American Journal of Alzheimer's Disease & Other Dementias®
2017, Vol. 32(7) 393-400

DOI: 10.1177/1533317517718954
journals.sagepub.com/home/aja
SAGE

Cognitive Fluctuations and Cognitive Test Performance Among Institutionalized Persons With Dementia

Brian J. Mainland, PhD, CPsych[1], Nathan Herrmann, MD, FRCP(C)[2,3], Sasha Mallya, MA[1], Alexandra J. Fiocco, PhD[1], Gwen-Li Sin, MBBS, MMed[4], Kenneth I. Shulman, MD, SM, FRCPsych, FRCP(C)[2,3], and Tisha J. Ornstein, PhD, CPsych[1]

Abstract

Objective: To examine the nature and frequency of cognitive fluctuations (CFs) among institutionalized persons with dementia. **Method:** A clinical interview and a medical chart review were conducted, and 55 patients were assigned a specific dementia diagnosis. The Severe Impairment Battery (SIB) was administered to assess cognitive function, and the Dementia Cognitive Fluctuation Scale (DCFS) was administered to each patient's primary nurse to determine the presence and severity of CFs. **Results:** A simple linear regression model was conducted with DCFS as the predictor variable and SIB total score as the dependent variable. The overall model was significant, suggesting that score on the DCFS significantly predicted SIB total score. Additionally, greater severity of CFs predicted poorer performance in the areas of orientation, language, and praxis. **Conclusions:** Results suggest that CFs exert a clinically significant influence over patients' cognitive abilities and should be considered as a source of excess disability.

Keywords

neurodegenerative diseases, geriatric assessment, geriatric psychiatry, long-term care, cognitive function, neurocognitive disorders

Introduction

Cognitive fluctuations (CFs) are defined as spontaneous alterations in cognition, attention, and arousal[1] that can range from transient "blackouts" to a delirious state and stupor.[2] These episodes can occur with different frequencies, which vary from infrequent to several times per day.[2] Cognitive fluctuations are common among patients with dementia, with an estimated frequency of occurrence of 80% to 90% in dementia with Lewy bodies (DLB), 40% in vascular dementia (VaD), and 20% in Alzheimer's disease (AD).[3] Cognitive fluctuations are not only more common in DLB than VaD and AD, but they are also more severe.[4] Indeed, Walker et al found that the difference in CF severity between DLB and AD was the single most significant symptom frequency difference between the two conditions, greater than any other core feature.[4]

Cognitive fluctuations are highly disabling above and beyond the existing cognitive impairment. Cognitive fluctuations have been found to have an independent, negative effect on activities of daily living in patients with dementia and are associated with increased burden for caregivers.[5] Although CFs are common in patients with dementia, their accurate identification and assessment presents a major clinical challenge.[1,3] This is surprising, given that reviews and consensus criteria have long highlighted the importance of CFs in the diagnosis and differential diagnosis of dementia.[1,6-9]

The importance of CFs is evident from anecdotal reports identifying considerable changes in day-to-day functioning.[10-12] Previous work has shown a strong association between CFs and variability in attention and impairments in consciousness.[13] However, many questions regarding the clinical impact of CFs remain unanswered. Because previous research on CFs has lacked objective methods of assessing their presence, it has been difficult to determine the degree of interference with cognitive performance that can be attributed to fluctuations. Most of what is known about the effect of fluctuations has been described in DLB.[1] Less is known about the extent to which CFs occur in other dementia subtypes and whether the presence of fluctuations impairs cognitive performance compared to patients with dementia who do not have features of fluctuations.

[1] Department of Psychology, Ryerson University, Toronto, Ontario, Canada
[2] Division of Geriatric Psychiatry, Department of Psychiatry, Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada
[3] Department of Psychiatry, University of Toronto, Toronto, Ontario, Canada
[4] Department of Psychiatry, Singapore General Hospital, Singapore, Singapore

Corresponding Author:
Sasha Mallya, MA, Department of Psychology, Ryerson University, 350 Victoria Street, Toronto, Ontario, Canada M5B 2K3.
Email: sasha.mallya@psych.ryerson.ca

Escandon et al[1] examined the differences in neuropsychological performance in patients with AD with and without CFs. Results showed an inverse correlation between the presence of CFs and composite score on a neuropsychological battery, as well as performance on the individual tests. Specifically, they found that the presence of CFs was associated with lower scores on measures of memory, visuospatial skills, and working memory. The pattern of cognitive deficits associated with CFs identified by Escandon et al[1] differs slightly from a similar study examining this association in a sample of patients with Parkinson disease with dementia (PDD).[14] In this study, results showed that the presence of CFs was associated with significantly reduced performance on a global measure of cognitive function (ie, the Dementia Rating Scale–version 2).[15] However, when performance on specific subscales of this measure was examined, findings showed that the presence of CFs was associated with impairment on measures of attention, memory, initiation, and perseveration.

The results of these studies provide evidence that the presence of CFs in patients with dementia is associated with deficits in cognitive performance; however, the specific pattern of cognitive deficits remains unclear. Moreover, these studies did not examine the association between severity of CFs and degree of cognitive impairment; instead, cutoff scores were used to classify participants into groups based on the presence or absence of CFs. The literature examining the association between CFs and neuropsychological performance is sparse, and those studies that have been published are limited by their lack of symptom severity ratings.[1,14,16]

Previous studies have also largely focused on community-dwelling individuals with mild dementia rather than severe dementia.[3] It has been suggested that identifying CFs in individuals in earlier stages of dementia may help physicians distinguish between DLB and PDD and subsequently improve the differential diagnosis of other dementias.[17] However, given that the frequency and severity of CFs increase with increasing dementia severity,[1] it is equally important to understand their impact in later stages of dementia.

Thus, the aim of this study was to examine the association between severity of CF symptoms and cognitive test performance in a sample of institutionalized patients with moderate to severe dementia, who we predicted would demonstrate at least some degree of CFs. We hypothesized that patients with more severe CF ratings would exhibit greater deficits on cognitive measures; specifically, we hypothesized that: (1) patients who have more severe CFs would exhibit reduced performance on a measure of global cognitive function and (2) subtest scores related to attention and memory skills would be most strongly associated with CF symptom severity.

Methods

Participants

In order to detect a medium effect size ($f^2 = 0.15$) with power of .80 and an α of .05 for a hierarchical regression analysis with 3 control variables and 1 test variable, a priori power analysis determined that a sample size of 55 participants was needed. Therefore, this study included a sample size of 55 elderly residents, over the age of 65 years, who had been admitted to the Veterans Affairs Canada long-term care facility at Sunnybrook Health Sciences Centre in Toronto, Ontario. Participants were identified as potential candidates for the study by a member of the research team, a geriatric psychiatrist who provides consultation–liaison service to the dementia care units of the facility. In order to be included in the study, patients had to be medically stable and have resided in the facility for at least 2 weeks. Participants were automatically excluded if they lacked adequate eyesight or motor functioning to complete the test measures. A total of 88 participants were screened as potential participants. Of those, 55 were found to have adequate eyesight and motor functioning to participate.

Measures

Cognitive fluctuations. The presence of CFs was assessed using the Dementia Cognitive Fluctuation Scale (DCFS).[17] The DCFS is a recently developed scale that showed good levels of sensitivity, specificity, reliability, external validity, and internal consistency.[17] The DCFS consists of 17 items under 4 domains: confusion, sleep, alertness, and communication. The research version of the scale is based on 4 items from the original scale that were found to best discriminate between patients with and without CFs (ie, marked differences in functioning during the daytime, daytime somnolence, daytime drowsiness, and altered levels of consciousness during the day).

The DCFS was administered to each patient's primary nurse, who responded to each item based on a 5-point Likert scale. For example, the first item asks: "How great is the difference between the worst period of function and the best period of function on that day?" Potential responses include: "1. No difference (no impact on daily functioning)," "2. A slight difference (only a mild impact on daily functioning)," "3. A moderate difference (a clear impact on daily functioning)," "4. A large difference (a severe impact on daily functioning)," and "5. A very large difference (a very severe impact on daily functioning." Nurses' ratings on each item were summed for a total score ranging from 4 to 20, with higher scores indicating more severe CFs.

Neuropsychological assessment. Participants completed the Severe Impairment Battery (SIB).[18] The SIB was developed to assess a range of cognitive abilities in patients who are too impaired to complete other standard neuropsychological assessment scales. It provides a global composite score as well as subtest scores across 6 subscales: attention, orientation, language, memory, visuoperception, and construction. In addition, there are brief assessments of social skills, praxis, and responding to name. Given that the upper limit of the attention span of patients with severe dementia is 30 minutes,[18] the SIB was designed to take approximately 20 minutes to administer. The test is designed to be well structured and psychometrically reliable, while at the same time appearing

to the patient as being more of an interview than a test in order to assist in maintaining the patient's attention for the duration of the testing period. It is composed of simple 1-step commands presented in conjunction with gestural cues, and the measure allows for scoring credit for nonverbal and partially correct responses.[18] The SIB has been found to be a reliable and valid measure for objectively evaluating patients with dementia, particularly for those in the moderate to severe range of functioning.[19,20] The total range of possible scores on the SIB is 0 to 152, with lower scores representing greater cognitive impairment.[18]

Procedure

This study was approved by the research ethics boards (REBs) at Sunnybrook Health Sciences Centre (REB # 280-2013) and Ryerson University (REB # 2013-278). Patients were contacted by the primary researcher, who provided more information about the study and obtained informed consent from patients' legal representative prior to the commencement of any study procedures. All consented participants underwent a comprehensive diagnostic screening interview, as well as a review of their medical history to ensure that they met *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*[21] criteria for a primary degenerative dementia. The interviews and reviews were conducted by a member of the research team, an experienced geriatric psychiatrist and associate scientist at the Brain Sciences Research Program at Sunnybrook Health Sciences Centre. Each patient was assigned a specific dementia diagnosis (eg, AD, VaD, etc). Patients were then administered the SIB, which took approximately 25 minutes to complete and was administered in the patient's unit. Finally, each patient's primary nurse was identified in order to have him/her complete the DCFS.

Statistical Analysis

A hierarchical multiple regression analysis was designed to predict SIB total score. Predictors for this model included patients' age, education, and time since institutionalization, which are all variables that have previously been shown to influence cognitive test performance.[22-24] Patients' ratings on the DCFS were also entered as a predictor. A theoretical entry order for potential predictor variables was predetermined as follows:

1. In the first block of this analysis, potential confounding variables that may be correlated with the outcome variable were entered. Specifically, research has demonstrated that differences in education,[25] age,[26] and time since institutionalization[27] may impact cognitive test scores. Entering each of these variables in block 1 allowed for a less biased assessment of the incremental ability of CFs to predict cognitive test performance.
2. Next, to assess its incremental ability to predict cognitive test performance, patients' DCFS score was entered in block 2.

The above model was constructed to systematically guide the regression analyses. After running the analyses, any variables that were not significantly correlated with the outcome variable were not included in the final regression model. Likewise, variables that did not incrementally predict SIB total score were removed before construction of the final model. Following completion of the final model, assumptions of hierarchical regression were checked for potential violations.

Results

Descriptive Statistics

Demographic characteristics are provided in Table 1. The majority of patients were male and Caucasian, which is representative of this type of Veteran Affairs Canada facility. The majority of the sample was born in Canada, with some participants born in Europe and 1 born in the Caribbean. Roughly half of the participants were married and one-third of the sample was widowed. The remainder was divorced, never married, or their marital status was unknown. The most common primary dementia diagnosis was AD, followed by mixed dementia, VaD, and PDD. Although diagnosis of dementia subtype in patients with severe disease is a challenge and CFs are part of the diagnostic criteria for DLB, none of these patients met criteria for DLB. The mean number of years of education was 12, with a range of 3.02 to 26.91 years. The mean age was 90 years, with a range of 81 to 97 years. Finally, the mean number of months since entering long-term care was 17.39, with a range of less than 1 month to over 95 months.

Psychotropic medications were examined in the sample, which revealed that 41 (76.4%) participants were on acetylcholine esterase inhibitors, 12 (21.8%) participants were on antipsychotics, 6 (10.9%) participants were on benzodiazepines, and 24 (43.6%) participants were on antidepressants.

Patients' medical comorbidities were categorized using the Charlson comorbidity index (for a review of this index).[28–30] The Charlson comorbidity index is a method of categorizing comorbidities of patients based on the *International Classification of Diseases* found in administrative data, such as hospital health records.[31] Each comorbidity has an associated weight that is based on the adjusted risk of mortality or resource use, and the sum of all the weights results in a single comorbidity score for a patient. A score of 0 indicates that no comorbidities were found. The mean score on this index was 2.84, and the standard deviation was 1.68. Neither participants' medication usage nor their level of medical comorbidity was associated with CFs in the current sample.

Predicting SIB Performance

Means, standard deviations, and range of scores for each variable of interest are provided in Table 2. A series of hierarchical multiple regression models were conducted to determine whether CFs predicted level of cognitive functioning.

Table 1. Demographic Characteristics of Sample.

Characteristic	Overall Sample (N = 55), n (%)
Age, mean (SD)[a]	90.41 (2.84)
Male	49 (89.10)
Ethnicity	
Caucasian	52 (94.55)
Romanian	1 (1.82)
Jamaican	1 (1.82)
African Canadian	1 (1.82)
Birthplace	
Canada	48 (87.27)
Europe	6 (10.91)
Caribbean	1 (1.82)
Education in years, mean (SD)[b]	12.39 (4.26)
Months in long-term care, mean (SD)[c]	17.39 (16.18)
Marital status	
Married	26 (47.27)
Widowed	19 (34.55)
Divorced	7 (12.73)
Never married	1 (1.82)
Unknown	2 (3.64)
Primary dementia diagnosis	
Alzheimer's disease	25 (45.45)
Vascular dementia	8 (14.55)
Mixed dementia	20 (36.36)
Parkinson disease with dementia	2 (3.64)

Abbreviation: SD, standard deviation.
[a]Range 81 to 97 years.
[b]Values represent data set after using expectation maximization (EM) to estimate missing values (n = 55), range 3.02 to 26.91.
[c]Range 0.43 to 95.21 months.

Table 2. Descriptive Statistics of Test Measures.

Measure	Mean (SD)	Range
Cognitive function		
SIB total score	86.65 (13.77)	15.00-100.00
SIB social interaction	5.98 (0.13)	5.00-6.00
SIB memory	9.95 (2.95)	2.00-14.00
SIB orientation	4.09 (1.46)	0.00-6.00
SIB language	42.71 (6.52)	6.00-48.00
SIB attention	4.87 (1.36)	1.00-6.00
SIB praxis	6.22 (1.96)	0.00-8.00
SIB visuospatial	7.11 (1.75)	0.00-8.00
SIB construction	3.76 (0.74)	0.00-4.00
SIB orientation to name	1.96 (0.27)	0.00-2.00
Cognitive fluctuation		
DCFS total score	10.07 (3.04)	5.00-17.00

Abbreviations: DCFS, Dementia Cognitive Fluctuation Scale[17]; SIB, Severe Impairment Battery.[18]

Model construction. Bivariate correlations between each potential independent variable and SIB scores (in addition to all relevant variable intercorrelations) are reported in Table 3. Although the current hierarchical regression entered SIB total score as the only dependent variable, correlations between each SIB subscale and each potential predictor are also reported in Table 3 for reference. Contrary to preliminary hypotheses, SIB total score was not significantly related to age ($r = .01$, $P = .467$), years of education ($r = -.04$, $P = .738$), or number of months in long-term care ($r = .43$, $P = .087$). Severe Impairment Battery total score was, however, significantly correlated with CFs, as per the DCFS ($r = -.31$, $P = .010$).

Table 4 displays the regression results for performance on the SIB. Age, years of education, and number of months in long-term care failed to account for unique variance in the outcome variable when entered into the hierarchical regression model at step 1 ($R^2 = .03$, $F_{3,51} = 0.05$, $P = .98$). When DCFS was entered in step 2, the variance in SIB total score accounted for by the model significantly increased, $\Delta R^2 = .10$, $F_{\text{change}(1,50)} = 5.44$, $P = .02$. In this model, DCFS emerged as the only significant predictor of SIB total score and the overall model again failed to reach significance, $R^2 = .10$, $F_{4,50} = 1.40$, $P = .247$. Because age, years of education, and number of months in long-term care did not significantly affect SIB total score when entered together into the model, they were eliminated as independent variables and only DCFS was retained for the final regression model.

Final model. A final simple linear regression model was conducted with DCFS as the independent variable and SIB total score as the dependent variable. The overall model was significant, $R^2 = .10$, $F_{1,53} = 5.69$, $P = .02$, and DCFS was found to significantly predict SIB total score, $\beta = -0.31$, $t(54) = -2.39$, $P = .02$. Further analyses explored possible violations of assumptions of regression and did not suggest any major violations of assumptions of multicollinearity, normality, homoscedasticity, or independence of errors.

Discussion

The aim of this study was to examine the association between CFs and cognitive performance in institutionalized patients with dementia. Specifically, this study sought to determine whether patients' scores on the DCFS predicted performance on the SIB, a measure designed to assess cognitive function in patients with advanced-stage dementia. Consistent with the hypothesis, the severity of CFs significantly predicted cognitive functioning. Greater severity of CFs was correlated with poorer cognitive functioning in the areas of orientation, language, and praxis. Similar findings have been demonstrated in other studies that tested the association between CFs and neuropsychological performance, however, these studies used different assessment measures and focused on community-dwelling individuals with less severe dementia.[1,14,32]

Similar to the study of Escandon et al,[1] the current study found that CFs correlate with language subtest scores on the SIB[19]; however, unlike the study by Escandon et al, the current study found that CFs were not related to memory or visuospatial subtest scores. There are several possible explanations for the differing pattern of associations observed between studies. First, Escandon et al assessed for the presence or absence of CFs as opposed to the severity of CFs. Second, it is possible that the observed differences may be due to the differences in

Table 3. Variable Intercorrelations.

Variable	1	2	3	4	5	6	7
1. Age	1.00	0.04	−0.03	−0.09	0.01	−0.17	−0.08
2. Education, years		1.00	0.19	0.28[a]	−0.04	0.01	−0.03
3. Months in long-term care			1.00	0.06	0.03	0.11	0.00
4. DCFS total				1.00	−0.31[a]	−0.13	−0.21
5. SIB total score					1.00	0.12	0.75[b]
6. SIB social interaction						1.00	0.28[a]
7. SIB memory							1.00
8. SIB orientation							
9. SIB language							
10. SIB attention							
11. SIB praxis							
12. SIB visuospatial							
13. SIB construction							
14. SIB orientation to name							

Study Aim 1a Variable Intercorrelations

	8	9	10	11	12	13	14
1. Age	0.24	0.02	−0.09	0.03	−0.07	0.13	0.07
2. Education, years	0.11	−0.10	0.15	−0.15	0.02	0.01	0.00
3. Months in long-term care	0.06	−0.04	0.05	0.14	0.10	0.03	−0.10
4. DCFS total	−0.43[c]	−0.28[a]	−0.08	−0.27[a]	−0.21	−0.18	−0.22
5. SIB total score	0.62[b]	0.95[b]	0.71[b]	0.66[b]	0.86[b]	0.71[b]	0.71[b]
6. SIB social interaction	0.10	−0.01	−0.01	0.16	0.09	−0.04	−0.02
7. SIB memory	0.39[c]	0.60[b]	0.62[b]	0.24	0.64[b]	0.48[b]	0.37[c]
8. SIB orientation	1.00	0.52[b]	0.34[a]	0.43[c]	0.50[b]	0.33[a]	0.39[a]
9. SIB language		1.00	0.57[b]	0.58[b]	0.77[b]	0.72[b]	0.77[b]
10. SIB attention			1.00	0.43[c]	0.58[b]	0.46[b]	0.39[c]
11. SIB praxis				1.00	0.56[b]	0.38[c]	0.44[c]
12. SIB visuospatial					1.00	0.52[b]	0.56[b]
13. SIB construction						1.00	0.69[b]
14. SIB orientation to name							1.00

Abbreviations: DCFS, Dementia Cognitive Fluctuation Scale[17]; SIB, Severe Impairment Battery.[18]
[a]$P < .05$.
[b]$P < .001$.
[c]$P < .01$.

the underlying cognitive abilities assessed by the measures used in each study. Third, as mentioned, the sample examined by Escandon et al was comprised primarily of patients with "very mild" dementia, with a very small percentage (16%) of their sample being classified as having "mild" dementia. Thus, the differing mean dementia severity between study samples may explain the difference in observed results, which could suggest that the pattern of deficits associated with CFs varies according to dementia severity.

Similar issues arise when attempting to draw comparisons between the current study and that of Varanese.[14] In their study, the authors compared performance on cognitive test measures between patients with Parkinson disease and no associated CFs to those with Parkinson disease with CFs. The authors used the Clinician Assessment of Fluctuation scale to assess CFs, which has been reported to be difficult to use due to the descriptive and open-ended nature of several questions. Similar to Escandon et al,[1] they classified patients as possessing CFs or not, and thus, the severity of the CFs was not considered.

Consistent with the findings of the current study, Varanese[14] found that the presence of CFs was associated with significantly reduced performance on a global measure of cognitive function. The results of this study further support the importance of CFs in predicting cognitive test performance, but the pattern of deficits differs from those reported by Escandon et al[1] and the findings of the current study. Potential contributing factors accounting for these differences again include differences in dementia type and severity, as well as different measures for assessment of CFs and cognitive function.

The current study placed emphasis on the severity of CF symptoms rather than grouping patients based on the presence or absence of CFs. This approach was favored for this study because our sample was comprised primarily of patients with moderate to severe dementia. Previous research has demonstrated that the presence and severity of CFs increases with increasing dementia severity,[1] and thus, we predicted that the majority of our sample would demonstrate at least some degree of CFs. This prediction was supported by the finding

Table 4. Summary of Hierarchical Regression for Variables Predicting Changes in SIB Total by Cognitive Fluctuation Severity.[a,b]

	B	SE	β
Step 1			
Constant	81.79	61.56	
Education	−1.59	0.46	−0.05
Age at testing	0.07	0.68	0.01
Month in LTC	0.03	0.12	0.04
Step 2			
Constant	107.44	60.06	
Education	0.14	0.46	0.04
Age at testing	−0.09	0.66	−0.02
Months in LTC	0.03	0.12	0.04
DCFS total	−1.48	0.64	−0.33[c]

Abbreviations: DCFS, Dementia Cognitive Fluctuation Scale; LTC, long-term care; SIB, Severe Impairment Battery.[18]
[a]$N = 55$.
[b]$R^2 = .00$ for step 1 ($P = .984$), $\Delta R^2 = .10$ for step 2 ($P = .024$). Model: $R^2 = .10$, adjusted $R^2 = .03$.
[c]$P < .05$.

that only 2 patients in our sample were rated as having no CFs (ie, a score of 5 of 20 on the DCFS).

Limitations and Future Directions

A potential limitation of the current study is that the DCFS is a newly developed scale and has not yet received widespread clinical or research application in the assessment of CFs. Specifically, a severity scale has not yet been validated, nor has the DCFS been validated specifically for persons with severe cognitive impairment. Despite these limitations, the DCFS does build on the most applicable items from previous well-validated scales and, thus, likely represents a superior measure for the presence of CFs. Early evidence suggests that the DCFS is a good measure for assessing the presence of CFs in patients with a range of dementia subtypes, but more research into its utility in detecting CF severity is warranted.

Another limitation is the use of a sample that was comprised of patients with a variety of dementia types. While this range of diagnoses accurately represents the diagnoses of patients currently living in Canadian long-term care facilities, comparisons could not be made across dementia types due to sample size restrictions. Previous research has acknowledged that "CF" is a term that remains elusive despite several attempts to identify, quantify, and assess the phenomenon.[8] While it is known that the frequency and severity of CFs differ depending on dementia subtype,[3,32] one particular issue concerning the current study is the potential that other qualitative characteristics of CFs also differ depending on dementia subtype. For example, it may be postulated that the fluctuations occurring in patients with AD have a particular quality or set of characteristics that differ from the type of fluctuations seen in patients with DLB. Previous research suggests that CFs may differentially impact dysgraphia in patients with AD versus DLB.[33] Additionally, CFs in DLB appear to present as brief, spontaneous episodes of confusion that impair the individual's ability to engage in meaningful cognitive activities, followed by a return to relatively normal functioning. In contrast, CFs in AD typically represent more enduring shifts in cognitive function that are often externally driven, elicited by an inability to keep up with the cognitive demands of their environment.[34] These findings suggest that qualitative differences in CFs indeed occur between dementia subtypes, and thus, more research is needed to determine whether differential cognitive impairment remains when assessing a broad range of cognitive domains across dementia subtypes.

Another limitation concerns the generalizability of the findings. First, the sample was predominantly male as the sample was collected from a veteran's long-term care facility. Thus, the results and implications of this study need to be interpreted with caution when considering their impact on female patients with dementia, who comprise the majority of residents in most long-term care settings. In addition, it was not possible to control for certain variables that may have influenced test performance, such as certain substances (eg, cholinesterase inhibitors, caffeine) that have been proposed to influence CFs.[32,33] However, due to the number of potential contributors present in inpatient settings, attempting to control for all potential variables was not feasible. Future research could examine individual contributors, such as medications, to determine whether they are associated with the presence or characteristics of CFs in dementia. Also, the design of this study was such that simultaneous longitudinal monitoring of individual changes in cognitive function and severity of CFs was not possible. This raises a potential sampling issue in that participants' degree of variability in CFs over time is unknown. Thus, the question remains of whether or not changing severity of CFs exerts differential intrapersonal effects on cognitive functioning or if those with more severe CFs at the onset of the disease go on to develop the most severe declines in cognitive functioning. Future research employing a longitudinal design would assist in further delineating this relationship.

Conclusion

The purpose of the current study was to investigate the nature of CFs in a sample of individuals with dementia living in a long-term care facility. Results of the current study suggest that CFs exert a broad and significant influence over patients' cognitive abilities and should be considered a source of excess disability. Specifically, increasing severity of CFs is associated with lower global cognitive performance, as well as performance on measures of orientation, language, and praxis. These findings are clinically important because they suggest that patients with more severe CFs should be flagged as individuals who will likely require a higher level of care and assistance. Overall, the characterization of CFs remains a challenging task.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

References

1. Escandon A, Al-Hammadi N, Galvin JE. Effect of cognitive fluctuation on neuropsychological performance in aging and dementia. *Neurology*. 2010;74(3):210-217. doi:10.1212/WNL.0b013e3181ca017d.
2. Franciotti R, Falasca NW, Bonanni L, et al. Default network is not hypoactive in dementia with fluctuating cognition: an Alzheimer disease/dementia with Lewy bodies comparison. *Neurobiol Aging*. 2013;34(4):1148-1158. doi:10.1016/j.neurobiolaging.2012.09.015.
3. Lee DR, Taylor J-P, Thomas AJ. Assessment of cognitive fluctuation in dementia: a systematic review of the literature. *Int J Geriatr Psychiatry*. 2012;27(10):989-998. doi: 10.1002/gps.2823/full.
4. Walker MP, Ayre GA, Perry EK, et al. Quantification and characterization of fluctuating cognition in dementia with Lewy bodies and Alzheimer's disease. *Dement Geriatr Cogn Disord*. 2000;11(6):327-335. doi:10.1159/000017262.
5. Lee JH, Oh ES, Jeong SH, Sohn EH, Lee TY, Lee AY. Longitudinal changes in clock drawing test (CDT) performance according to dementia subtypes and severity. *Arch Gerontol Geriatr*. 2011;53(2): e179-e182. doi:10.1016/j.archger.2010.08.010.
6. Ballard CG, Aarsland D, McKeith I, et al. Fluctuations in attention: PD dementia vs DLB with parkinsonism. *Neurology*. 2002;59(11):1714-1720.
7. Kolbeinsson H, Jónsson A. Delirium and dementia in acute medical admissions of elderly patients in Iceland. *Acta Psychiatr Scand*. 1993;87(2):123-127.
8. McKeith IG, Dickson DW, Lowe J, et al. Diagnosis and management of dementia with Lewy bodies: third report of the DLB Consortium. *Neurology*. 2005;65(12):1863-1872. doi:10.1212/01.wnl.0000187889.17253.b1.
9. Robertsson B, Blennow K, Gottfries CG, Wallin A. Delirium in dementia. *Int J Geriatr Psychiatry*. 1998;13(1):49-56.
10. Briel R, McKeith I, Barker W, Hewitt Y. EEG findings in dementia with Lewy bodies and Alzheimer's disease. *J Neurol Neurosurg Psychiatry*. 1999;66(3):401-403.
11. Hely MA, Reid WGJ, Halliday GM, McRitchie DA. Diffuse Lewy body disease: clinical features in nine cases without coexistent Alzheimer's disease. *J Neurol Neurosurg Psychiatry*. 1996;60(5):531-538.
12. Wagner MT, Bachman DL. Neuropsychological features of diffuse Lewy body disease. *Arch Clin Neuropsychol*. 1996;11(3):175-184. doi:10.1016/0887-6177(95)00022-4.
13. Walker MP, Ayre GA, Ashton CH, et al. A psychophysiological investigation of fluctuating consciousness in neurodegenerative dementias. *Hum Psychopharmacol Clin Exp*. 1999;14(7):483-489. doi:10.1002/(SICI)1099-1077(199910)14:7<483::AID-HUP133>3.0.CO;2-T.
14. Varanese S. Fluctuating cognition and different cognitive and behavioural profiles in Parkinson's disease with dementia: comparison of dementia with Lewy bodies and Alzheimer's disease. *J Neurol*. 2010;257(6):1004-1011. doi: 10.1007/s00415-010-5453-3.
15. Jurica PJ, Leitten CL, Mattis S. *Dementia Rating Scale-2 (DRS-2)*. Montreal, Canada: Psychological Research Institute; 2001.
16. Ballard C, O'Brien J, Gray A, Cormack F. Attention and fluctuating attention in patients with dementia with Lewy bodies and Alzheimer disease. *Arch Neurol*. 2001;58(6):977-982.
17. Lee DR, McKeith I, Mosimann U, et al. The dementia Cognitive Fluctuation Scale, a new psychometric test for clinicians to identify cognitive fluctuations in people with dementia. *Am J Geriatr Psychiatry*. 2013;22(9):926-935. doi:10.1016/j.jagp.2013.01.072.
18. Saxton J, McGonigle-Gibson KL, Swihart AA, Miller VJ. Assessment of the severely impaired patient: description and validation of a new neuropsychological test battery. *Psychol Assess*. 1990;2(3):298-303.
19. Panisset M, Roudier M, Saxton J, Boiler F. Severe impairment battery: a neuropsychological test for severely demented patients. *Arch Neurol*. 1994;51(1):41-45. doi: 10.1001/archneur.1994.00540130067012.
20. Schmidt JA, Wagner CC, Kiesler DJ. Psychometric and circumplex properties of the octant scale Impact Message Inventory (IMI-C): a structural evaluation. *J Couns Psychol*. 1999;46(3):325-334.
21. American Psychiatric Association. *DSM-IV*. Washington, DC: American Psychiatric Association; 2000. doi:10.1176.
22. Brayne C, Calloway P. The association of education and socioeconomic status with the Mini Mental State Examination and the clinical diagnosis of dementia in elderly people. *Age Ageing*. 1990;19(2):91-96.
23. Deary IJ, Corley J, Gow AJ, et al. Age-associated cognitive decline. *Br Med Bull*. 2009;92(1):135-152. doi:10.1093/bmb/ldp033.
24. Winocur G, Moscovitch M, Freedman J. An investigation of cognitive function in relation to psychosocial variables in institutionalized old people. *Can J Psychol*. 1987;41(2):257-269. doi:10.1037/h0084156.
25. Ganguli M, Ratcliff G, Huff J, et al. Effects of age, gender, and education on cognitive tests in a rural elderly community sample: norms from the Monongahela Valley Independent Elders Survey. *Neuroepidemiology*. 1991;10(1):42-52. doi:10.1159/000110246.
26. Ardila A, Ostrosky-Solis F, Rosselli M, Gómez C. Age-related cognitive decline during normal aging: the complex effect of education. *Arch Clin Neuropsychol*. 2000;15(6):495-513. doi:10.1016/S0887-6177(99)00040-2.
27. Wilson RS, McCann JJ, Li Y, Aggarwal NT, Gilley DW, Evans DA. Nursing home placement, day care use, and cognitive decline in Alzheimer's disease. *Am J Psychiatry*. 2007;164(6):910-915. doi: 10.1176/ajp.2007.164.6.910.
28. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies:

Development and validation. *J Chronic Dis*. 1987;40(5):373-383. doi: 10.1016/0021-9681(87)90171-8.

29. Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care*. 2005; 43(11): 1130-1139. doi:10.1097/01.mlr.0000182534.19832.83.
30. Quan H, Parsons GA, Ghali WA. Validity of information on comorbidity derived rom ICD-9-CCM administrative data. *Med Care*. 2002; 40(8): 675-685. doi: 10.1097/01.MLR.0000020927.46398.5D.
31. World Health Organization. *International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10)*. Geneva: World Health Organization; 1992.
32. Ballard C, Walker M, O'Brien J, Rowan E. The characterisation and impact of "fluctuating" cognition in dementia with Lewy bodies and Alzheimer's disease. *Int J Geriatr Psychiatry*. 2001; 16(5):494-498.
33. Onofri E, Mercuri M, Donato G, Ricci S. Cognitive fluctuations in connection to dysgraphia: a comparison of Alzheimer's disease with dementia Lewy bodies. *Clin Interv Aging*. 2015;10:625-633. doi:10.2147/CIA.S79679.
34. Bradshaw J, Saling M, Hopwood M, Anderson V, Brodtmann A. Fluctuating cognition in dementia with Lewy bodies and Alzheimer's disease is qualitatively distinct. *J Neurol Neurosurg Psychiatry*. 2004;75(3):382-387. doi:10.1136/jnnp.2002.002576.