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Executive Functions in Frontotemporal Dementia and Lewy Body Dementia

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Diagnosis of different types of dementia is often based on clinical symptomatology rather than underlying pathology; therefore, accurate diagnosis depends on a thorough description of cognitive functioning in different dementias. Furthermore, direct comparison of cognitive functions between different types of dementia is necessary for differential diagnosis. Executive dysfunction is common in several types of dementia, including frontotemporal dementia (FTD) and Lewy body dementia (LBD); however, FTD and LBD patients have never been directly compared on measures of executive functioning. The authors compared the performance of 17 FTD and 15 LBD patients on 6 measures of executive functioning in terms of statistical group differences, mean severity of clinical impairment in comparison to normal controls, and frequency of impairment. Results indicated a remarkably similar pattern of performance across all areas examined in terms of mean performance, as well as degree and frequency of impairment. Only the Stroop test produced results that could potentially differentiate the patient groups. These findings suggest that both FTD and LBD should be considered disorders involving executive dysfunction.

Keywords: dementia, frontotemporal dementia, Lewy body dementia, executive functioning

Dementia is a progressive neurodegenerative syndrome that encompasses deficits in a wide variety of areas, including memory, speech and language, visuospatial abilities, executive functioning, personality, and behavior. Dementia increases in prevalence with age, doubling approximately every 5 years, and ranging from 2% to 3% in individuals ages 65 to 74 years to more than 30% in individuals ages 85 and over. Alzheimer's disease (AD) is the most common and most studied form of dementia, accounting for approximately one half to two thirds of all dementias (Chertkow, 2008; Hendrie, 1998). However, there are several other types of dementia that are less well studied, including vascular dementia, frontotemporal dementia (FTD), and Lewy body dementia (LBD). One area of cognitive functioning that is commonly impaired in many dementias is executive functions (Knopman, Boeve, & Petersen, 2003). However, executive deficits in multiple types of dementia are rarely studied together with the same measures, which makes it difficult to determine whether executive dysfunction is more severe or more prevalent in certain types of dementia in comparison to others. Thus, the aim of this study was to examine executive functioning deficits in two forms of dementia where this type of dysfunction is prominent, namely FTD and LBD.

FTD and LBD have distinctive underlying pathologies; however, diagnosis is based on clinical symptomatology rather than underlying pathology. Therefore, it is important to understand the extent to which symptoms and cognitive deficits are distinct or overlapping in different dementia groups. It is important to note that executive dysfunction has been identified as part of the symptomatology of both FTD and LBD, making it difficult to distinguish between these two conditions without a thorough categorization of the nature of these deficits. A description of these deficits may contribute to an earlier and more accurate diagnosis, which could enable the implementation of preventative therapies and aid

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in the clinical management of the disorders. To this end, the present study addressed executive functioning in FTD and LBD across four domains: working memory, inhibitory control, generative behavior, and planning. In addition, the degree and frequency of impairment in each domain were examined.

Executive Functioning

Executive functioning is a multidimensional construct that has been conceptualized as high-level control over lower level cognitive functioning and higher order cognitive capacities that subserve independent, goal-directed behavior (Perry & Hodges, 1999; Royall et al., 2002; Stuss & Levine, 2002). Executive control is particularly important in novel situations in which automated, routine behaviors are inadequate and in which the individual must plan and carry out a sequence of actions while monitoring progress toward a goal and adjusting behavior as necessary. Recent work has demonstrated that several cognitive abilities subsumed under the umbrella term of *executive functions* are related, yet separable. For example, Miyake and colleagues (2000) used confirmatory factor analysis to demonstrate that shifting, updating, and inhibition were clearly distinguishable, yet they shared some underlying commonality. Various subcomponents have been suggested to belong to the construct of executive functioning, including planning, initiation, organization, self-monitoring, cognitive flexibility, set shifting, inhibitory control, generative behavior, abstraction, updating of working memory, and divided attention (Alvarez & Emory, 2006; Miyake et al., 2000; Royall et al., 2002; Spreen & Strauss, 1998; Stuss & Levine, 2002). Many of those subcomponents are measured by tests that can be considered to tap into four overarching domains that are frequently cited in the literature: working memory, inhibitory control, generative behavior, and planning. As these four domains encompass many aspects of executive functioning, we have chosen to focus on them in this study.

Working memory has been defined as the short-term maintenance and storage of task-relevant information while performing a cognitive task (Miyake & Shah, 1999). The updating of working memory has been distinguished as a component of executive functioning using confirmatory factory analysis (Miyake et al., 2000), and it has been argued that the manipulation of information held online, particularly when interference is present, represents the executive component of working memory (D'Esposito, Postle, & Rypma, 2000; Stuss & Levine, 2002). Thus, cognitive tasks that assess working memory typically require participants to continually maintain and update information held in mind. The Brown–Peterson task (BPT; Spreen & Strauss, 1998) and the Letter–Number Sequencing (LNS) subtest of the Wechsler Adult Intelligence Scale—Third Edition (WAIS–III; Wechsler, 1997) were the measures of working memory used in this study. These two tasks assess short-term memory while performing an interfering cognitive task (BPT) and the manipulation of information held online (LNS) and are therefore likely to be sensitive to the executive component of working memory (Stuss & Levine, 2002).

Inhibitory control refers to the ability to suppress behavior or information that is irrelevant to or impedes the task at hand, and is necessary to overcome prepotent, automated behaviors in novel situations (Shallice & Burgess, 1993). Inhibitory control is often tested by requiring participants to give a response other than the one that is most salient. Consequently, we used the Hayling test (Burgess & Shallice, 1997) and the Victoria version of the Stroop test (Spreen & Strauss, 1998).

The essence of generative behavior is the ability to produce behaviors and responses quickly and efficiently. Thus, tests that measure verbal fluency require individuals to produce material within certain constraints during a specified time limit. These tasks require executive control for initiation (generation of words), organization of verbal retrieval, self-monitoring (tracking responses already given), and inhibition of responses that do not fit within the constraints (Henry & Crawford, 2004). Verbal fluency is often measured by requiring the patient to generate a list of words that begin with a specified letter (phonemic fluency) or that belong to certain semantic categories (e.g., animals; semantic fluency). Phonemic fluency has been generally accepted as a measure of executive function because generating words on the basis of orthographic criteria is an unfamiliar task requiring novel search strategies. However, semantic fluency likely relies on well-established semantic knowledge, and therefore likely reflects semantic memory in addition to some aspects of executive functioning (Henry & Crawford, 2004; Stuss et al., 1998). Furthermore, clustering (production of words within subcategories) and switching (shifting between clusters) can be examined for both phonemic and semantic fluency. Switching has been argued to be more related to executive functioning than clustering, as the number of switches is more important than mean cluster size for optimal performance on phonemic fluency, whereas clustering and switching are equally important for performing well on semantic fluency (Troyer, Moscovitch, & Winocur, 1997).

Finally, planning a series of actions necessary to achieve a certain goal is another central aspect of executive functioning (Owen, 1997; Spreen & Strauss, 1998). This requires the ability to initiate and organize behavior in time and space, monitor progress toward the goal, and adjust behavior as necessary. Developing a plan of action is necessary when multiple steps must be coordinated to reach a goal (Owen, 1997). The measure of planning used in this study was the Tower of London (TOL; Shallice, 1982), in which participants must move balls on pegs of varying heights to match a model configuration within certain constraints. In this task, it is necessary to plan and execute the series of moves required to achieve the goal of matching the model.

Executive functions have been linked to the frontal lobes and, in particular, to the dorsolateral prefrontal cortex (DLPFC). The prefrontal cortex is uniquely positioned to integrate information from multiple brain regions because it is connected to more brain areas than any other cortical region and is a major target for both limbic and basal ganglia–thalamocortical circuits (Fuster, 2002; Royall et al., 2002). Therefore, the prefrontal cortex has been proposed to be primarily involved in unifying executive control over lower level functions (Gazzaley & D'Esposito, 2007). Lesion and functional imaging studies have linked the DLPFC to many aspects of executive functioning, including verbal fluency, working memory, attention (e.g., attentional switching, selective attention, and sustained attention) inhibitory control, set shifting, and planning (for reviews, see Gazzaley & D'Esposito, 2007; Stuss & Levine, 2002). However, several studies have found that some individuals with lesions to the frontal lobes perform within the normal range on tests of executive function and some patients with nonfrontal lesions perform poorly on those tests (see Alvarez &

Emory, 2006, for a review). The exact nature of the relationship between executive functioning and the frontal lobes is still under debate, but it is clear that some relationship exists. Some researchers have suggested that the control of executive functions is not localized exclusively within the frontal lobes, but rather within the system of circuits connected to the prefrontal cortex (Royall et al., 2002). As the prefrontal cortex and the networks connected to the prefrontal cortex are affected in FTD and LBD (Grossman, 2002; Simard, van Reekum, & Cohen, 2000), executive dysfunction would be expected in both of these types of dementia.

Executive Function in Frontotemporal Dementia

FTD is the most common of three major clinical syndromes of the broader category *frontotemporal lobar degeneration* (FTLD). Although the use of terminology in this area has been inconsistent, FTLD can be thought of as encompassing the clinical syndromes with degeneration generally confined to the prefrontal and anterior temporal lobes and involving non-AD type pathology (Neary, Snowden, & Mann, 2005). In addition to FTD, semantic dementia (SD) and nonfluent progressive aphasia (NFPA) fit into this category. All three syndromes are characterized by insidious onset and gradual progression, but the core diagnostic features differ between the subtypes. In general, patients with the more broadly defined FTLD often exhibit impairment in memory in daily activities similar to that seen in AD; however, it has been suggested that deficits related to executive functioning, such as inattention, inability to focus on one task, and easy distractibility, may account for this impairment (Attix & Welsh-Bohmer, 2006; Heilman & Valenstein, 2003). In addition, individuals with FTLD may also demonstrate extrapyramidal features such as rigidity, gait instability, and other secondary signs of Parkinson's disease (Attix & Welsh-Bohmer, 2006). The average age of onset of FTLD is approximately 10 years earlier than that of AD, with a mean age of onset of about 62 years and a range from as low as 21 years to as high as 80 years. FTLD represents approximately 12% of all dementias that occur before the age of 65, and the risk of developing this form of dementia does not seem to increase with age (Grossman, 2002).

The subtype FTD is sometimes referred to as the behavioral variant of FTLD because it involves primarily early deficits in social and interpersonal conduct, behavioral dysregulation, and more marked attentional and executive impairment. In contrast, NFPA is characterized by progressive difficulties in expressive language functioning with relatively preserved comprehension. However, later in the progression of NFPA, behavior dysregulation similar to that seen in FTD may be present. Finally, as the label suggests, the primary characteristics of SD are impairments in understanding the meaning of an object or word and difficulties in naming and comprehension (Chertkow et al., 2001; Neary et al., 2005). Previous research has been criticized for collapsing together the subtypes of FTLD (Hodges et al., 1999; Kramer et al., 2003); therefore, we chose to focus specifically on the FTD subtype in this article in order to more clearly understand the nature of executive functioning.

Three distinctive histopathological conditions underlie FTLD, all of which are characterized by atrophy of the frontal and temporal lobes as well as neuronal loss and microvacuolation. The most common is *frontal lobe dementia of the non-Alzheimer's type*, alternatively called *dementia lacking distinctive histopathology*, so named because of the lack of intracytoplasmic inclusions or swollen cells seen in other conditions underlying FTLD. The other two conditions of FTLD are (a) Pick's disease with both Pick bodies (agyrophilic inclusions) and Pick cells (swollen cells) and (b) Pick's disease with swollen cells only. The majority of the histopathology is located in the neocortex of the frontal lobes and the anterior temporal lobes; however, lesions in subcortical regions such as the thalamus, neostriatum, or white matter pathways linking prefrontal and anterior temporal regions may be present (Grossman, 2002; Heilman & Valenstein, 2003). Each of these histological types can be associated with each of the three clinical syndromes described above; however, the neuropathological topographies may differ, with FTD affecting the prefrontal and anterior temporal cortices, NFPA involving asymmetric left hemisphere frontal and temporal atrophy, and SD involving atrophy of the middle and inferior temporal cortex (Neary et al., 2005).

Given the prominent frontal lobe pathology present in FTLD, executive dysfunction would be expected in this disorder. In particular, the prefrontal distribution of neurodegeneration in FTD makes executive dysfunction even more likely in this subtype. Indeed, deficits in multiple domains of executive functioning have been reported in FTD (for a review, see Elderkin-Thompson, Boone, Hwang, & Kumar, 2004). For example, deficits in working memory have been found on digit span backward tasks (Kramer et al., 2003; Rosen et al., 2004), although certain studies have found no impairment on digits backward (Hodges et al., 1999; Perry & Hodges, 2000) or spatial working memory (Rahman, Sahakian, Hodges, Rogers, & Robbins, 1999) tasks. Inhibitory control has been found to be impaired in FTD using the Stroop test and Elevator Counting With Distraction (Perry & Hodges, 2000; Rosen et al., 2004). Deficits in both phonemic and semantic fluency have also been reported (Hodges et al., 1999; Pasquier, Lebert, Grymonprez, & Petit, 1995; Rosen et al., 2004; Wicklund, Rademaker, Johnson, Weitner, & Weintraub, 2007), and planning deficits have been found using the TOL in both moderate (Carlin et al., 2000) and mild (Rahman et al., 1999) FTD. In addition, impairments have been reported in set shifting and decision making (Perry & Hodges, 2000; Rahman et al., 1999).

Relatively fewer studies have examined executive functioning in NFPA and SD. However, the most consistent findings are deficits on both phonemic and semantic fluency in NFPA and SD (Hodges et al., 1999; Marczinski & Kertesz, 2006; Rosen et al., 2004; Wicklund et al., 2007; Zakzanis, 1999) and a deficit in cognitive flexibility (Trail Making) in NFPA (Heidler-Gary et al., 2007; Wicklund et al., 2007; Zakzanis, 1999). Inconsistent or unreplicated findings have been reported for other domains of executive functioning (Heidler-Gary et al., 2007; Rosen et al., 2004; Zakzanis, 1999). When the subtypes of FTLD are compared with each other, it is generally reported that the three groups perform similarly on measures of phonemic, semantic, and design fluency, as well as measures of working memory (Hodges et al., 1999; Kramer et al., 2003; Libon et al., 2007; Marczinski & Kertesz, 2006; Rosen et al., 2004; Wicklund et al., 2007; but see Hodges et al., 1999, and Marra et al., 2007). However, once again, findings for other measures of executive functioning have been variable or unreplicated (Heidler-Gary et al., 2007; Kramer et al., 2003; Marra et al., 2007; Rosen et al., 2004). Although all three subgroups of FTLD appear to demonstrate some degree of deficits

in executive functioning, it is difficult to determine the effects of language deficits in patients with NFPA and SD on their performance on tests of executive functioning. Thus, we chose to examine executive dysfunction specifically in FTD patients, in whom these deficits have been most clearly established.

Executive Function in Lewy Body Dementia

LBD is a form of dementia characterized by parkinsonian motor disturbances, hallucination, disturbances in arousal and sleep, and fluctuating cognitive symptoms. The extrapyramidal features seen in LBD are similar to those seen in FTD, but are typically more severe (Heilman & Valenstein, 2003). The most common cognitive symptoms include deficits in executive functioning, visuospatial abilities, and attention, but anterograde amnesia similar to that seen in AD (though less severe) is usually present later in the progression of the disease (Calderon et al., 2001; Knopman et al., 2003). Similar to FTD, it has been suggested that underlying deficits in attention or executive dysfunction are responsible for cognitive deficits seen in other areas, such as memory and speech (Attix & Welsh-Bohmer, 2006; Knopman et al., 2003).

As suggested by the name, the major neuropathological feature of LBD is Lewy body inclusions, which are abnormal protein aggregates present in the neurons of the limbic system and neocortical regions. In addition, pathology seen in AD (neurofibrillary tangles and amyloid plaques), microvacuolation, loss of synapses, and dysfunction of the dopamine system (as seen in Parkinson's disease) are also common (Heilman & Valenstein, 2003; Knopman et al., 2003; Simard et al., 2000). The brain areas most often affected in LBD include the anterior frontal and temporal cortices, cingulate area, insula, substantia nigra, nucleus basalis of Meynert, locus ceruleus, nucleus raphe dorsalis, and amygdala (Simard et al., 2000).

Both the Lewy body pathology occurring in the frontal lobes and disruption of circuits linking the frontal cortex with subcortical structures make it likely that executive dysfunction will be present in LBD (Dubois, Pillon, & McKeith, 2007). Although fewer studies have examined executive functioning in LBD, as with FTD, studies have shown that patients with LBD are impaired in several domains of executive functioning (for a review, see Simard et al., 2000). For example, deficits have been reported for LBD patients on working memory tasks such as digit span (Crowell, Luis, Cox, & Mullan, 2007) and digits backward (Calderon et al., 2001). In one study, LBD patients were impaired on tests of inhibitory control such as the Stroop test (which some patients were unable to complete) and Elevator Counting With Distraction (Calderon et al., 2001), as well as on an experimental task requiring set shifting and response inhibition (Bradshaw, Saling, Anderson, Hopwood, & Brodtmann, 2006). Deficits in both phonemic and semantic fluency have also been reported, as well as impairments in cognitive flexibility and set shifting, as measured by Trail Making and the Wisconsin Card Sorting Test (WCST; Calderon et al., 2001; Crowell et al., 2007; Ferman et al., 2006). To date, no studies have examined planning abilities in patients with LBD. Given that many of the deficits reported in certain domains of executive functioning have not been replicated in other studies, the executive dysfunction in LBD is not as well established as it is in FTD.

FTD Versus LBD

The deficits in memory and executive function seen in FTD and LBD overlap considerably with each other and with those found in AD (Attix & Welsh-Bohmer, 2006; Heilman & Valenstein, 2003). There is some evidence that executive functions are more impaired in FTD than AD (for a review, see Harciarek & Jodzio, 2005), with this being found for a composite measure of executive functioning (Walker, Meares, Sachdev, & Brodaty, 2005), working memory (digits backward: Kramer et al., 2003; dual task: Perry & Hodges, 2000), inhibitory control (Stroop: Pachana, Boone, Miller, Cummings, & Berman, 1996; Elevator Counting With Distraction: Perry & Hodges, 2000), phonemic fluency (Hodges et al., 1999; Lindau, Almkvist, Johansson, & Wahlund, 1998; Pachana et al., 1996; Wicklund et al., 2007), and cognitive flexibility (Trails B: Heidler-Gary et al., 2007; WCST: Perry & Hodges, 2000). However, several studies have found no differences between AD and FTD on executive measures, such as working memory (digits backward: Perry & Hodges, 2000; Rosen et al., 2004), inhibitory control (Stroop: Pachana et al., 1996; Perry & Hodges, 2000; Rosen et al., 2004), phonemic and semantic fluency (Diehl & Kurz, 2002; Hodges et al., 1999; Kramer et al., 2003; Nedjam, Devouche, & Dalla Barba, 2004; Pasquier et al., 1995; Perry & Hodges, 2000; Rosen et al., 2004), and cognitive flexibility (Trail Making: Kramer et al., 2003; WCST: Nedjam et al., 2004).

A recent literature review has concluded that the most consistent difference between the cognitive profiles of LBD and AD is a greater deficit in spatial working memory in LBD (Simard et al., 2000); however, some studies have shown that patients with LBD perform worse than AD patients on other measures of executive functioning, including other types of working memory (digits backward: Calderon et al., 2001; digit span: Crowell et al., 2007), inhibitory control (experimental response inhibition task: Bradshaw et al., 2006; Stroop errors: Guidi, Paciaroni, Paolini, De Padova, & Scarpino, 2006), phonemic fluency (Calderon et al., 2001; Crowell et al., 2007; Ferman et al., 2006; Galasko, Katzman, Salmon, & Hansen, 1996), and set shifting (Trails B: Crowell et al., 2007; Ferman et al., 2006; Kraybill et al., 2005; Salmon et al., 1996; WCST: Preobrazhenskaya, Mkhitaryan, & Yakhno, 2006). In addition, a recent meta-analysis combined various measures of executive functioning using effect sizes, and found that LBD patients were more impaired on executive functioning than both controls and AD patients (Collerton, Burn, McKeith, & O'Brien, 2003). However, as with FTD, several other studies have found no differences between LBD and AD on measures of executive functioning, such as working memory (digit span and digits backward: Gnanalingham, Byrne, & Thornton, 1997; Johnson, Morris, & Galvin, 2005; Salmon et al., 1996), inhibitory control (Elevator Counting With Distraction: Calderon et al., 2001), phonemic and semantic fluency (Crowell et al., 2007; Galasko et al., 1996; Gnanalingham et al., 1997; Guidi et al., 2006; Noe et al., 2004; Salmon et al., 1996), and cognitive flexibility (WCST: Gnanalingham et al., 1997). Thus, whereas much is known about the similarities and differences on measures of executive function between AD and FTD and between AD and LBD, information on how FTD and LBD compare is lacking.

Both FTD and LBD patients have prominent executive dysfunction, which is consistent with the neuropathologies underlying the two syndromes. FTD and LBD may present with similar types of

cognitive deficits, such as executive dysfunction, and there may be similarities in other areas as well, such as motor disturbance (Chertkow et al., 2001). When individually compared with AD on measures of executive functioning, both FTD and LBD patients have been found to be equally or more severely impaired than AD patients. However, FTD and LBD patients have never been directly compared on measures of executive functioning; therefore, it is very important to characterize the executive dysfunction in these two groups using the same tests given that executive deficits have been reported to be part of the diagnostic criteria for both groups.

The Present Study

It is currently unknown whether there is a difference in the severity or frequency of executive dysfunction in FTD and LBD. In addition, there may be differences between the two groups in the relative degree of impairment in one domain of executive functioning in comparison with other domains. Differentiating the two groups on the basis of performance on tests of executive function could aid in earlier and more accurate diagnosis. Therefore, we compared executive functioning in FTD and LBD patients in several different ways. First, we conducted an analysis to determine whether there were statistical differences between the two groups. We then compared clinical impairment on each of the different measures by computing standardized scores for each of the groups using data collected from our elderly controls and comparing the groups on the average degree of impairment as well as the frequency of impairment. Examining both statistical differences and differences in clinical impairment is important because statistical comparisons can only provide information regarding reliable differences between the groups, not whether those differences are clinically significant or frequent. Given that both FTD and LBD patients performed worse than AD patients on measures of executive function, we predicted that both groups would be impaired on each of the tests of executive functioning administered in this study. However, as FTD is more typically thought of as a disorder involving prominent executive dysfunction, we predicted that FTD patients would perform more poorly than LBD patients across the different measures.

Method

Participants

FTD and LBD are far more rare than AD, and it is often difficult to accumulate a large enough sample to study. Therefore, the Consortium on Cognition and Aging (CCA) of the Quebec Research Network on Aging pooled resources from memory clinics and academic centers across the province of Quebec by developing a registry of patients with some of the more rare forms of dementia. The CCA chose to include FTD and LBD patients in the registry, and common diagnostic tools and protocols for clinical, neuropsychological, and brain-imaging testing were developed for the assessment of these patients. The CCA also tested patients with mild cognitive impairment (MCI), and executive function in MCI is the focus of a companion article to the present study (Johns et al., 2008).

Seventeen FTD patients and 15 LBD patients were recruited who met the inclusion criteria for this study. Patients were initially seen by one of the participating physicians as part of their normal clinical work. Informed consent was obtained from all the participants or their family members as appropriate, and ethical approval for the study was obtained from all institutions involved. During the initial examination with the physicians, patients completed a mental status assessment and a physical evaluation to confirm the diagnosis of FTD or LBD. FTD was diagnosed according to the consensus criteria by Neary and colleagues (2005), which were based on a change or impairment in character or social conduct that was insidious in onset and gradual in its progression, and involved emotional blunting and loss of insight. Patients meeting the diagnostic criteria for FTLD but with expressive language or semantic deficits as the primary feature were excluded. LBD was diagnosed according to the consensus criteria by McKeith and colleagues (2004), which required two of the three following features: fluctuating cognition with variation in attention and alertness, recurrent visual hallucinations, and spontaneous motor features of parkinsonism. Although consideration of cognitive function was involved in the diagnosis of both disorders, the diagnosis was based on clinical judgment, without reference to any specific neuropsychological test. Following the independent diagnosis of the physician, the patient was assessed using the CCA's extensive neuropsychological battery; thus, the clinical diagnosis was reached without knowledge of the specific neuropsychological findings.

Twenty normal elderly controls (NECs) were recruited to serve as a control group for the calculation of clinical impairment. NECs were recruited from the same community as the patients through posters advertising the study and visits to senior centers and residences. Participants in the control group all scored above a cutoff of 25 on the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975).

To qualify for the study, participants had to be free of serious health problems and possible systemic causes of their illness as demonstrated by additional clinical investigations and blood work. Thus, participants were excluded if there was evidence of another brain disease or a chronic psychiatric disorder (other than mild depression), such as cerebrovascular disease, head trauma, cerebral infection, metabolic dysfunction, thyroid dysfunction, B_{12}/folic acid deficiency, epilepsy, psychosis, schizophrenia, intoxication, or alcohol abuse. For FTD and LBD patients, this information was obtained through the physical examination, and for controls, through a self-report questionnaire.

The three groups were compared on important demographic variables (see Table 1 for means and proportions). There was a significant group difference for age, $F(2, 49) = 4.33$, $p = .019$. FTD patients were significantly younger than LBD patients but not controls ($p = .021$ and $p = .108$, respectively), which is consistent with the earlier age of onset typical for this patient group (Grossman, 2002). However, age was not significantly correlated with any of the variables in this study and, therefore, was not used as a covariate in any of the group comparisons. The groups did not differ in number of years of education, $F(2, 49) = 2.21$, $p = .121$. With regards to sex, the NECs had a smaller proportion of men than did the FTD and LBD groups, $\chi^2(1, N = 37) = 4.66$, $p = .031$, and $\chi^2(1, N = 35) = 5.04$, $p = .025$, respectively, which were comparable in their sex distribution, $\chi^2(1, N = 32) = 0.030$, $p = .863$. As Quebec is a bilingual province and participants were tested in their primary language (either French or English), the

Table 1
Participant Demographics: Frontotemporal Dementia (FTD), Lewy Body Dementia (LBD), and Controls (NECs)

Variable	FTD		LBD		NEC		Group difference ($p < .05$)
	M	*SD*	*M*	*SD*	*M*	*SD*	
Age (years)	66.59	9.0	73.3	5.7	71.4	5.0	FTD < LBD
Education (years)	11.5	4.1	10.1	3.8	12.45	2.0	*ns*
Sex (% male)	70.6	—	73.3	—	35.0	—	Controls < FTD = LBD
Language (% French)	82.4	—	86.7	—	60.0	—	*ns*

groups were also compared on language distribution, which was comparable in the three groups, $\chi^2(2, N = 52) = 3.98$, $p = .137$.

FTD and LBD patients were also compared on a number of clinical measures, as summarized in Table 2. The two groups did not have a significantly different level of overall cognitive impairment, as measured by the MMSE, and did not report significantly different levels of subjective memory impairment, as measured by the Subjective Memory Complaints Scale (Schmand, Jonker, Hooijer, & Lindeboom, 1996). There was a nonsignificant trend toward a group difference on the Barthel Index (Mahoney & Barthel, 1965), a measure of functional independence in basic activities of daily living (e.g., feeding, bathing, and grooming), with LBD patients exhibiting greater impairment. This difference would be expected, given the nature of physical impairment in LBD. There were no group differences on the Functional Activities Questionnaire (Pfeffer, Kurosaki, Harrah, Chance, & Filos, 1982), a measure of higher level activities of daily living (e.g., paying bills, shopping, and cooking). Both FTD and LBD patients were impaired on this measure. Finally, there were no differences on the Geriatric Depression Scale (Yesavage et al., 1982), a measure of recent depressive symptoms, on which scores were indicative of mild depression in both FTD and LBD.

Materials and Procedure

The two patient groups were tested at each of the individual clinics, and control participants were tested at Concordia University and the Institut Universitaire de Gériatrie de Montréal. Common evaluation tools and standardized procedures were provided to each of the testing centers to ensure a standardized method of testing. In addition, the neuropsychologists, nurses, and graduate students who completed the testing were trained on the administration of the tests, and all tests were administered according to standardized procedures. Participants were tested in their primary language (either French or English), and equivalent French and English versions of each of the tests were employed.

Six tests of executive functioning were administered as part of a longer battery of neuropsychological tests administered in standardized order, which included tests of learning and memory, language, visuospatial function, attention, and motor praxis. The six measures of executive functioning were the BPT, the LNS, the Hayling test, the Stroop test (Victoria version), phonemic and semantic fluency, and the TOL.

Adapted Brown–Peterson Task. The version of the BPT used in this study was taken from the computerized Memoria Battery (Belleville, Chatelois, Fontaine, & Peretz, 2003; Bherer, Belleville, & Peretz, 2001). Participants were presented with sets of three consonants that were randomly sampled from the alphabet, but were not phonologically similar and did not form any known acronyms. These consonant trigrams were to be kept in mind for delay periods of 0, 10, 20, or 30 s, during which an arithmetic interference task was performed (adding 1 to a series of randomly generated numbers presented orally). The delay periods were randomly ordered, and an auditory cue signaled the end of the delay and the commencement of recall. During the recall phase, participants were required to write down the letters they could remember from the consonant trigram in the order in which they were presented. There were 3 practice trials and 12 test trials (3 trials of each of the 4 delay periods). The number of correct letters recalled for each delay period was recorded.

Letter–Number Sequencing. The LNS is a subtest of the WAIS–III (Wechsler, 1997), in which a sequence of intermixed digits and letters is presented orally to the participant, and the participant must recall the digits first in ascending order followed by the letters in alphabetical order. The test consists of seven

Table 2
Clinical Characteristics in Frontotemporal Dementia (FTD) and Lewy Body Dementia (LBD)

Variable	FTD		LBD		*df*	*F*	*p*
	M	*SD*	*M*	*SD*			
MMSE	24.53	4.90	23.83	4.59	1, 27	0.149	.702
SMCS	6.94	5.04	7.07	4.03	1, 29	0.006	.938
BI	97.44	11.03	85.27	2.21	1, 29	4.10	.052
FAQ	15.69	9.56	17.80	10.14	1, 29	0.357	.555
GDS	5.69	4.63	8.07	6.81	1, 26	1.13	.298

Note. MMSE = Mini-Mental State Examination; SMCS = Subjective Memory Complaints Scale; BI = Barthel Index; FAQ = Functional Activities Questionnaire; GDS = Geriatric Depression Scale.

blocks of increasing length, with three trials per block. One point is awarded for every correct trial, and the total number of correct trials was recorded.

Hayling test. The Hayling test is a measure of inhibitory control with two separate sections, each containing 15 sentences with the last word missing. In each section, the examiner reads the sentences aloud, and the participant is required to complete the sentence as quickly as possible. In Section 1, the participant must give a response that sensibly completes the section, and in Section 2, the participant must give a response that is unconnected to the sentence in every way. In other words, the participant must inhibit the automated response that sensibly completes the sentence and generate an alternative response. For example, in the sentence "Most cats see very well at _____," the participant must suppress the response *night* and generate an unrelated response, such as *banana*. The response latencies for both sections were recorded, as well as the number of connected errors (words that sensibly complete the sentence, e.g., *night*) and somewhat connected errors (words that are related to the sentence in some way, e.g., *dog*) for Section 2. An inhibition time score was calculated to control for differences in response initiation time by subtracting the mean response latency of Section 1 from the mean response latency of Section 2. In addition, a weighted error score was calculated by assigning 3 points to connected errors and 1 point to somewhat connected errors, as per the protocol outlined by Belleville, Rouleau, and Van der Linden (2006). Finally, an overall scaled score was calculated according to the procedure outlined in Burgess and Shallice (1997). The English version of this test was published by Burgess and Shallice (1997), and the French version was published by Belleville and colleagues (2006).

Stroop test. The University of Victoria version of the Stroop test (Spreen & Strauss, 1998) consists of three parts, in which stimuli in blue, red, green, and yellow ink are presented in six rows of four items. The first section consists of 24 colored dots, and the second section consists of common words (*and*, *when*, *hard*, *over*) printed in colored ink. In the third part, color names are printed in each of the different colors except the color that corresponds with the word (i.e., the word *blue* is never printed in blue ink). In each section, participants are required to name the color of the ink and to disregard any verbal content. Thus, in the color condition, the participant must inhibit the prepotent response of reading the color word, and instead name the color of the ink in which the word is printed. The time to complete each section and the number of errors for each section were recorded. Interference scores were calculated by subtracting the dot condition from the color condition for both time and errors to control for color naming speed.

Verbal fluency. Participants completed both a phonemic fluency task and a semantic fluency task (Spreen & Strauss, 1998). In the phonemic task, participants must generate as many words as possible that begin with a certain letter within certain parameters. English-speaking participants were given the letters *F*, *A*, and *S*, with 60 s to generate words, and French-speaking participants were given the letters *P*, *L*, and *T*, with 90 s to generate words, according to standardized administration procedures. For semantic fluency, participants were asked to generate as many words as possible from a given category (animals). The total numbers of correct words generated for both phonemic and semantic fluency were recorded. In addition, both phonemic and semantic fluency were scored for clustering and switching, as per the procedure outlined by Troyer et al. (1997). Clusters are groups of words produced consecutively that belong to the same phonemic or semantic subcategory. For phonemic fluency, clusters are defined as groups of words that begin with the same two letters (e.g., *aim, air*), differ only by a vowel sound (e.g., *sale, sole*), rhyme (e.g., *fair, flair*), or are homonyms (e.g., *son, sun*). For semantic fluency, clusters are defined as a group of words that are part of the same semantic subcategory, such as farm animals, pets, African animals, and various zoological categories (for complete scoring rules, refer to the Appendix of Troyer et al., 1997). A switch is defined as a transition between clusters and is a measure of the ability to shift between categories. The total number of switches and the mean cluster size were recorded.

Tower of London. The version of the TOL used in this study was an abridged version (Shallice, 1982), in which there are two boards, each with three pegs of progressive lengths. Each board has a red, yellow, and blue ball arranged on the pegs in a certain way. One ball fits on the shortest peg, two balls on the medium peg, and three balls on the longest peg. The balls on the examiner's board are arranged in a model configuration, and the balls on the participant's board are arranged in a starting configuration. The participant must move the balls on his or her board to match the model configuration in as few moves as possible, moving only one ball at a time, and never placing the ball anywhere except on another peg. There are 12 trials, 3 of which require a minimum of 3 moves to complete, and 9 of which require a minimum of 5 moves to complete. Of the 5-move trials, 6 contain a trigger, which is an instance where one of the balls can be moved directly into its final position from the first move. Three of those trials contain a positive trigger, where moving the ball directly into its final position helps with the resolution of the problem, and the other 3 trials contain a negative trigger, where moving the ball directly into its final position hinders the resolution of the problem.

Results

Group Comparison

The primary goal of the study was to compare performance on the tests of executive functioning between FTD and LBD patients. However, we first compared the FTD and LBD patients with the NECs, using the Geriatric Depression Scale score as a covariate because NECs scored significantly lower than FTD and LBD patients on this measure, $F(2, 45) = 6.44$, $p = .003$, to establish significantly reliable deficits. As expected, both FTD and LBD patients performed significantly worse than NECs on all of the measures of executive functioning included in this study (except Hayling time and mean cluster size for semantic fluency in LBD patients; see Table 3). However, as the focus of this study was on examining similarities and differences between FTD and LBD patients, the results reported below represent comparisons using just the two dementia groups. Each neuropsychological measure was treated as a separate family of comparisons, and Bonferroni corrections were used for multiple comparisons within the same neuropsychological measure and for follow-up comparisons where appropriate. Not all patients completed all of the tasks, and missing data were primarily due to difficulties performing the task or discontinuation due to fatigue. The number of patients that completed each task is indicated below. To ensure that the subgroups of patients who completed each of the tasks were comparable in

Table 3
Mean (SD) Performance of Frontotemporal Dementia (FTD) Patients, Lewy Body Dementia (LBD) Patients, and Normal Elderly Controls (NECs) on Tests of Executive Functioning

Variable	FTD	LBD	NEC
Brown–Peterson Task	4.83 (2.15)***	3.08 (2.15)***	7.51 (1.79)
0-s delay	7.50 (2.54)	6.42 (2.54)	8.75 (0.64)
10-s delay	3.83 (3.13)**	2.50 (2.47)***	7.35 (1.63)
20-s delay	3.75 (3.14)	2.00 (1.71)***	6.55 (2.28)
30-s delay	4.25 (2.73)**	1.42 (2.31)***	7.40 (1.85)
Letter–Number Sequencing			
Total score	4.88 (3.91)***	3.80 (2.93)***	10.75 (2.40)
Stroop test			
Interference time (s)	30.87 (39.82)*	62.71 (68.75)**	12.00 (4.44)
Interference errors	5.94 (6.71)**	10.79 (5.65)***	0.45 (1.43)
Hayling test			
Inhibition time (s)	82.29 (88.77)*	127.02 (168.43)	32.56 (24.22)
Errors score	25.85 (12.14)***	30.46 (7.64)***	3.70 (2.23)
Overall scaled score	1.62 (0.96)***	1.15 (0.56)***	5.65 (1.04)
Phonemic fluency			
Total words	24.18 (18.39)***	14.62 (8.43)***	46.76 (12.68)
Mean cluster size	1.36 (0.56)*	1.02 (0.67)**	1.82 (0.71)
Number of switches	16.37 (15.28)**	10.31 (6.05)***	28.63 (7.62)
Semantic fluency			
Total words	9.41 (4.51)***	7.54 (3.89)***	18.85 (3.99)
Mean cluster size	1.76 (1.02)*	2.21 (1.51)	2.28 (0.60)
Number of switches	4.00 (2.53)**	2.62 (1.80)***	6.79 (2.20)

Note. Significant differences are indicated for FTD and LBD patients in comparisons with NECs. Comparisons between FTD and LBD patients are described in text.
* $p < .05$. ** $p < .01$. *** $p < .001$.

terms of MMSE score and education, we compared each of the subgroups on those two measures, which resulted in no significant differences in any of the comparisons (MMSE, $p > .398$ in all cases; education, $p > .189$ in all cases). Mean scores for each of the measures are presented in Table 3.

Working memory. Twelve FTD patients and 12 LBD patients completed the BPT, which was analyzed using a mixed analysis of variance (ANOVA) with group (FTD, LBD) as the between-subjects factor, and delay (0 s, 10 s, 20 s, 30 s) as the within-subjects factor. The main effect of group just missed traditional levels of significance, $F(1, 22) = 3.93$, $p = .060$, and there was a significant main effect of delay, $F(3, 66) = 31.83$, $p < .001$, $\eta^2 = .591$, where both groups demonstrated a substantial drop in the number of letters recalled in the 10-s, 20-s, and 30-s delay conditions relative to the 0-s delay condition, $p < .001$, but there were no differences in the number of letters recalled between the 10-s, 20-s, or 30-s delay periods. However, there was no Group × Delay interaction, $F(3, 66) = 1.18$, $p = .324$. Sixteen FTD patients and 15 LBD patients completed the LNS, which was analyzed using a univariate ANOVA. There was no difference in performance on this task, $F(1, 29) = 0.741$, $p = .400$.

Inhibitory control. Sixteen FTD patients and 14 LBD patients completed the Stroop test. This test was analyzed with a multivariate ANOVA, which revealed a group difference approaching significance, $\lambda(2, 27) = .805$, $p = .053$, $\eta^2 = .195$. Follow-up comparisons revealed that this effect was driven by a significant difference in the number of errors, $F(1, 28) = 4.51$, $p = .043$, $\eta^2 = .139$, with LBD patients making more errors than FTD patients. There was no difference in inhibition time on the Stroop, $F(1, 28) = 2.50$, $p = .125$. Thirteen FTD patients and 13 LBD patients completed the Hayling test, which was analyzed with a multivariate ANOVA. There was no significant group difference on this measure, $\lambda(2, 22) = .874$, $p = .385$.

Verbal fluency. Seventeen FTD patients and 13 LBD patients completed the verbal fluency tasks. Phonemic and semantic fluency were analyzed together using a multivariate ANOVA. Results indicated no significant group differences on these measures, $\lambda(2, 27) = .901$, $p = .385$. Furthermore, clustering and switching for phonemic and semantic fluency were analyzed together using a multivariate ANOVA, and no group differences were observed, $\lambda(4, 24) = .844$, $p = .377$.

Planning. This task was very difficult for both the FTD and the LBD patients, and many patients were unable to complete the task. Eventually, the task was dropped from the testing protocol. However, the fact that both groups demonstrated difficulty with this task indicates that there is an impairment in planning in both FTD and LBD.

Profile of Executive Functioning

Comparisons of group means are useful for determining whether reliable differences exist between groups, but they do not provide information as to whether these differences are large enough to be detectable in clinical practice. Therefore, we calculated standardized scores for each of the FTD and LBD patients on the basis of the means and standard deviations of the control group. As can be seen in Figure 1, mean standardized scores for FTD and LBD patients revealed that both groups were clinically impaired on all of the tasks of executive functioning compared with the normal controls (with the exception of the 20-s delay condition of the BPT

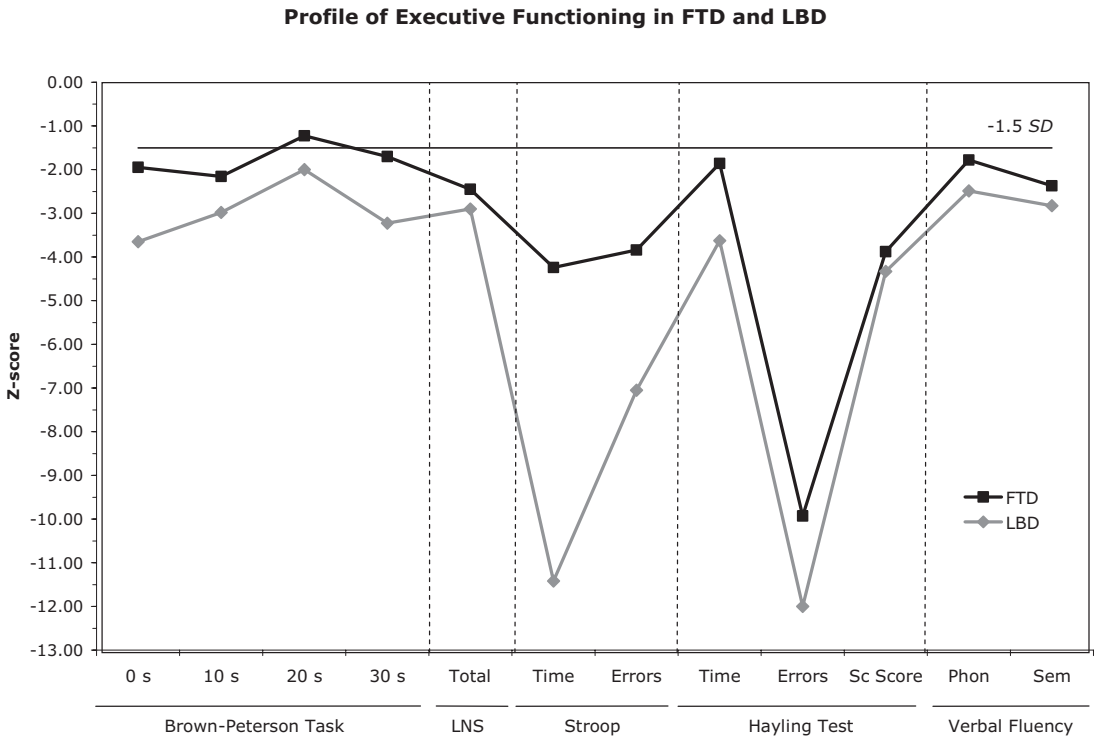

Figure 1. Average degree of impairment expressed as standardized scores across tests of executive functioning in frontotemporal dementia (FTD) and Lewy body dementia (LBD) in comparison to normal elderly controls. LNS = Letter-Number Sequencing; Sc Score = overall scaled score; Phon = phonemic; Sem = semantic.

in FTD patients), with impairment defined as greater than 1.5 standard deviations below the mean. Furthermore, FTD and LBD patients exhibited a similar profile of executive functioning, with both groups performing comparatively worse on the tests of inhibitory control (Stroop and Hayling tests) than the verbal fluency tasks and the working memory tasks (BPT and LNS). Both FTD and LBD patients exhibited severe impairment on the Stroop and Hayling tests, with a relatively greater impairment on errors on the Hayling test (and time on the Stroop test in LBD patients). However, on these two tests, there were substantial differences between the groups, with the LBD group showing a greater impairment (Stroop inhibition time difference: 7.18 *SD*; Stroop errors difference: 3.21 *SD*; Hayling errors difference: 2.07 *SD*). Thus, although both groups were impaired on working memory and verbal fluency tasks and severely impaired on the tests of inhibitory control, LBD patients showed a greater deficit than FTD patients on some of the measures.

Frequency of Impairment

A complementary way to look at differences in executive function in FTD and LBD is to determine whether impairment on any of the measures is more frequent in one of the groups. Therefore, we determined how many patients in each group were impaired on each of the measures, and then calculated the percentage of patients impaired in each group. As can be seen in Figure 2, impairment was highly prevalent, with more than 75% of patients being impaired on each of the tests of executive functioning in both FTD and LBD groups. As can be seen in Figure 2, the sensitivity of each of these tasks is very high. Furthermore, where differences existed between groups, impairment was more frequent in the LBD group, with a difference of 25% on the BPT, 12.5% on the Stroop, and 17.7% on verbal fluency. Very similar frequencies of impairment were found for the LNS and the Hayling test.

Discussion

This was the first study to directly compare FTD and LBD patients on measures of executive functioning. In addition, a strength of this study is that we examined a relatively pure sample of FTD patients given that we were careful to exclude any patients who met the criteria for FTLD but displayed the characteristics of SD or NFPA. We examined both statistical group differences and differences in clinical impairment, which included comparisons of the average degree of impairment and the frequency of impairment. The important finding of this study is that FTD and LBD patients performed remarkably similarly across the different measures employed, and when differences emerged between patient groups, it was consistently the LBD patients who performed more poorly. This is interesting and somewhat surprising given that FTD is more typically considered to be a disorder with prominent executive dysfunction. We begin the discussion of our findings by summarizing the results of the comparisons of the two patient groups with the NECs, and follow it with a more in-depth discussion of the comparisons between FTD and LBD patients.

We compared both FTD and LBD patients with controls to determine the presence of reliable and clinically significant deficits

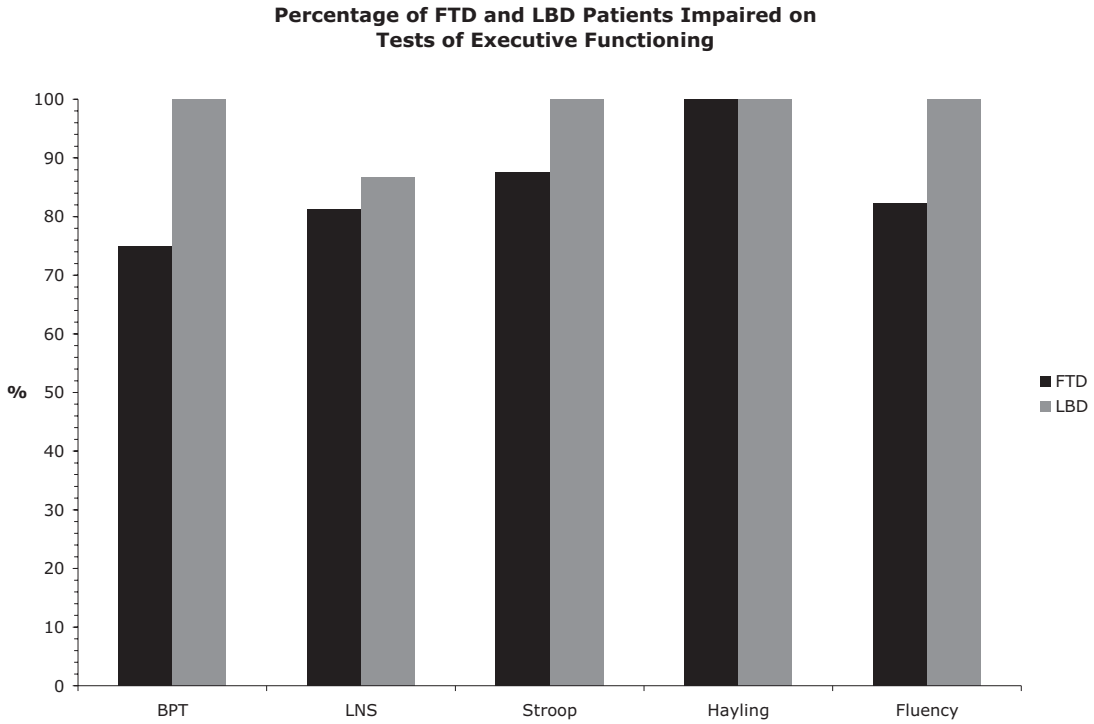

Figure 2. Frequency of executive impairment in frontotemporal dementia (FTD) and Lewy body dementia (LBD) on each test of executive functioning. BPT = Brown–Peterson Task; LNS = Letter–Number Sequencing.

on the measures of executive functioning that were administered in this study. The statistical comparison revealed that both patient groups performed significantly worse than controls on virtually all of the measures. Both groups showed reliable deficits in working memory (BPT and LNS), inhibitory control (Stroop test and Hayling test, with the exception of inhibition time on the Hayling test in LBD patients), and verbal fluency (both phonemic and semantic). It is interesting that there was a deficit on verbal fluency in FTD patients, even after excluding the subgroups in which we would expect an impairment on this task (SD and NFPA). This finding could be due to the deficits on the executive aspect of the task (switching; Troyer et al., 1997), which was present in both the LBD and FTD groups. Both groups also demonstrated a clinically significant impairment (greater than 1.5 *SD* below the mean of the NECs) on all of the measures of executive functioning administered (with the exception of the 20-s delay condition on the BPT in FTD patients). Furthermore, the analysis of individual patient performance in comparison to normal controls on each of the tests of executive functioning revealed that executive dysfunction was highly prevalent in both FTD and LBD, with over 75% of patients being impaired on each of the tests.

We now turn to the comparisons between FTD and LBD patients. First, statistical comparisons of mean performance on each of the tests revealed that FTD and LBD patients performed very similarly overall. Nevertheless, the mean scores of the LBD group were consistently poorer than those of the FTD group across the different measures. Furthermore, the Stroop test was the only measure that revealed statistically reliable group differences, with a strong trend toward significance in the omnibus test and a significant difference in error scores in the follow-up comparison.

Second, the clinical comparisons revealed that FTD and LBD groups had a similar pattern of impairment across the tests of executive functioning, and the impairments were highly prevalent in both groups. Both FTD and LBD patients were more severely impaired on the measures of inhibitory control than on tests of working memory or verbal fluency, with a particularly severe impairment on errors on the Hayling test. It is very striking that both groups showed severe deficits on the Hayling test (see Figure 1), and that all patients showed this deficit (see Figure 2). It is interesting to note that there was convergence in the findings from the statistical analyses and the analyses of the severity and prevalence of impairment, and in all events, it was the LBD group that was more impaired. LBD patients were consistently more severely impaired across the different measures, with these differences being substantial for the Stroop test and the Haying test. LBD patients were also more frequently impaired on the BPT, the Stroop, and verbal fluency. It is important to note that the greater severity and frequency of impairment on the Stroop in LBD patients indicate that the impairment is both marked and frequent, and is consistent with the statistically reliable difference indicating that LBD patients make more errors than FTD patients on this test. Thus, we have converging evidence from several lines (the frequency analysis, the mean standardized scores, and the statistical analysis) that, although both groups were impaired on the Stroop, this impairment was more striking and frequent in the LBD group. This adds to the previous body of research that has found deficits on the Stroop in both LBD (Calderon et al., 2001) and FTD (Pachana et al., 1996) relative to AD patients (Guidi et al., 2006; Pachana et al., 1996); however, we have now compared the two groups directly.

This study has several important strengths, namely statistical comparison with a carefully matched control group and analysis of

the data with regards to the severity and frequency of impairment. Nevertheless, we must be cautious about our findings because of some limitations. The first is the relatively small sample size of patients, which may have limited statistical power to detect differences in performance between the two groups (e.g., on the BPT). However, both FTD and LBD are rare forms of dementia, and the final sample size arrived at in this study is the result of the joint efforts of eight memory clinics across the province of Quebec recruiting patients over 3.5 years. Furthermore, our sample size is comparable to previous studies (Collerton et al., 2003; Hutchinson & Mathias, 2007). Nevertheless, given the small sample size in this study, these results should be considered preliminary findings, and replication with larger sample sizes would be beneficial.

Another limitation to consider is that many of the FTD and LBD patients were unable to complete the TOL, making it impossible to comment on similarities or differences in planning abilities in the two groups. Future studies should be aimed at comparing planning abilities in these two groups using a task that may be easier for these individuals to complete, such as a maze task. An additional limitation of this study is that our LBD patients were sampled exclusively from memory clinics and, thus, may not be representative of the overall population, as many LBD patients present to motor disorder clinics. It is possible that our sample of LBD patients contains an overrepresentation of individuals with cognitive dysfunction, resulting in a greater severity or frequency of executive deficits than what might be found in the overall population. A final limitation is that the findings of this study are based on clinically diagnosed probable cases rather than definite cases with confirmed neuropathology. Thus, we must be cautious in interpreting these results.

Notwithstanding these limitations, our finding of widespread impairments on tasks of executive functioning in both LBD and FTD is consistent with what has previously been reported in the literature (e.g., Elderkin-Thompson et al., 2004; Simard et al., 2000). However, this is the first study to directly compare FTD and LBD patients, allowing us to demonstrate that executive functioning in FTD and LBD is similar in terms of mean scores, the relative degree of deficit as assessed by standardized scores, and the frequency of impairment, with the Stroop test being the only measure with the potential to differentiate between the two groups. It is interesting that the LBD patients actually performed consistently more poorly than the FTD patients on the different measures and across the different types of analyses used in this study. Thus, although executive dysfunction has more typically been considered to be characteristic of FTD, the results of this study suggest that LBD should be reconceptualized as a disorder strongly characterized by executive dysfunction that is as severe, if not more so, than that seen in FTD. Our results highlight the importance of including measures of executive function in the neuropsychological test battery when attempting to characterize the cognitive impairment of these patient groups.

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Call for Nominations

The Publications and Communications (P&C) Board of the American Psychological Association has opened nominations for the editorships of **Experimental and Clinical Psychopharmacology, Journal of Abnormal Psychology, Journal of Comparative Psychology, Journal of Counseling Psychology, Journal of Experimental Psychology: Human Perception and Performance, Journal of Personality and Social Psychology: Attitudes and Social Cognition, PsycCRITIQUES, and Rehabilitation Psychology** for the years 2012–2017. Nancy K. Mello, PhD, David Watson, PhD, Gordon M. Burghardt, PhD, Brent S. Mallinckrodt, PhD, Glyn W. Humphreys, PhD, Charles M. Judd, PhD, Danny Wedding, PhD, and Timothy R. Elliott, PhD, respectively, are the incumbent editors.

Candidates should be members of APA and should be available to start receiving manuscripts in early 2011 to prepare for issues published in 2012. Please note that the P&C Board encourages participation by members of underrepresented groups in the publication process and would particularly welcome such nominees. Self-nominations are also encouraged.

Search chairs have been appointed as follows:

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- **Journal of Comparative Psychology,** John Disterhoft, PhD
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- **Journal of Personality and Social Psychology: Attitudes and Social Cognition,** Jennifer Crocker, PhD
- **PsycCRITIQUES,** Valerie Reyna, PhD
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