.24	.31	**.76***
	(.003)	(.038)	(.301)	(.317)	(.090)		(.386)	(.259)	(.423)	**(<.001)**	(.110)	(.051)	**(<.001)**
7. Depression (CES-	-.09	-.08	-.44	-.38	.15	-.27		-.33	**-.63***	.28	.19	<.01	-.07
D)	(.326)	(.342)	(.010)	(.022)	(.219)	(.081)		(.039)	**(<.001)**	(.067)	(.158)	(.500)	(.349)
8. Conscientiousness	.03	-.08	.37	.14	-.08	.36	-.41		.05	-.16	-.05	-.14	-.09
(IPIP-50)	(.450)	(.345)	(.025)	(.239)	(.347)	(.029)	(.015)		(.390)	(.195)	(.405)	(.231)	(.324)
9. Neuroticism (IPIP-	-.14	.08	.46	.45	-.39	.06	-.57	.43		-.13	.10	.01	.12
50)	(.240)	(.351)	(.007)	(.008)	(.021)	(.376)	(.001)	(.011)		(.249)	(.310)	(.477)	(.259)
10. Brixton mistakes	-.49	-.01	.53	.21	-.18	-.45	.16	-.17	.05		-.12	-.28	-.50
	(.005)	(.483)	(.002)	(.145)	(.180)	(.010)	(.209)	(.201)	(.399)		(.265)	(.067)	(.003)
11. Stroop interference	-.13	-.37	-.18	-.49	-.25	-.20	.26	-.06	-.20	-.02		-.02	.02
	(.271)	(.033)	(.197)	(.007)	(.118)	(.165)	(.106)	(.390)	(.165)	(.469)		(.460)	(.469)
12. Verbal fluency FAS	.35	.16	-.10	-.32	.36	.28	.07	.28	.01	-.04	-.20		.47
	(.036)	(.215)	(.309)	(.049)	(.032)	(.076)	(.358)	(.079)	(.481)	(.420)	(.172)		(.004)
13. Verbal fluency	.51	.17	-.18	.04	.27	.45	-.23	.15	.15	-.45	-.49	.49	
animals	(.003)	(.200)	(.178)	(.418)	(.083)	(.009)	(.121)	(.221)	(.223)	(.010)	(.007)	(.004)	

Appendix E. Comparison table of the STIDA and MMQ

STIDA questions	Question possibly equivalent in the MMQ
1. Have you recently experienced any change in your ability to remember things?	MMQ-Satisfaction Q.11 My memory is really going downhill lately.
2. Do you have more trouble than usual remembering a short list of items, such as a shopping list?	No clear equivalent.
3. Do you have trouble remembering things from one second to the next?	MMQ-Ability Q.3 Have trouble remembering a telephone number you just looked up. MMQ-Ability Q.4 Not recall the name of someone you just met. MMQ-Ability Q.7 Forget what you were just about to do; for example, walk into a room and forget what you went there to do. MMQ-Ability Q.14 Forget what you were going to say in conversation.
4. Do you have much more trouble than usual remembering recent events?	No clear equivalent.
5. Do you have any difficulty in understanding or following spoken instructions?	No clear equivalent.
6. Do you have more trouble than usual following a group conversation or plot in a TV program due to your memory?	No clear equivalent to us. (The best equivalent would be MMQ-Ability Q.14 Forget what you were going to say in conversation. However, we believe that forgetting what you were going to say in a conversation and losing track of the conversation are two different things. The second appears to be a greater memory concern to us.)
7. Do you have trouble finding your way around familiar streets?	No clear equivalent.