Word-finding difficulties in Parkinson’s disease: Complex verbal fluency, executive functions and other influencing factors

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Abstract

Background: Persons with Parkinson’s disease (PD) frequently report word-finding difficulties. Many of the established tests are, however, insufficient in detecting mild cases of such symptoms. Results from earlier research have suggested that controlled oral word association tests (COWATs) with high demands on cognitive processing resources could prove helpful in detecting the more subtle (language-related) problems seen in neurological disorders such as PD.

Aims: First, to examine whether persons with PD (PwPD) differ in performance on different types of COWATs compared with non-brain-damaged controls. Second, to investigate possible relationships between executive functions and the novel complex oral semantic fluency (COSEF) task performance scores in the PwPD group. Third, to investigate whether age, years of education, severity of motor symptoms and self-perceived severity of word-finding difficulties influenced the COSEF task results.

Methods & Procedures: A total of 17 PwPD participated in the study. Their results were compared with a matched control group (n = 17) at both group and individual levels. One phonemic and two types of semantic COWATs were used. Correlations between the COSEF task and executive function results, age, education and severity of motor symptoms were analysed in the PwPD group.

Outcomes & Results: The PwPD group had significantly lower scores on the COSEF task compared with the control group, but not on the other COWATs. A variation in the results was seen on an individual level. In the PwPD group, large significant correlations were seen between the COSEF task and verbally based tasks measuring working memory and cognitive flexibility. Both age and education, but neither self-perceived severity of word-finding difficulties nor motor symptoms, were correlated with the COSEF task result in the group of PwPD.
**Conclusions & Implications:** The results are in line with the predictions that a relatively more cognitive demanding COWAT such as the COSEF task could prove valuable when assessing word-finding difficulties in PD in research and clinical assessment.

**KEYWORDS**
anomia, executive functions, high-level language, Parkinson’s disease, verbal fluency, word-finding difficulties

**What this paper adds**

**What is already known on the subject**
Varying degrees of word-finding difficulties are a common symptom in PD and may affect everyday communication. Discreet word-finding difficulties can be hard to detect with the established language assessment tools.

**What this paper adds to existing knowledge**
This study adds insights into how PwPD perform on different types of COWATs compared with a control group. It also sheds light on the relationships between a novel, more cognitive complex COWAT and executive functions in PD.

**What are the potential or actual clinical implications of this work?**
More cognitively complex COWATs can contribute significantly to the assessment of discreet word-finding difficulties, but it is important to include a thorough anamnesis regarding language and communication in PwPD.

**INTRODUCTION**

Parkinson’s disease (PD) is a progressive neurological disease characterized mainly by degeneration of dopaminergic neurons in the substantia nigra. Epidemiological studies in Western Europe and the United States report relatively consistent prevalence figures of around 100–200 individuals per 100,000. The prevalence increases with age and is around 1% in the population over the age of 60 years (Tysnes & Storstein, 2017). The ratio between men and women is 3:2 (Kalia & Lang, 2015). The main symptoms seen in PD are rigid body movements, bradykinesia and resting tremors (Tysnes & Storstein, 2017). The severity of these motor-related symptoms is commonly rated using a symptom severity scale and Hoehn and Yahr (1967) presented a five-step scale for motor-related problems seen in PD. In addition to these main symptoms, a varying number of persons with PD (PwPD) experience symptoms such as motor speech problems (dysarthria), dysphagia, depression, fatigue, cognitive impairment, for example, executive functions and memory, and language deficits such as impaired comprehension and word-finding difficulties (Altmann & Troche, 2011; Kalia & Lang, 2015; Tysnes & Storstein, 2017).

Executive functions can be described as self-monitoring functions such as working memory, cognitive flexibility and inhibition, which are important functions in planning, goal orientation, self-control and selective attention (Diamond, 2013; Henry & Crawford, 2004). Deficits in executive functions have been suggested to be one of the more predominant cognitive dysfunctions in PD (Miura et al., 2015). Depletion of dopamine producing neurons in substantia nigra which affects the subcortico-frontal circuit has been argued to be one of the causes to the executive dysfunction seen in PD (Henry & Crawford, 2004; Miura et al., 2015).

Regarding language ability in PD, Altmann and Troche (2011) describe both impaired comprehension and production problems, including word-finding difficulties, in their review of research on language deficits in PD. Further, in Schalling et al. (2017), 188 informants with PD answered questions regarding speech, language and swallowing through a self-report questionnaire. The two most frequently reported symptoms were weak voice (71.0%) and word-finding problems (58.6%).

Word-finding difficulties, or anomia, is a common symptom in many neurological diseases and in damage to the brain (Goodglass & Wingfield, 1997; Laine & Martin, ...
They may manifest as, for example, increased effort, latency, and semantic and phonemic errors. The difficulties may also vary in severity depending on the progression, location and size of the brain damage (Rohrer et al., 2008).

For some PwPD, the word-finding difficulties have a negative impact on everyday conversational interactions as they may lead to atypical word choices, problems formulating ideas, and frequent pauses and gaps in everyday conversations. This may lead to an increased need for conversational repairs (Miller et al., 2006; Saldert et al., 2014). Word-finding difficulties have been seen in PwPD both with and without dementia (Miller, 2017).

Although word-finding difficulties are commonly assessed using picture naming tasks, less severe word-finding difficulties are also often explored with controlled oral word association tests (COWATs). The participant is asked to produce as many words as possible during a set time period (Spren & Risser, 2003; Tallberg et al., 2008). In the following text we will use the acronym COWATs for these types of tests, as proposed by Spren and Risser (2003). Examples of COWATs include phonemic and semantic fluency tasks. A phonemic fluency task normally involves three letters, and a semantic fluency task often uses a single category (often animals and actions).

It is known that increased age and education may influence the performance on COWATs, and several different processes and abilities are involved in the performing of these tasks (Bauer & Saldert, 2020; Tallberg et al., 2008). Besides being dependent on motor functions such as ability to articulate and vocalize, a person’s performance on COWATs relies on language functions such as word knowledge, semantic memory, and ability to activate lexical representations and retrieve and produce specific words. Further, COWATs requires self-monitoring cognitive skills such as executive functions: working memory, inhibition and cognitive flexibility (Henry & Crawford, 2004; Whiteside et al., 2016).

Whiteside et al. (2016) explored COWATs using factor analysis. In their study, one factor included language tasks in the form of confrontation naming and a vocabulary test. The other factor included tests of executive functions. They found that both phonemic and semantic COWATs loaded onto the language factor, but not to the executive functions factor. They argued that COWATs are primary a language tasks, but they emphasize that both executive and language functions can influence a person’s performance on COWATs. Working memory and executive functions are important in keeping track of already given words, inhibiting incorrect words, and in the switching of retrieval strategies (Diamond, 2013; Henry & Crawford, 2004; Rende et al., 2002). It has been argued that the two subsystems in Baddeley’s (1992) conceptualization of working memory contribute to the performance on phonemic and semantic verbal fluency tasks (Rende et al., 2002). The phonological loop is, for example, involved when searching for words with a specific initial letter and the visuospatial sketchpad is important for strategies of visualization, for example, visualizing different habitats when retrieving animals in a semantic verbal fluency task.

Verbal fluency in PD has been explored in earlier studies, yet the conclusions have been inconsistent. In a meta-analysis, Henry and Crawford (2004) concluded that PwPD performed poorer on COWATs, especially COWATs with semantic categories. They suggested that the impaired performance on COWATs was connected to deficits in semantic memory functions rather than deficits in executive functions. When exploring the differences in performance between PwPD with and without dementia, they found that both groups scored lower than people without PD on COWATs with semantic categories. People with PD and dementia performed worse on phonemic COWATs, whereas only small to moderate deficits were seen in PwPD without dementia. Berg et al. (2003) reported no differences in performance on a phonemic COWAT between participants with PD but without dementia and a control group, but a significant difference was found on a semantic COWAT. Herrera et al. (2012) argued that dopamine medication may influence performance on controlled verbal fluency. When comparing PwPD on dopamine medication with a healthy control group, they found no differences in performance on COWATs. When comparing PwPD off dopamine medication and a healthy control group, they found significant COWAT differences in the phonemic and action category. The authors suggested that dopamine depletion could result in slower cognitive processing in participants with PD (off dopamine medication). Based on research showing that brain areas involved in motor processes are also recruited during lexical access, they argue that the frontal lobe dysfunction might make it harder for PwPD to retrieve words with meanings related to motor function, such as action words or verbs. Action COWATs have been suggested to be sensitive to cognitive decline seen in PD. Piatt et al. (1999) compared PwPD with and without dementia and found that PwPD with dementia performed poorer especially in an action COWAT. No differences were seen between PwPD without dementia and a healthy control group on the semantic and phonemic COWATs.

In their review article, Altmann and Troche (2011) describe that PwPD performed poorer than healthy aged-matched peers on many so-called high-level, that is, more complex, language tasks. They define this as language production at discourse level, in contrast to production of single words. High-level language tasks place high demands on cognitive abilities such as working memory, process...
speed and executive functions. Body and Perkins (2006) provide and discuss examples of terms used to describe cognitive processing dependent on linguistic as well as other cognitive abilities. Terms commonly used are high-level language, higher order language, cognitive–linguistic, cognitive–pragmatic, and complex language function (Body & Perkins, 2006). The common denominator is that tasks measuring abilities which are requiring this type of processing needs to be cognitively demanding and depending on an integration of language and non-language functions. It has been argued that more subtle language difficulties can be hard to detect with established language assessment tools, such as standard diagnostic aphasia tests (Bauer & Saldert, 2020; Berg et al., 2003; Lethlean & Murdoch, 1997; Miller, 2017; Saldert, 2017). The reason for this could be that many of the established language assessment tools do not include tasks sensitive to higher level language functions, or more complex tasks, taxing the interface of language and other cognitive functions.

Bauer and Saldert (2020) suggested that a COWAT that is more cognitively demanding than standard COWATs may be helpful in detecting subtle language difficulties seen in a variety of neurological diseases such as multiple sclerosis and PD. They developed a novel fluency test, the complex oral semantic fluency (COSEF) task, based on the theories of divergent thinking as discussed by Guilford and Hoepfner (1971). Divergent thinking has been described as an ability to produce a variety of solutions to a problem. Guilford and Hoepfner (1971) suggested that the ability to perform divergent thinking operations may be measured in fluency tasks, as divergent production, with differing degrees of constraints. Thus, while a picture-naming task is dependent on a convergent process in the activation and production of a single, correct response, fluency tasks should put higher demands on both language ability and executive functions, requiring the activation and production of several, related, but different items. Referring to Guilford and Hoepfner (1971), Bauer and Saldert (2020) proposed that an increase in restrictions in terms of number of specifications of mandatory features in adequately produced items may increase the demands on executive functions, divergent thinking and access to the semantic system. The COSEF task is a COWAT that is intended to be demanding on processes associated with divergent thinking and semantic retrieval. The difference between many of the established verbal fluency tasks and the COSEF task is that instead of one single semantic restriction (e.g., the participants are to list animals or activities), the COSEF task involves multiple semantic restrictions, where the combination of more than one feature is required (e.g., the participants are to list objects that are both long and sharp) (Bauer & Saldert, 2020). In their study, they found that a group of participants with multiple sclerosis (MS) and subjective word-finding difficulties scored significantly lower on the COSEF task compared with a matched control group with no brain damage. Bauer and Saldert (2020) concluded that the validity of the COSEF tasks should be investigated with other clinical groups and that possibly relationships between executive function and results on the COSEF task needs to be further explored.

To sum up, PD is a neurodegenerative disorder where word-finding difficulties are frequently reported. These difficulties are often assessed using COWATs. The established aphasia test batteries and COWATs have often failed to detect language problems in PD. It has been suggested that the COSEF task with its multiple restrictions could be a sensitive measure when assessing subtle language difficulties in multiple sclerosis and other clinical groups. Earlier research has also indicated that executive functions may influence verbal fluency performance in PD, and these problems have been seen in PwPD both with and without dementia.

Aims and research question

The aims of this study were threefold. The first aim was to examine whether PwPD without dementia differ from non-brain damaged individuals in performance on COWATs with single restrictions and a novel multiple restrictions COWAT, the COSEF task. A second aim was to investigate the relationship between the COSEF task and executive functions in PwPD measured using Digit Span Backwards, Trail Making Test and Design Fluency Test. Finally, the third aim was to investigate whether self-reported word-finding difficulties, age, years of education, and severity of motor symptoms influence performances on executive functions tasks and the results on the COSEF task.

METHODS

Ethical considerations

The study was approved by the Regional Ethical Board of Gothenburg, Sweden (reference number 506-16). The participants gave written consent after receiving oral and written information.

Participants

This study was based on a cross-sectional survey where data were collected through consecutive sampling.
Participants in a research project on anomia in neurological diseases were recruited through a network of speech and language therapists in the region of Västra Götaland in Sweden and through the Swedish Parkinson Association. A total of 20 participants with PD were invited to participate in the main study; 17 of them met the inclusion criteria in the current sub-study: native Swedish speaking, subjective word-finding difficulties and a documented PD diagnosis. Exclusion criteria were any other documented neurological disease, injury or condition (including dementia) besides PD, alcohol or substance abuse, any type of atypical parkinsonism and severe dysarthria. Information regarding diagnosis and severity of disease was obtained through the participants’ medical records by research assistants with a speech and language therapy degree.

The group of PwPD who met the inclusion and exclusion criteria was compared with a group of individuals with self-reported no known neurological diseases or brain damage who were matched according to age, gender and education (Table 1). This control group was drawn from a data reference bank that contains data on results on four different COWAT tasks for 110 participants recruited through convenience sampling (Bauer & Saldert, 2020). No measure of results on executive functions or other cognitive tasks were available for the control group. There were no significant differences between the groups regarding education \( t(32) = 0.16, p = 0.88 \), age \( t(32) = -0.012, p > 0.91 \) or gender distribution \( \chi^2(1, N = 34) = 0.47, p = 0.49 \).

### Materials and procedure

The testing took place in a secluded area with minimum distractions in either an office environment or the participant’s home environment. It was led by one of four speech–language therapists employed as research assistants. All test leaders followed a test protocol and had received training in using the test material before assessment of participants.

The participants with PD were tested using a large battery of tests for the assessment of different aspects of anomia for another research project. The testing procedure for all tasks in the main project took 3–4 h for the participants with PD and was divided into two sessions over 2 days, with a break after every 45 min of testing. The tests used in the current study were administered after the first break. Only the participant and the test leader were present during the testing. The test leader assessed the participant according to the motor symptom progression scale by Hoehn and Yahr (1967), where a score of 1 signifies unilateral motor problems with minimal or no impact on function and a 5 indicates bilateral motor problems with severe impact on function.

### Table 1

| | PwPD (n = 17) | | Control (n = 17) | |
|---|---|---|---|---|
| | Variance | Mean | SD | Variance | Mean | SD |
| Age (years) | 53–83 | 72.5 | 8.4 | 54–85 | 72.9 | 8.9 |
| Education (years) | 6–18 | 13.4 | 3.4 | 6–17 | 13.2 | 3.2 |
| H&Ya | 1–4 | 2.3 | 0.9 | – | – | – |
| Gender | | | | | |
| Females | 9 | | | 7 | | |
| Males | 8 | | | 10 | | |

*Note: A stage of the disease according to the Hoehn and Yahr (1967) motor symptom scale for PD. A 1 indicates unilateral motor problems with minimal or no impact on function and a 5 indicates bilateral motor problems with severe impact on function.*
That is, participants were first asked to name ‘things that are round and flat’ and then ‘things that are long and sharp’. In the phonemic and semantic verbal fluency tasks, participants were instructed to produce as many words as possible. They were told to exclude proper names and were given 1 min for each letter and each category. In the semantic verbal fluency tasks, participants were informed that the initial letter no longer was important. In all four fluency tests, the participants were asked to continuously produce new words without making inflections or compounds.

The tests of executive function were selected to cover various aspects of executive functions. To tap into working memory, Digit Span Backwards was used (Semel et al., 2003). The Trail Making Test was chosen to measure cognitive flexibility and working memory (Sánchez-Cubillo et al., 2009). For the Trail Making test, the quotient between parts B and A was used in the analysis. It has been suggested that a quotient between the completion times for the two parts could be of clinical value and make the test more sensitive to cognitive flexibility (Arbuthnott & Frank, 2000). The Design Fluency Test was used to measure cognitive flexibility as well as divergent thinking based on visual stimuli. (Delis et al., 2001).

**Scoring procedure**

The scoring procedure was carried out separately by two research assistants at the University of Gothenburg’s Speech and Language Pathology Unit. Scoring guidelines for the COSEF task have been developed by Bauer and Saldert (2020). While most established fluency tasks do not allow synonyms, both synonyms and metaphorical interpretations were accepted in the COSEF task, as we were interested in measuring access to a variety of semantic representations in the lexicon. An example of an accepted metaphorical interpretation is ‘a tall and smart professor’ for an object that is ‘long and sharp’, where the word sharp could refer to someone’s intellect. Repetitions, inflections and compounds were not allowed. Further, circumlocutions and superordinate categories, for example, ‘tools’ or ‘toys’, were not accepted. Loan words or more newly created expressions had to be included in the Swedish Academy’s official glossary (SAOL) or generate more than 500 Google hits to be scored as adequate. The object referred to was not allowed to be altered in form or function to fit the constraints, for example, a grape that has been stomped on would not meet the criteria for something that is flat and round. For F-A-S, animals and verb fluency, the scoring procedures followed those presented by Tallberg et al. (2008). The executive function tests were scored according to the guidelines for the respective test (Delis et al., 2001; Sánchez-Cubillo et al., 2009; Semel et al., 2003).

An intraclass correlation coefficient (ICC) between the research assistants’ scoring of the COSEF task was calculated to estimate interrater reliability. A two-way random model with absolute agreement and single measure was used. The interrater reliability was defined as excellent according to Cicchetti’s (1994) guidelines, (ICC = 0.990; 95% confidence interval = 0.978–0.996, p < 0.001). This is in line with the ICC reported by Bauer and Saldert (2020).

**Statistical analysis**

Data were analysed using IBM’s SPSS version 25. Due to a small sample, all statistical analyses were made using non-parametric tests. Normal distribution on the verbal fluency tasks with single and multiple restrictions was assessed using a Shapiro–Wilk test. All data were concluded to come from a normal distribution. The scores on the single restriction phonemic and semantic verbal fluency task were converted to standard scores (SS) according to Swedish norm values from Tallberg et al. (2008). To answer the research questions formulated in the first aim, whether PwPD without dementia differ from non-brain-damaged individuals in performance on COWATs with single restrictions or the COSEF task, the PwPD’s results on the COSEF task, phonemic, animals and actions fluency tasks were compared with the control group’s results using a Mann–Whitney U-test. Correlation analysis with Spearman’s rho was used to answer the questions formulated under the second and third aims regarding the relationships between scores on COWATs, Digit Span Backwards, the Trail Making Test and Design Fluency Test, as well as age, years of education and severity of motor symptoms according to Hoehn and Yahr (1967). The size of the correlation was described as small, medium and large according to suggestions by Cohen (1988). A small correlation is defined as a correlation coefficient of 0.10–0.29, a medium as a correlation coefficient of 0.30–0.49 and a large correlation is defined as a correlation coefficient of 0.50 and above. Due to the small number of participants and use of non-parametric tests, no correction of the p-value was done despite that multiple comparisons was performed. Data from the COWATs were also studied with a modified t-test. Crawford and Howell (1998) argue that there is a risk of type 1 error when using normative control samples with fewer than 50 participants in single case studies. Thus, test results from the participants were compared with the mean and SD of the control group using the modified t-test. Due to the heterogeneity in the PwPD
### RESULTS

#### Differences between groups on COWATs

The PwPD group produced fewer adequate responses/items on the COSEF task (mdn = 11) compared with the controls (mdn = 16). The difference in total number of adequate responses/items was significant ($U = 213.5, p = 0.02$) (Table 2). No significant differences in the total number of adequate responses/items were found between the groups on the COWATs with single restriction, that is, neither on the phonemic COWAT ($U = 163, p = 0.54$) nor on the semantical COWATs animals ($U = 194.5, p = 0.09$) and actions ($U = 169.5, p = 0.39$). Moreover, no significant differences were seen when comparing the groups with SS on the single-class restriction COWATs with norms from Tallberg et al. (2008).

When examining the results on COWATs individually with a modified $t$-test, only five of the PwPD differed significantly from the mean of the control group on the multiple restriction COWAT, COSEF (Table 3). That is, a majority of the PwPD with subjective word-finding difficulties performed within the normal variance of the non-brain-damaged control group, and in some cases even higher than their matched control peers.

#### Relationships between the COSEF task and executive functions

To examine the relationships between the COSEF task and executive functions among the PwPD, a Spearman correlation analysis was performed comparing the total number of adequate responses/items on the COSEF task with the Trail Making Test quotient (B/A), and performance on the Digit Span Backwards and Design Fluency Test (Table 4). Significant large correlations were found between the COSEF task and Trail Making Test part B divided by A ($r = -0.59, p = 0.01$). A large correlation was also seen between the COSEF task and Digit Span Backwards ($r = 0.54, p = 0.03$). A small and non-significant correlation was found between total number of adequate responses/items on the COSEF task and Design Fluency Test score ($r = 0.27, p = 0.29$).

#### Influence of background factors

To investigate the relation between the results of self-reported word-finding difficulties, age and education on the total number of adequate responses on the COSEF...
TABLE 3  
Scores on verbal fluency tasks for individuals with PD and self-reported degree of word-finding difficulties

| Age (years) | Education (years) | H&Y | COSEF | FAS | Animals | Actions | WFD* |
|------------|------------------|-----|-------|-----|---------|---------|------|
| PS1        | 83               | 13  | 3     | 16  | 27↓     | 19      | 12   | 6    |
| PS2        | 83               | 6   | 3     | 9*  | 11↑     | 14      | 7    | 3    |
| PS3        | 82               | 17  | 2     | 9*  | 35      | 11↑     | 15   | –    |
| PS4        | 62               | 17  | 1     | 14  | 43      | 13↓     | 10   | 5    |
| PS5        | 70               | 11  | 3     | 27  | 70      | 35      | 34   | 3    |
| PS6        | 79               | 16  | 2     | 6*  | 45      | 13↓     | 16   | 4    |
| PS7        | 73               | 9   | 3     | 4*  | 48      | 15      | 14   | 3    |
| PS8        | 66               | 14  | 2     | 6*  | 28↓     | 12↓     | 13   | 7    |
| PS9        | 67               | 17  | 1     | 19  | 48      | 14↓     | 14   | 3    |
| PS10       | 72               | 17  | 2     | 13  | 34      | 19      | 14   | –    |
| PS11       | 79               | 15  | 4     | 9*  | 23↓     | 5*↓     | 4    | –    |
| PS12       | 72               | 15  | 2     | 14  | 66      | 22      | 18   | 6    |
| PS13       | 71               | 15  | 3     | 8*  | 31↓     | 16      | 15   | 5    |
| PS14       | 82               | 9   | 2     | 11↓ | 40      | 23      | 23   | 6    |
| PS15       | 53               | 13  | 1     | 20  | 66      | 29      | 22   | 4    |
| PS16       | 75               | 18  | 2     | 6*  | 40      | 9*     | 7    | 3    |
| PS17       | 64               | 10  | 3     | 19  | 27↓     | 22      | 15   | 2    |

Note: *WFD = self-reported word-finding difficulties graded between 0 to 8, where 0 = no word-finding difficulties and 8 = every time I speak. (Data were unfortunately missing for participants PS3, PS10 and PS12.)

b Performance differs by more than 1 SD from the control group’s mean.

c Performance differs by more than 1.5 SD from the control group’s mean.

* Correlation significant at the 0.05 level (two-tailed).

TABLE 4  
Correlations between verbal fluency, background factors and executive functions in the PwPD group

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| 1. COSEF | 1 | –0.59* | 0.54* | 0.27 | –0.40 | 0.38 | –0.19 | –0.17 |
| 2. TMT B/A | 1 | –0.51* | –0.60* | 0.29 | –0.30 | 0.03 | 0.11 |
| 3. DSB | 1 | 0.17 | –0.05 | 0.14 | –0.22 | 0.19 |
| 4. DFT | 1 | –0.20 | 0.28 | –0.33 | 0.18 |
| 5. Age | 1 | –0.36 | 0.43 | 0.10 |
| 6. Education | 1 | –0.34 | 0.18 |
| 7. H&Y | 1 | –0.25 |
| 8. WFD | 1 |

Notes: *COSEF = complex oral semantic fluency test.

TMT B/A = quotient between Trail Making Test parts A and B.

DSB = Digit Span Backwards.

DFT = Design Fluency Test scaled score; Age = participant’s age.

*Education = years of education.

H&Y = stage of the disease according to Hoehn and Yahr’s (1967) motor symptom scale for PD. WFD = self-reported word-finding difficulties rated as between 0 to 8, where 0 = no word-finding difficulties and 8 = every time I speak.

*Correlation significant at the 0.05 level (two-tailed).

Task, Spearman’s rho was used. Both age ($r = –0.40, p = 0.12$) and education ($r = 0.38, p = 0.13$) correlated moderately with the COSEF task in the group of PwPD. There was also a medium negative correlation ($r = –0.33, p = 0.20$) between the results on the Design Fluency Test and degree of motor symptoms as measured by Hoehn and Yahr’s motor symptom scale. No correlation was found between severity of motor symptoms and the COSEF task. Furthermore, no positive correlation was found between self-reported word-finding difficulties and the COSEF task ($r = –0.17, p = 0.56$) in the group of PwPD. In the control group a small positive correlation was found between age
(r = 0.24, p = 0.35) and the COSEF task, but no correlation was found between education (r = 0.04, p = 0.88) and the COSEF task.

**DISCUSSION**

The first aim of the current study was, based on earlier research on the COSEF task, to examine whether PwPD without documented dementia differ in performance on COWATs with single or multiple restrictions compared with a control group. Significant between-group differences were seen in performance on a multiple restriction COWAT, the COSEF task. PwPD produced significantly fewer adequate responses than the control group on the COSEF task, while no significant differences were found on the established phonemic or semantic single restriction COWATs. However, when single case methodology was used, it became clear that there was a large variation within the group and many of the PwPD did not differ significantly from the matched control group on the COSEF task.

A second aim of the study was to investigate whether there were any relationships between scores on the COSEF task and executive functions in the group with PD. There were large correlations between the COSEF task, working memory and cognitive flexibility as measured with Digit Span Backwards and the Trail Making Test (B/A). These tasks use stimuli which are verbally and language based, that is, letters and figures. No correlation was found when examining the COSEF task and the visually based Design Fluency Test. This task measures cognitive flexibility and divergent fluency by assessing the participants’ ability to generate different geometric patterns.

A third aim was to investigate data on background factors such as age, years of education and motor-related problems. Age and years of education have in previous research appeared to influence the result on COWATs (Bauer & Saldert, 2020; Tallberg et al., 2008). Both age and years of education correlated moderately to largely with the COSEF task results in the group of PwPD. Furthermore, severity of motor symptoms correlated moderately with results on the Design Fluency Test. Interestingly, no correlation was seen between subjective word-finding difficulties and the COSEF task in the group of PwPD.

**Performance of PwPD on controlled oral word association tasks**

The COSEF task was constructed based on Guilford’s and colleagues’ (Guilford, 1967; Guilford & Hoepfner, 1971) theories on how to measure divergent production (Bauer & Saldert, 2020). Bauer and Saldert (2020) suggested that the multiple semantic class restriction put strain on the participants’ divergent thinking, requiring both cognitive flexibility and semantic retrieval. The PwPD as a group in the current study performed poorer than the control group on the COSEF task but not on the single restriction COWATs. The main explanation to this could be that the COSEF task is both cognitively and semantically more demanding. The established COWATs used in this study (FAS, Actions and Animals) do allow some degree of automatic spreading activation of semantic representations. That is, several words referring to items sharing single semantic features may automatically be activated and produced in clusters. The shared single feature may, for example, be that the words denote a housekeeping activity, or a specific kind of animal which lives at a farm. In contrast, the multiple restrictions in the COSEF task requires the participant to perform a more cognitively effortful search, scanning more distantly related semantic networks for items sharing the multiple features. Language abilities rely on cognitive abilities such as executive functions and retrieval of semantic knowledge. Changes in cognitive functions in PD could be one explanation as to why the group of PwPD performed poorer on the more COSEF tasks. As mentioned earlier, impaired executive functions and access to semantic knowledge are often observed in PwPD. They can be present early in disease progression although the person does not meet the criteria for a dementia diagnosis (Aarsland et al., 2009; Muslimović et al., 2005).

When examining the data using a modified t-test (Crawford & Howell, 1998), it became clear that there was a large variance in performance within the group of PwPD (Table 3). Only nine of the 17 PwPD performed 1 SD or more below the control group’s mean value on the COSEF task. Most of the participants (13 of 17) performed 1 SD or more below the control group’s mean value on at least one of the COWATs, but not always the COSEF task. This shows that the COSEF task does not provide a single sufficient method for the assessment of mild word-finding difficulties. Further, the results indicate that administering a single COWAT, irrespective of type, is insufficient in cases of more mild subjective word-finding difficulties. The variation in performance cannot be explained by a single factor but may be a combination of multiple factors such as disease progression, age, education and general cognitive functions. Based on the correlation between age and education, one may want to argue that a more complex task such as COSEF may be especially useful in younger and more highly educated individuals. However, the results in the group of participants with MS in Bauer and Saldert (2020) also displayed this variation and the authors...
argued that factors such as personal characteristics, including personal interests, knowledge and experiences, could affect how the COSEF task is performed at an individual level.

Even though the COSEF task with its higher complexity was significantly harder for the PwPD group than for the group without brain damage, it failed to clearly reflect self-reported word-finding difficulties in the majority of the PwPD. Subjective word-finding difficulties is a complex matter. How one experiences difficulties retrieving words in everyday interaction depends on several factors, including personal characteristics and experiences. For example, a person who is talkative, or is conscious about how they express themselves, might experience discreet word-finding difficulties as more significant than persons who use their language less deliberative or to a more limited extent. It is possible that even though the groups were matched according to age and education, that personal characteristics and experience differed between the PwPD and their matched peers.

As a clinician, it is important to note that even if a person with PD does not perform poorly on the COSEF task or single restriction COWATs, subjective word-finding difficulties can be present and negatively affect the person’s communication (Miller et al., 2006; Saldert et al., 2014; Schalling et al., 2017). Therefore, it is important to include questions about language and everyday communication when assessing PwPD. The COSEF task could contribute to the diagnosis of subtle language-related problems such as word-finding difficulties in PD when used together with other language assessment tools, for example, single restriction COWATs, and a thorough anamnesis regarding language and communication.

Relationships between verbal fluency with multiple restrictions and executive functions

The relation between the results of the executive function tests and the COSEF task indicates that the COSEF task does put higher demands on cognition and semantic retrieval and may be a sensitive measure of more subtle word-finding difficulties. The Digit Span Backwards task is suggested to place high demands on working memory. There was a large correlation between this task and the COSEF task. In earlier research, the Digit Span Backwards task has been shown to be challenging to PwPD (Miura et al., 2015). Cognitive flexibility, as an aspect of executive function, was assessed using the Trail Making Test and the Design Fluency Test. A large correlation between the Trail Making Test (B/A) and the COSEF task was found. Previous research has suggested that the Trail Making Test is challenging to PwPD because of the load it places on executive and motor functions (Miura et al., 2015; Muslimović et al., 2005). One way to reduce the influence of motor function is to use the quotient between parts B and A, and this would make the test more sensitive to cognitive flexibility (Arbuthnott & Frank, 2000).

In the current study, no correlation was seen between the Trail Making Test (B/A) and stage according to Hoehn and Yahr (1967), a scale which is mainly based on motor functions. However, a correlation was found between the visually based cognitive flexibility test, The Design Fluency Test and stage according to Hoehn and Yahr (1967), suggesting that results on the task was affected by motor related difficulties. Some of the participants found the drawing part challenging due to tremor and poor motor control.

Thus, influence from motor related deficits may have obscured a possible correlation between the results on the COSEF task and the Design Fluency Test. However, the fact that the COSEF task correlated with the Trail Making Test (B/A), both of them using verbal and linguistic stimuli, but not with the Design Fluency Test, which is dependent on the processing and production of non-verbal, visually based stimuli, may suggest another explanation. It may indicate that although divergent production is requiring cognitive flexibility, the result in such tasks is also dependent on other factors in the specific task. In this case, language, and more specifically word finding ability in a word fluency task like COSEF, and spatial ability in the Design Fluency Task.

Methodological discussion and limitations

First and foremost, the size of the PwPD group in this study was modest, which may have impacted the results. The limited number of participants prevents the use of statistical methods, such as factor analysis, or regression analysis, which could provide more information on factors influencing the results on the COSEF task. It is also possible that the PwPD in the current study were not representative of the population with PD. The ratings on the progression stage scale (Hoehn & Yahr, 1967) indicate that this might be the case. Most of the participants with PD were rated as being in stage 3 or lower. Only one scored 4 out of 5. This means that most of the participants had mild to moderate PD-related motor symptoms that had little to no effect on their everyday life.

No screening for depression was done. Affective disorders are frequently seen in PD. These symptoms are known to affect cognitive abilities such as memory and executive functions in PwPD (Muslimović et al., 2005). The test schedule allowed the participants to take their
Parkinson medication in accordance with their usual scheme, but time since the participants’ last intake of their medication was not recorded. These factors could have influenced the participants’ performance. Another factor that could have influenced the performance was the general disease progression. No such measurement was obtained in the current study. The participants were rated according to the H&Y motor severity scale, yet this factor did not correlate with the performance on the COSEF task.

As mentioned above, the entire testing process for participants with PD took approximately 3–4 h and was divided into two sessions held on two different days with a break every 45 min. According to Kalia and Lang (2015), some PwPD will experience fatigue. Even after taking a break, many of our participants said they felt tired after the testing session. This could have influenced their performance, especially on the tests that were administered near the end of each session. To control for this possibly confounding factor, the tests were administered in two different orders. Irrespective of test order, however, the tests used in the current study were administered after the first break, and the risk of fatigue influencing the results was thus reduced.

The participants were tested in different types of rooms. Some were tested in their home environment and others in hospitals or an office environment. Two of the participants were tested in a suboptimal room. This room was small, with poor lighting and no windows. Both these participants said spontaneously that this made them feel tired. Bauer and Saldert (2020) raised another important point regarding the testing environment when using the COSEF task. Since the COSEF task requires the participants to recall objects with certain features, participants may search the room for visual clues to retrieve more words. Since the test environments had different amounts of visual stimuli present, this could have served as an advantage for some of the participants, especially those who were tested in their home environment where test leaders did not have any control over the interior. However, the control group pooled from Bauer and Saldert (2020) were tested under similar circumstances as the PwPD in the current study.

Further research

Additional research on larger groups is needed to explore to what extent the COSEF task works as an instrument to detect subjective word-finding difficulties in neurodegenerative diseases such as PD. Further research on the relation between the task and executive functions is also required. It is known that PwPD may have impaired response inhibition (Henry & Crawford, 2004), which is one of the core executive functions according to Diamond (2013). The inclusion of a test for inhibition, for example, the Stroop test (Stroop, 1935) may add information regarding the influence from different aspects of executive function on the word-finding difficulties seen in the COSEF task among PwPD.

There are numerous reports on word-finding difficulties in everyday conversations in PwPD, but most of them report either responses in questionnaires or conversation analysis on everyday interaction (Miller et al., 2006; Saldert et al., 2014; Schalling et al., 2017). Further exploration of the relationship between performance on COWATs and language function in everyday communication could deepen the understanding of the clinical significance of using COWATs as an assessment tool to detect discreet word-finding difficulties in PD. More research is also required for the establishment of validity and reliability of the COSEF task in different clinical groups.

CONCLUSIONS

This study provides an insight into performance on COWATs in PwPD without documented dementia but with self-reported word-finding difficulties. Although the group of PwPD produced significantly fewer adequate responses than a matched control group, this was not the case for each individual, and not on all four COWATs. Furthermore, the results on the COSEF task do not mirror self-reports of degree of word-finding difficulties. Stronger working memory and cognitive flexibility, higher level of education and lower age may be linked to better performance on the COSEF task, indicating the complexity of the task, while motor function may not. This suggests that word-finding difficulties do not always progress the same way as motor-related problems in PD. In conclusion, this tells us that it is important in clinical settings when working with PwPD to include questions about language- and communication-related issues such as word-finding difficulties, as this is a symptom that may otherwise be missed during clinical assessments.

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CONFLICT OF INTEREST
The authors declare no conflict of interest. The authors alone are responsible for the content and writing of the paper.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy and ethical restrictions.

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REFERENCES
Aarsland, P.D., Brønnick, B.K., Larsen, B.J., Tysnes, B.O. & Alves, B.G. (2009) Cognitive impairment in incident, untreated Parkinson disease: the Norwegian ParkWest study. Neurology, 72, 1121–1126.
Altman, L.J. & Troche, M.S. (2011) High-level language production in Parkinson’s disease: a review. Parkinson’s Disease, 2011, 238956.
Arbuthnott, K. & Frank, J. (2000) Trail making test, part b as a measure of executive control: validation using a set-switching paradigm. Journal of Clinical and Experimental Neuropsychology, 22, 518–528.
Baddeley, A. (1992) Working memory. Science, 255, 556–559.
Bauer, M. & Saldert, C. (2020) Complex oral semantic verbal fluency in non-brain-damaged adults and individuals with multiple sclerosis and subjective anomia. Aphasiology, 34, 1471–1486.
Berg, E., Björnram, C.K., Laakso, B., Johnels, L. & Hartelius, L. (2003) High-level language difficulties in Parkinson’s disease. Clinical Linguistics & Phonetics, 17, 63–80.
Body, R. & Perkins, M.R. (2006) Terminology and methodology in the assessment of cognitive-linguistic disorders. Brain Impairment, 7(3), 212–222. http://doi.org/10.1375/brim.7.3.212
Cicchetti, D.V. (1994) Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. Psychological Assessment, 6(4), 284–290.
Cohen, J. (1988) Statistical power analysis for the behavioral sciences, 2nd, Hillsdale: NJ: Lawrence Erlbaum Associates.
Crawford, J.R. & Howell, D.C. (1998) Comparing an individual’s test score against norms derived from small samples. The Clinical Neuropsychologist, 12, 482–486.
Delis, D., Kaplan, E. & Kramer, J. (2001) Delis-Kaplan Executive Function System (D KEFS). Technical manual. Bromma: Pearson Clinical & Talent Assessment
Diamond, A. (2013) Executive functions. Annual Review of Psychology, 64, 135–168.
Goodglass, H. & Wingfield, A. (1997) Anomia: Neuroanatomical and cognitive correlates, San Diego: Academic Press.
Guilford, J.P. (1967) The nature of human intelligence. New York, McGraw-Hill Book Company.
Guilford, J.P. & Hoepfner, R. (1971) The analysis of intelligence, New York, McGraw-Hill Book Company,
Henry, J.D. & Crawford, J.R. (2004) Verbal fluency deficits in Parkinson’s disease: a meta-analysis. Journal of the International Neuropsychological Society, 10, 608–622.
Herrera, E., Cuertos, F. & Ribacoba, R. (2012) Verbal fluency in Parkinson’s disease patients on/off dopamine medication. Neuropsychologia, 50, 3636–3640.
Hoehn, M.M. & Yahr, M.D. (1967) Parkinsonism: onset, progression, and mortality. Neurology, 17, 427–427.
Kalia, L.V. & Lang, A.E. (2015) Parkinson’s disease. The Lancet, 386, 896–912.
Laine, M. & Martin, N. (2013) Anomia: Theoretical and clinical aspects, Hove: Psychology Press.
Lethelean, J.B. & Murdoch, B.E. (1997) Performance of subjects with multiple sclerosis on tests of high-level language. Aphasiology, 11, 39–57.
Macoir, J. & Lavoie, M. (2021) Definitions: anomia. Cortex, 144, 212–212.
Miller, N. (2017) Communication changes in Parkinson’s disease. Practical Neurology, 17, 266–274.
Miller, N., Noble, E., Jones, D. & Burn, D. (2006) Life with communication changes in Parkinson’s disease. Age and Ageing, 35, 235–239.
Miura, K., Matsu, M., Takashima, S. & Tanaka, K. (2015) Neuropsychological characteristics and their association with higher-level functional capacity in Parkinson’s disease. Dementia and Geriatric Cognitive Disorders Extra, 5, 271–284.
Muslimović, D., Post, B., Speelman, J.D. & Schmand, B. (2005) Cognitive profile of patients with newly diagnosed Parkinson disease. Neurology, 65, 1239–1245.
Platt, A.L., Fields, J.A., Paolo, A.M., Koller, W.C. & Tröster, A.I. (1999) Lexical, semantic, and action verbal fluency in Parkinson’s disease with and without dementia. Journal of Clinical and Experimental Neuropsychology, 21, 435–443.
Rende, B., Ramsberger, G. & Miyake, A. (2002) Commonalities and differences in the working memory components underlying letter and category fluency tasks: a dual-task investigation. Neuropsychology, 16, 309–321.
Rohrer, J.D., Knight, W.D., Warren, J.E., Fox, N.C., Rossor, M.N. & Warren, J.D. (2008) Word-finding difficulty: a clinical analysis of the progressive aphasias. Brain, 131, 8–38.
Saldert, C. (2017) Pragmatic assessment and intervention in adults. Cummings, L., Research in clinical pragmatics, Perspectives in Pragmatics, Philosophy & Psychology. II Wien: Springer. 527–558. 10.1007/978-3-319-47489-2_20
Saldert, C., Ferm, U. & Bloch, S. (2014) Semantic trouble sources and their repair in conversations affected by Parkinson’s disease. International Journal of Language & Communication Disorders, 49, 710–721.
Sánchez-Cubillo, I., Periáñez, J.A., Adrover-Roig, D., Rodríguez-Sánchez, J.M., Ríos-Lago, M., Tirapu, J., et al. (2009) Construct validity of the Trail Making Test: role of task-switching, working memory, inhibition/interference control, and visuomotor abilities. Journal of the International Neuropsychological Society, 15, 438–450.
Schalling, E., Johansson, K. & Hartelius, L. (2017) Speech and communication changes reported by people with Parkinson’s disease. Folia Phoniatica et Logopaedica, 131–141.
Semel, E., Wiig, E. & Wayne, S.A. (2003) Clinical Evaluation of language fundamentals—fourth edition (CELF-4), Swedish version. Bromma: Pearson Clinical & Talent Assessment.

Spreen, O. & Risser, A.H. (2003) Assessment of aphasia, New York: Oxford University Press.

Stroop, J.R. (1935) Studies of interference in serial verbal reactions. Journal of Experimental Psychology, 18(6), 643–642.

Tallberg, I.M., Ivachova, E., Jones Tinghag, K. & Östberg, P. (2008) Swedish norms for word fluency tests: FAS, animals and verbs. Scandinavian Journal of Psychology, 49, 479–485.

Tysnes, O.-B. & Storstein, A. (2017) Epidemiology of Parkinson’s disease. Journal of Neural Transmission, 124(8), 901–905.

Whiteside, D.M., Kealey, T., Semla, M., Luu, H., Rice, L., Basso, M.R., et al. (2016) Verbal fluency: language or executive function measure? Applied Neuropsychology: Adult, 23, 29–34.

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