Language and Health 1 (2023) 2–9

Contents lists available at ScienceDirect

Language and Health

journal homepage: www.sciencedirect.com/journal/language-and-health

Long COVID: The impact on language and cognition

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ARTICLE INFO

Keywords:
Brain fog
Cognitive-communication disorder
COVID-19
Language disorder
Long COVID
Speech-language pathology

ABSTRACT

COVID-19 continues to have profound health and economic consequences around the world. Aside from the large number of deaths from this viral infection, there is a growing population of individuals who have not made a good recovery from their COVID illnesses. These children and adults continue to experience COVID symptoms for months and even years after the onset of their illness. One group of symptoms that can be particularly troubling are language and cognitive difficulties. These difficulties can compromise learning and academic attainment and prevent a return to employment in adults. The author has examined the language skills of 110 adults who reported experiencing Long COVID. Among these individuals, 99 adults reported significant cognitive-linguistic difficulties as part of their ongoing COVID symptoms. This article examines these difficulties in detail. It proposes that these cognition-based language difficulties should be included in the class of cognitive-communication disorders. These disorders are typically assessed and treated by speech-language pathologists who manage communication difficulties in clients with traumatic brain injury, right-hemisphere damage, and neurodegeneration.

1. Introduction

The COVID-19 pandemic has left its mark on human health in ways that extend beyond a large and tragic number of global deaths. For many individuals who survived their COVID infections, and had mild to moderate illnesses initially, the virus has posed a serious and persistent threat to health in the form of Long COVID. It is not an exaggeration to say that this debilitating condition has destroyed the lives of those who have developed what the World Health Organization calls the "post COVID-19 condition". Apart from ongoing physical symptoms, it is now widely recognized that cognitive dysfunction is part of Long COVID. This manifests in all manner of problems with memory, planning, reasoning, and attention. Importantly, language is also compromised, leading to significant communication problems that impact on daily functioning in areas such as employment, social relationships, and family role. In previous work, the author has characterized these language difficulties and their impact on functioning in a study of 92 adults with Long COVID (Cummings, 2023a) and in an online survey of 973 adults with self-reported Long COVID and "brain fog" (Cummings, 2023b). In this article, the focus of discussion will be on specific linguistic impairments that these adults experience, with illustration provided through data recorded and analyzed by the author.

The article unfolds as follows. In Section 2, Long COVID is defined by examining the clinical case definition of the post COVID-19 condition that is adopted by the World Health Organization. The language difficulties that are the focus of this discussion are part of a wider group of cognitive-linguistic difficulties that have been labelled as "brain fog" by people with Long COVID. Section 2 also examines the types of difficulties that constitute "brain fog" as well as the prevalence of these difficulties. In Section 3, specific linguistic difficulties are examined and illustrated by using data from adults with Long COVID as they perform a range of language tasks. These tasks include activities like narrative production and confrontation naming. It will be argued that some apparently "normal" scores in these tasks mask considerable linguistic difficulties that might go unnoticed if performance is based solely on language test scores. The health professionals who assess and treat language difficulties are speech-language pathologists. How cognitive-linguistic difficulties in Long COVID may best be conceptualized within the type of diagnostic categories that are recognized by these health professionals is addressed in Section 4.

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https://doi.org/10.1016/j.laheal.2023.05.001
Received 10 March 2023; Received in revised form 3 May 2023; Accepted 16 May 2023
Available online 22 June 2023

2. What is Long COVID?

Terms such as Long COVID and COVID long haulers emerged early in the COVID-19 pandemic to describe people for whom the symptoms of COVID illness persisted well beyond the point at which viral illnesses normally resolve. Although these terms are widely used by patient groups and media outlets, in most scientific and medical contexts the terminology of the World Health Organization (2021) is adopted. WHO has developed the following clinical case definition of what it calls "post COVID-19 condition":

> *"Post COVID-19 condition occurs in individuals with a history of probable or confirmed SARS CoV-2 infection, usually 3 months from the onset of COVID-19 with symptoms and that last for at least 2 months and cannot be explained by an alternative diagnosis. Common symptoms include fatigue, shortness of breath,* ***cognitive dysfunction*** *but also others and generally have an impact on everyday functioning. Symptoms may be new onset following initial recovery from an acute COVID-19 episode or* ***persist from the initial illness****. Symptoms may also fluctuate or relapse over time."*

For present purposes, two features of this definition are noteworthy. The first is that cognitive dysfunction is now a widely recognized feature of the post COVID-19 condition alongside physical symptoms. This was not always the case. Many adults who presented to medical professionals with COVID-related cognitive issues in the early months of the COVID-19 pandemic had their symptoms dismissed as depression, anxiety, and even post-traumatic stress disorder (PTSD). The second noteworthy feature concerns the timing of cognitive symptoms. Although there is no empirical evidence to support this claim, it appears likely that cognitive issues in Long COVID persist from the initial illness. Many people who participated in the author's study withdrew from work and social activities during the acute stage of their infections. In the absence of the types of cognitive demands that these activities place on an individual, it may have appeared to many that their cognition was not affected by their illness. However, as physical symptoms lessened and people attempted to resume occupational and social activities, the extent of their cognitive difficulties became apparent for the first time.

Several studies have examined the prevalence of cognitive dysfunction, or "brain fog", in adults with Long COVID. In a meta-analysis of 19 studies involving 11,324 patients with post COVID-19 syndrome, Premraj et al. (2022) reported brain fog in 32% of patients. Additional cognitive symptoms in these patients included memory issues (27%) and attention disorder (22%). Davis et al. (2021) reported cognitive dysfunction in 88% of 3,762 participants with confirmed or suspected COVID-19 with illness lasting over 28 days. Cognitive dysfunction was one of three symptoms that were most commonly experienced after 6 months of illness (fatigue and post-exertional malaise were the other two symptoms). Children also develop Long COVID. Like adults, they can experience cognitive dysfunction. Lopez-Leon et al. (2022) conducted a systematic review and meta-analysis of 21 studies that examined 80,071 children and adolescents with COVID-19. The prevalence of Long COVID was 25.24%. Cognitive symptoms, which included reduced concentration, learning difficulties, confusion, and memory loss, had a prevalence of 6.27% in these children and adolescents.

Although the term "brain fog" has descriptive benefits for people with Long COVID, it has limited scientific value when discussing cognitive difficulties in the post COVID-19 condition. This is because the term captures a rather loose group of cognitive and language problems, ranging from word-finding difficulty and issues with reading and writing to memory loss and concentration problems. To gain some insight into the nature and prevalence of these difficulties, the author conducted an online survey of 973 adults with Long COVID (Cummings, 2023b). These adults were asked to indicate if they experienced a range of cognitive-linguistic difficulties (see Table 1). The most commonly reported symptom was word-finding difficulty (93.1%). Of 11 language difficulties examined, nine occurred in over 50% of survey respondents. Clearly, there is a considerable burden of language and communication problems in people with Long COVID. What this burden looks like in terms of the responses of individual participants to tasks in the COVID-19 language study reported in Cummings (2023a) is examined in Section 3.

Table 1
Language and communication problems in 973 adults with Long COVID.

Language problem	Frequency
I struggle to find words	93.1%
I forget what I wanted to say	90.9%
I lose concentration easily when talking to others	89.6%
I mix words up and produce incorrect words	72.4%
I cannot recall what has been said earlier in conversation	65.4%
I find reading difficult	61.7%
I cannot recall what has been said in conversation after it has taken place	60.6%
I find writing difficult	51.2%
I veer off topic in conversation and cannot get back	50.8%
I struggle to produce utterances and sentences	46.6%
I struggle to understand what people are saying	38.2%

3. Language in adults with Long COVID

The author's study of language in adults with Long COVID revealed several cognitive-linguistic difficulties. Participants with Long COVID had significantly poorer performance than healthy participants in the study in the following areas: delayed and immediate verbal recall; informativeness of spoken discourse; letter fluency; and category fluency for animals (Cummings, 2023a). This is not the place to rehearse the findings of this study in detail. Instead, the focus of this paper is on exploring some of the individual responses of participants to the tasks used in the study. This will allow readers to understand the extent to which language is disrupted in Long COVID, an issue that is not properly appreciated if only language test scores are considered. Also, it will help readers to understand the cognitive processing difficulties that give rise to language and communication problems in Long COVID. This will prepare the ground for the classification of language problems in Long COVID as a cognitive-communication disorder in Section 4.

3.1. Discourse informativeness

Adults with Long COVID in the study produced spoken discourse which was less informative than discourse produced by healthy participants in the study. This finding was consistent across all three discourse production tasks used in the study: the Cookie Theft picture description task from the Boston Diagnostic Aphasia Examination (Goodglass et al., 2001); Flowerpot Incident narration (storytelling based on a sequence of six, black-and-white line drawings); and Cinderella narration (telling the story of Cinderella after viewing pictures in a wordless picture book). This finding was not solely related to memory problems; reduced informativeness was also a feature of spoken discourse production in response to pictures that the speaker viewed throughout his or her performance of the task. It was argued in Cummings (2023a) that the reduced informativeness of adults with Long COVID on these tasks was related to higher-level discourse processes involved in the management of information. These processes make extensive use of cognitive skills, particularly executive functions such as planning and organization. Specifically, adults with Long COVID were able to produce grammatically well-formed, meaningful discourse which was nevertheless not particularly *informative*. Below, several ways in which adults with Long COVID produced spoken discourse with reduced informativeness are examined.

Memory problems in adults with Long COVID led to reduced informativeness of the stories that participants produced during

immediate and delayed verbal recall. Considerable information was omitted during these tasks, resulting in scores that fell well below the mean performance of healthy participants on the same tasks. Below, a 49-year-old woman called VT is recalling the 100-word Sam and Fred story that was used to examine immediate and delayed recall in the study. Prior to her COVID illness, VT worked part-time as a French teacher in a secondary school. She was tested at 211 days (7 months) after the onset of her COVID illness. At this stage, VT was still on sick leave from work; subsequently, she had to leave work on account of Long COVID. VT's scores on both immediate recall (5/14) and delayed recall (3.5/14) placed her between 2 and 3 standard deviations below the mean scores of healthy participants (9.73/14 and 9.38/14, respectively). Her use of "Tam" is a simple mishearing of the author's speech, possibly related to the author's accent and/or the administration of the task online:

Immediate recall

> "Tam and Fred are two farmers (2.86) they're working some fields (1.51) **something about the barn door** and um (.) there's a bad, bad weather storm coming and they're very distressed and maybe **somebody helps them**"

Delayed recall

> "two farmers I'm tempted to say Fred and Tam um (1.68) barn door open ah disastrous weather um can't recollect if **somebody helped them** or not um very atmospheric scene setting ah struggling with the sequence of events I'm retaining two farmers worked very hard um **some kind of** unmitigated disaster can't I think it was the weather-related um and that's it"

During immediate recall, VT omitted considerable information. She did not recall that crops were washed away, that sheep and cows escaped from the barn, and that the animals were returned to the barn by nightfall. There was also no mention of the fact that the farmers were brothers and that they had worked on the farm for thirty years. The same information is omitted on delayed recall. Additionally, VT is unsure on delayed recall if the farmers received assistance – she reported that they *did* receive help on immediate recall – and she omits a further point of information, namely, that the farmers were working the fields. There are also several remarks during delayed recall that allude to VT's cognitive difficulties (e.g., *can't recollect, struggling with*) as well as language that masks or conceals the omission of information during recall (viz., *very atmospheric scene setting*).

VT's lexical choices also contribute to the reduced informativeness of her responses on these recall tasks. The use of the indefinite pronouns *something* and *somebody* takes the place of more specific (and, hence, more informative) lexical forms such as *the barn door blew open* and *the villagers helped the farmers*. There is little information conveyed through the indefinite noun phrase *some kind of*. VT's lexical choices compound her omission of information and reduce yet further the informativeness of her responses to these recall tasks.

On these recall tasks at least, reduced informativeness seems to be a direct consequence of VT's post-COVID memory problems. But reduced discourse informativeness in adults with Long COVID cannot always be so easily explained in terms of memory difficulties. On occasions when memory was not taxed during discourse production, reduced informativeness was also a feature of the language used by adults with Long COVID in the study. Below, a 36-year-old man called DB is describing the Cookie Theft picture from the Boston Diagnostic Aphasia Examination (Goodglass et al., 2001). DB contracted SARS-CoV-2 through his work as a hospital physiotherapist. He developed acute COVID-19 in March 2020 and returned to work after 10 days. DB worked full-time for 6 months. However, in September 2020 his fatigue became so severe that he had to cease working. At the time of testing, DB had been on sick leave for 2 months. DB obtained a score of 4/12 on this picture description task. This score was between 2 and 3 standard deviations below the mean score of 7.79/12 for healthy participants in the study:

Cookie theft

> "I see (.) uh two (.) children that may look like a boy and a girl er (.) looking for cookies in a cookie jar in a top cupboard and a (.) woman who (.) may be their mother (.) erm washing dishes at the sink the sink is (.) overflowing uhm (.) and she's in front of a window with the curtains open"

DB's description omits considerable information. He does not describe how the boy is standing on a stool and that the stool is about to tip over. DB does mention the girl but fails to describe any actions that she undertakes. He does not state, for example, that the girl has her arm outstretched to receive cookies from the boy and that she is gesturing to the boy to be quiet so that their mother does not become aware that they are stealing cookies from the cupboard. The mother is standing in a puddle of water. But this, too, is omitted from DB's description.

The reduced informativeness of DB's description cannot be explained in terms of memory difficulties as the Cookie Theft picture is displayed throughout the task. A more plausible explanation is that DB failed to scan the scene adequately, reporting only the two most salient features of the picture – the boy is taking cookies and the woman is washing dishes. The cognitive processes that might explain DB's behaviour include a failure to *attend* to all events in the picture. Also, DB may not have been able to achieve sufficient suppression or *inhibition* of his response to the two most salient features of the scene, so much so that these features came to dominate his description of the picture to the exclusion of other details. Attention and inhibition belong to a group of cognitive skills called executive functions. There is evidence of executive function impairments in adults with Long COVID (Miskowiak et al., 2021; Krishnan et al., 2022). Also, DB's performance on letter fluency (a measure of executive function) was between 1 and 2 standard deviations below the mean score of healthy participants on this task in the study, suggesting that DB had some difficulties in the area of executive function. Although impaired executive function is a cognitively plausible explanation of DB's picture description problems, it is difficult to say with certainty if it was the cause of the reduced informativeness of his discourse.

The Flowerpot Incident narration created further challenges for adults with Long COVID. This task involves a sequence of six, black-and-white line drawings which the narrator must develop into a coherent story. Unlike the single scene in the Cookie Theft picture, this narrative task requires the speaker to integrate information by drawing inferences that connect events depicted in the individual pictures. This task was particularly challenging for a 49-year-old female participant ('ST') with Long COVID. Prior to her COVID illness, ST was a police inspector. She was tested at 519 days (17.3 months) after the onset of her COVID illness. ST obtained an informativeness score of 7/20 on this task. This score placed her between 2 and 3 standard deviations below the mean score of healthy participants (13.85/20) on the same task:

Flowerpot incident

> "a plant falls on a man's head he's angry (1.94) and then goes inside (1.31) the house (5.25) then he's knocking a door which I can't work out if he's in the house maybe a flat um (2.79) then the lady (.) or a lady ah gives his dog a bone and he kisses her hand (1.88) I think"

ST's omission of information was extensive. She omitted certain propositions in their entirety such as '*The man and his dog are walking along the street*' and '*A woman answered the door*'. There is also partial omission of propositions, e.g., that the plant falls from *a balcony*. But

most problematic of all – and the most significant cause of the reduced informativeness of ST's narrative – is ST's failure to embed the actions of the characters within a network of concepts that give coherence to the events in the story. We are not told the man's *purpose* in going inside the building, viz., to remonstrate with the owner of the apartment from which the plant fell. We are also not told the *consequence* of the plant striking the man on the head (he developed a painful lump) or the *reason* why the woman gave the man's dog a bone (to make amends for the injury he sustained). Concepts such as purpose, consequence, and reason create coherence between events in the story; their omission makes the characters' actions appear disconnected and unmotivated.

There is also some confusion on ST's part about *where* the man is. This suggests that ST is unable to draw an inference to the effect that the door the man is knocking on is the door to the apartment from which the plant fell. Finally, ST uses a definite noun phrase to introduce the house into the story. This assumes that there has been some prior mention of the house when this is not the case (a listener may reasonably ask *what house?*). In this instance, it is the combination of omitted information, a lack of unifying concepts and inferences, and difficulty introducing new information that leads to the reduced informativeness of ST's narrative.

The most challenging discourse production task in the study was Cinderella narration. The cognitive demands of this task include the retention of a large amount of information in memory alongside the need to plan and organize many different events and characters across several episodes in the story. Given this level of cognitive complexity, it is not surprising that some of the most marked reductions in informativeness for the adults with Long COVID in the study occurred in this task. The narrative below was produced by a 42-year-old female participant ('PB') with Long COVID. PB also worked as a police officer prior to contracting SARS-CoV-2. She was tested at 456 days (15.2 months) after the onset of her COVID illness. PB achieved an informativeness score of 19.5/50 on this task. This score was between 2 and 3 standard deviations below the mean score (32.1/50) of healthy participants on the same task:

Cinderella

> "Cinderella's (1.77) mother dies and her father (1.74) marries (2.22) a lady with two (.) step dau [daughters] so two daughters (1.14) and (16.49) and (1.62) **her father I think is the king** (1.71) and his son is looking for a prince (2.00) princess sorry, sorry princess and she so they have (1.77) a (.) **ball arranged** and (4.04) Cinderella wants to go but thee stepsisters won't let her go and she has to stay behind so thee fairy godmother (1.35) cast a spell and **she** had a **beautiful dress and carriage** (1.88) and went to the ball where she (4.09) danced with a prince and (1.15) **at midnight she had to be home** so **she ran** and to left one of her glass slippers behind and he found the slipper and wanted to find (2.30) who is the woman was that owned the slipper and (1.56) thee stepmother had a locked (.) her in her room but **they** managed to get her out and the prince (1.59) she tried the shoe on and it fit and **a prince** married her"

Like other adults with Long COVID, PB omitted considerable information from her narrative (e.g., Cinderella was made to do all the household chores). Additionally, she produced some incorrect information such as when she stated that Cinderella's father was the king. PB's informativeness was further reduced by the omission of parts of propositions. We are not told that the ball was arranged to take place *at the palace*, that Cinderella's dress and carriage came from *her rags and a pumpkin*, and that she ran away *from the palace and towards her waiting carriage*. PB also does not state *why* Cinderella had to be home at midnight (the spell would be broken at midnight).

As well as these informational difficulties, PB did not use pronominal reference effectively. She occasionally used pronouns in the absence of a prior referent. This occurs towards the end of her narrative when she stated *they managed to get her out*; there is no clear referent of the pronoun *they* in the preceding discourse context (the referent in this case is the mice). On a further occasion, PB used the pronoun *she* to refer to Cinderella when the proximal referent is actually the fairy godmother; although on this occasion at least, the hearer's prior knowledge of the story would have guided the correct assignment of a referent. PB also used the indefinite noun phrase *a prince* at the very end of her narrative. This form is more appropriate for the first mention of a character when the prince had in fact already been mentioned earlier in the story. This is further evidence of PB's difficulties in managing information in discourse.

In this section, we have examined the language of adults with Long COVID in a range of discourse contexts. For the most part, this language has been grammatically well-formed and meaningful. However, it has not been as *informative* as the language that is used by healthy participants on the same tasks. In trying to establish why this is the case, we have looked to cognitive processes such as executive functions to understand the informational difficulties of adults with Long COVID. In short, these adults retain knowledge of language form and meaning, but they are unable to leverage this knowledge to produce *informative* discourse on account of post-COVID cognitive difficulties. This results in well-formed and meaningful discourse that is nonetheless markedly under-informative. In the next section, we examine how COVID-related cognitive difficulties compromise language in a different context, namely, the access and retrieval of words from the mental lexicon during confrontation naming.

3.2. Word-finding difficulty

The confrontation naming performance of adults with Long COVID studied by Cummings (2023a) did not differ from the naming performance of healthy participants in the study. However, this normal test performance belies considerable word-finding difficulty in these adults. Among the 973 adults who completed the online Long COVID survey, word-finding difficulty was the most commonly reported language symptom, with some 93% of respondents stating that they experienced this problem (Cummings, 2023b). The extent of these difficulties becomes apparent when the naming performance of individual participants in the study is examined. This reveals considerable cognitive inefficiency during naming. The following data is from a 49-year-old woman called TC. Before her COVID infection, TC was healthy and worked as a university lecturer. She was recorded at 337 days (11.2 months) after the onset of her infection. TC obtained a score of 18/20 on confrontation naming. This score was comparable to the mean performance of healthy participants on the same task (mean = 17.62; standard deviation = 2.08). TC's responses to five pictures are shown in Table 2:

Table 2
TC's responses during confrontation naming.

Target word	TC's response
seahorse	"it's a one of those sea things urm urm urm urm they're very small erm seahorse"
doorknob	"you open the door with it erm it's uhm uhm eer I wanna say door handle but there's a better word than that erm erm because you'd find it in a kitchen on a on a on a press erm er I know what it is it's a doorknob"
windmill	"it's a erm er (.) things go around with the wind it's a windmill"
thimble	"you sew with it and you put it on your (.) finger no you don't you put it on your thumb it is a thimble"
lobster	"the pinchy guys it's a er it's a lobster"

Table 3
NV's responses during confrontation naming.

Target word	NV's response
chisel	"siss, siss, screw not a screwdriver it's um (1.39) a thing you use te, te, do wood um (5.97) ah, juh, juh, te is it tu, tu (1.08) chuh (1.47) chisel"
artichoke	"it's a vegetable um (2.32) hum (4.71) it's a lot of effort to eat it you have it with butter (1.21) ah (3.87) ah (3.34) ah, ah (.) ar, artichoke"
cannon	"ah (3.87) it's a um (2.53) big gun um (5.87) xxx (*unintelligible*) cannon"

To achieve naming of each of these pictures, TC undertook extensive circumlocution. She effectively talked around each target word as a means of eliciting its production. TC used circumlocution to name all 20 target words in the confrontation naming task. It was clear that post-COVID, TC's lexical access and retrieval displayed cognitive inefficiencies, and that circumlocution was a compensatory strategy that she had adopted to facilitate her naming of pictures.

NV is a 53-year-old woman. Prior to her COVID infection, NV was a healthy secondary school teacher. She was studied at 795 days (26.5 months) after the onset of her COVID illness. Although NV achieved a maximum score of 20/20 on confrontation naming, her naming performance exhibited considerable struggle. Pauses, dysfluency, and circumlocutions (e.g., *a thing you use to do wood*) were used extensively before the target word was produced. Table 3 shows how NV proceeded to name three items during the confrontation naming task:

These cases demonstrate how test scores alone are not always a reliable indicator of an individual's linguistic performance. Like other participants with Long COVID in the study, TC and NV had essentially normal naming based on the scores that they obtained. However, as the above data demonstrates, naming was a cognitively inefficient process for both participants, a finding that is consistent with self-reported word-finding difficulties in speakers with Long COVID.

3.3. Verbal fluency

In the study, verbal fluency was examined in adults with Long COVID through the use of letter fluency and category fluency tasks. During letter fluency, participants were asked to produce as many words as possible beginning with the letters F-A-S in 60 s. They were instructed to avoid proper names like *Francis* and *Sally* and morphological variants of the same word (e.g., *fishes, fished, fishing*). Letter fluency is viewed as a measure of executive function, although this has been challenged in some studies (e.g., Whiteside et al. (2016) reported that in their study letter fluency loaded exclusively onto a language factor and not executive function). Participants undertook two category fluency tasks in the study. They were asked to produce the names of as many animals and vegetables as possible in 60 s. Category fluency examines lexical generation; participants must access a specific semantic field in their mental lexicon and produce as many exemplars of the field as possible. On all these verbal fluency tasks with the exception of category fluency for vegetables, adults with Long COVID had significantly poorer performance than healthy adults in the study. Below, some of the difficulties that adults with Long COVID had on these tasks are examined. Explanations of these difficulties in terms of cognitive processing problems are considered.

For many adults with Long COVID and poor letter fluency, reduced *speed of processing* appeared to compromise the production of words beginning with F-A-S. This was evident both in the production of a small number of words in 60 s, and in the presence of lengthy timed pauses between each word that was produced. Below are the 'A' words that were produced by a 49-year-old woman ('KS') with Long COVID. KS worked as a doctor in general practice before contracting SARS-CoV-2. She was tested 449 days (15 months) post COVID onset and had been on sick leave for some time at this point. KS's combined letter fluency score was 29 words. This score placed her between 1 and 2 standard deviations below the mean score (48 words) of healthy participants on the same task.

> "aim (1.38) able (3.11) ambivalent (2.40) and (7.32) ask (1.81) answer (5.61) aunty (14.75) artichoke"

KS produced only 8 words beginning with 'A' in 60 s (one word every 7.5 s on average). This compares to a mean score of 11.9 words beginning with 'A' in a study of verbal fluency in 1,300 healthy participants (Tombaugh et al., 1999). Even more noteworthy, however, are the lengthy timed pauses throughout KS's response. It took over 7 s for KS to produce *ask* and over 14 s to produce *artichoke*. KS was able to produce words according to the search criteria of the task (i.e., words beginning with 'A' that are not proper names, etc.). She was also able to avoid repetition of words. However, her speed of processing was reduced, with each word taking longer to access and produce than is typically the case in healthy participants.

A quite different difficulty is on display in the following 'S' words produced by a 58-year-old woman ('OL') with Long COVID. OL was tested at 533 days (17.7 months) post COVID onset. She was not working on account of her COVID illness. After excluding the proper name *Skype* and derivational forms of the same word (e.g., *sink-sinkhole*) – these words do not satisfy the criteria of the task – OL produced a total of 16 words beginning with 'S':

> "sugar, spice, saturated, smelly, socks, um sink, sinkhole, um southern, south (.) ah sausages (.) ah sensations (1.30) ah silly um (1.79) saucer (.) ah socks (2.78) stilts, stiletto heels my favourite um (1.33) sugar (3.21) spice (4.38) Skype (1.29) um screwdriver ah (2.51) secateurs, scribe (.) ah um (2.11) saus [sausage] no I said that one"

The number of 'S' words produced by OL is similar to the mean score of healthy participants on the same letter fluency task (Tombaugh et al., 1999). What is noteworthy about OL's response is not the overall number of words she produces but the number of times she repeats words. This occurs on four occasions: *socks-sugar-spice-sausage*. Only on the last of these words does OL realize that she has already produced the word *sausage* and she initiates a correction. OL's repetition of words suggests some difficulty with the monitoring of her verbal output. As well as reduced self-monitoring, OL also has difficulty inhibiting words (e.g., *Skype*) that do not satisfy the criteria for the task. On this occasion, OL has normal speed of processing; her difficulties lie in the *monitoring* of her verbal output and the suppression or *inhibition* of words that do not satisfy the task criteria.

Category fluency for animals was another area of relatively poor verbal fluency performance for adults with Long COVID in the study. This task assesses an individual's ability to access the mental lexicon, locate the target category of animals, and produce as many instances of the category as possible in 60 s. Animals of all types (mammals, reptiles, birds, etc.) can be included. Examinees can produce general words (e.g., *dog*) and specific words (e.g., *spaniel*). However, in terms of scoring, one mark is awarded when these terms are produced consecutively (e.g., *dog-spaniel*) and when animal names represent different developmental stages (e.g., *lamb-sheep*). Like letter fluency, the respondent must avoid repetition of words.

When healthy individuals undertake category fluency tasks, they typically employ two strategies called *clustering* and *switching*. Clustering involves the generation of consecutive words belonging to the same subcategory; in switching, respondents generate words consecutively that belong to different subcategories. Clustering facilitates

the generation of words by allowing respondents to undertake a search of a single subcategory and, hence, a relatively small lexical space. Because switching involves conducting a search across different subcategories, it can be a less efficient strategy for word generation.

Some adults with Long COVID made effective use of clustering during the category fluency tasks in the study. Unsurprisingly, these adults obtained scores for animal naming that are consistent with the performance of healthy participants on the same task. A 56-year-old woman ('LL') with Long COVID produced the following words during animal naming. LL was tested 250 days (8.3 months) after the onset of her COVID illness. At the time of testing, LL had not returned to her pre-COVID employment as a primary school teacher on account of her COVID illness:

> "donkey, cow, sheep (1.21) chicken, hen (1.29) um horse (1.21) um fly (1.37) a dog, cat (1.14) ah mouse, rat (1.93) ah um (1.62) what other animals are there (1.96) hens think I've already said hens (3.95) ah giraffe (1.10) lions, tiger um rhino, orangutan, monkey (1.51) um parrots (5.25) penguin, whale, fish"

LL produced a total of 20 animal names (a *hen* is a female chicken and so *chicken* and *hen* was given one score). This score is similar to mean scores of 20.1 words (Tombaugh et al., 1999) and 18.4 words (Acevedo et al., 2000) obtained by healthy participants the same age as LL in large normative studies. Clustering was used to good effect by LL and facilitated her generation of animal names. There are two large clusters in LL's response. The first cluster can be broadly categorized as *farm animals*, at least in a UK context: *donkey-cow-sheep-chicken-hen-horse*. The second cluster is *native African animals* and contains the instances *giraffe-lions-tiger-rhino-orangutan-monkey*. There are also two smaller clusters, one inside and one outside a larger cluster. The cluster *primates* occurs inside the *native African animals* cluster and contains the two instances *orangutan* and *monkey*. The other cluster is *rodents* and contains the instances *mouse* and *rat*.

LL used clustering effectively to generate as many animal names as possible in 60 s. However, many other adults with Long COVID in the study appeared unable to use a clustering strategy to any significant extent during animal naming. This resulted in category fluency scores that were well below the mean scores of healthy participants in large normative studies. A 58-year-old woman ('OL') with Long COVID produced the following words during the animal category fluency test in the study. OL was tested at 533 days (17.7 months) following the onset of her COVID illness. OL worked as a project manager, and she owned her own jewelry business before contracting SARS-CoV-2. However, she had not been able to resume work on account of her ongoing COVID illness:

> "elephant, ape, ostrich um (1.01) dog, cat, mouse um (2.05) penguin um (1.13) tiger (1.28) ah (5.14) monkey um (3.92) xxx (*unintelligible*) dolphin um (3.04) sparrow (8.70) I can't really think (1.82) this is not good um (2.22) rat (8.83) uh bad"

OL produced a total of 12 animal names. This score placed her between 1 and 2 standard deviations below the mean score of healthy participants in studies by Tombaugh et al. (1999) and Acevedo et al. (2000). There is little clustering on display. OL produces three bird names – *ostrich, penguin,* and *sparrow* – but they are interspersed by other words. The two rodent names *mouse* and *rat*, which were produced consecutively by LL, are separated by five other animal names in OL's response. Words in the *native African animals* category – *elephant, ape, tiger,* and *monkey* – are also produced in two groups of two words. OL makes extensive use of switching. In the sequence *monkey-dolphin-sparrow-rat*, OL switches between the subcategories of primate, marine animal, bird, and rodent.

That OL's lack of clustering and use of switching was a less cognitively efficient lexical generation strategy is not only evident in the total number of words that OL produced, but also in the duration of pauses between words. LL and OL produced a similar number of pauses during their naming (12 and 10 pauses, respectively). But whereas these pauses had an average duration of 1.96 s during LL's animal naming, they had an average duration of 3.03 s during OL's generation of animal names. OL's use of switching as her dominant lexical generation strategy was cognitively less efficient than LL's use of clustering. The additional cognitive processing required to switch between lexical subcategories during OL's generation of animal names resulted in a lower number of words with more time required to produce each word.

4. Management of cognitive-linguistic difficulties in Long COVID

The cognitive-linguistic difficulties examined in Section 3 raise a number of important questions. The first question concerns how these difficulties should be assessed and diagnosed by health professionals. These professionals include speech-language pathologists and neuropsychologists, although this section will focus on the former group of clinicians. The part of this question that relates to diagnosis depends on how we conceive of cognitive-linguistic difficulties in Long COVID. Should these difficulties sit among aphasias or are they cognitive-communication disorders? Or do these difficulties form a novel category of communication disorder that has the potential to expand the current nosology of language disorder?

The second question concerns the impact of cognitive-linguistic difficulties on the daily functioning of adults with Long COVID. We will see below that the impact is significant, with COVID-related language difficulties compromising employment, social relationships, and family roles, among other domains. The third question is related to the second question in that it addresses how the impact of COVID-related language difficulties on employment may be best addressed by occupational health teams. Speech-language pathologists are ideally positioned to make employers and occupational health professionals aware of how cognitive-linguistic difficulties in Long COVID can serve as a barrier to work reintegration in much the same way that physical symptoms of COVID-19 (e.g., respiratory difficulties) can compromise a return to work. This takes the professional role of speech-language pathologists beyond the assessment and diagnosis of cognitive-linguistic difficulties in adults with Long COVID to include important education and advocacy work on behalf of these clients.

When the cognitive-linguistic difficulties of adults with Long COVID were examined in Section 3, a point that was only briefly addressed but which is particularly relevant to the diagnosis of these difficulties is that the structural language skills of these adults are in relatively good condition. For the most part, adults with Long COVID use well-formed, meaningful language that contains an appropriate range of vocabulary. The language of these adults displays few of the grammatical, lexical, and semantic difficulties of adults with aphasia, even as it is produced with considerable hesitancy and non-fluency related to problems with memory and planning. These adults also have relatively good auditory verbal comprehension. They are able to follow complex language that is used to convey task instructions, although in many cases these instructions have to be repeated to facilitate language comprehension. In short, the linguistic knowledge of adults with Long COVID remains intact, even as they find it difficult on account of cognitive processing problems to leverage this knowledge to produce discourse and perform other language tasks. The language problems of these adults are cognitive in nature, with knowledge of linguistic rules (if that is how we want to conceive of linguistic knowledge) still largely intact.

Given the cognitive origin of language difficulties in adults with Long COVID, we need to conceive of these difficulties, less in terms of a primary language impairment like aphasia and more in terms of a cognitive-communication disorder. (It should be noted that aphasia *can* occur in COVID-19, particularly in severe disease; see Priftis (2023) for a review.) Cognitive-communication disorders are familiar to speech-language pathologists, particularly those clinicians who assess and treat adults with conditions like traumatic brain injury (TBI), right-hemisphere damage (RHD), and neurodegenerative disease (e.g., Alzheimer's

disease). Adults with these conditions have been noted to communicate less adequately than their structural language skills in phonology, syntax and semantics would predict. Sentence-level syntax is relatively intact in these adults even as they struggle to tell a story or give an informative description of a scene. These discourse-level difficulties arise from cognitive deficits in areas such as executive function (see Cummings (2017) for further discussion). Within a nosology of language disorder, there are grounds for including the communication difficulties of adults with Long COVID in the class of cognitive-communication disorders, albeit the physiological basis of these difficulties is less well understood than in other cognitive-communication disorders.

In order to diagnose cognitive-communication difficulties in Long COVID, speech-language pathologists must know how best to assess these difficulties. One of the most important lessons to emerge from clients with TBI and RHD who have cognitive-communication disorders is that these disorders are not revealed on standardized language assessments of the type used to assess adults with aphasia. The predominantly word- and sentence-level formats of these assessments are not sensitive to the effects of cognitive dysfunction on language. This was confirmed in Cummings (2023a); there was no significant difference in test scores between adults with Long COVID and healthy participants on a sentence generation task and a confrontation naming task used in the study. This was despite the fact that the picture naming of these adults displayed considerable cognitive inefficiencies (see Section 3.2).

The tasks that were most sensitive to the cognitive-linguistic difficulties of adults with Long COVID in Cummings (2023a) were discourse production tasks. As the cognitive demand of these tasks increased, from picture description (Cookie Theft) at the simplest to production of a fictional narrative (Cinderella) at the most complex, the performance of adults with Long COVID showed a stepwise decrease. Inefficiencies in cognitive skills (e.g., executive function) that are used to plan a complex narrative like the Cinderella story are exposed by discourse production tasks but remain hidden from view in test formats that are based on individual words and sentences. Speech-language pathologists are encouraged to view discourse production tasks as an indispensable tool in the assessment of Long COVID adults with cognitive-communication difficulties in much the same way that they recognize the benefits of these assessments for clients with TBI and RHD.

It is not an exaggeration to say that Long COVID has a devastating impact on the lives of those who are affected by the condition. The impact of this debilitating illness and its accompanying cognitive-communication difficulties is felt across all life domains, but particularly on employment, social relationships, and family role. In Cummings (2023b), the extent of that impact was quantified in an online survey of 973 adults with Long COVID and self-reported "brain fog". In terms of employment, the impact was most significant. Some 67.9% of respondents were in full-time employment prior to developing COVID-19. This dropped to only 24.6% after the onset of their COVID illness. There was an equally significant increase in the number of people who were not working due to disability; this rose from just 2.4% before developing COVID-19 to 32.5% after the onset of COVID illness. Most remarkable of all is that only 22.8% of respondents agreed with the statement 'I meet the communication needs of my job or college'.

The impact on employment is even more keenly felt given that the average age of respondents to the survey was just 47.4 years (Cummings, 2023b). This is a much younger population of adults than those typically assessed and treated by speech-language pathologists (e.g., adults with strokes and neurodegenerative diseases). Long COVID had brought the careers of many of these middle-aged adults to an abrupt end. Many others had substantially reduced the number of hours that they worked or had changed the types of roles that they could perform.

With communication skills significantly compromised by Long COVID, many respondents to the survey reported a loss of friendships and other social relationships as a consequence (Cummings, 2023b). Respondents often avoided social interactions because they felt embarrassed (54.9%) or frustrated (83.2%) by their poor communication skills post COVID-19. Some 65.8% of respondents reported that they had less desire to communicate with others. Many social relationships that had been forged with work colleagues deteriorated when respondents were on long periods of sick leave. Adults with Long COVID were often either too tired to engage in the communication that was required to maintain these relationships or felt that their health and communication problems were dismissed by work colleagues. Statements such as "*You look so well*" and "*I often struggle to find words also*" were a source of considerable frustration for adults with Long COVID. There was a feeling among these adults that they had been abandoned by friends and family members because they could no longer serve their needs. One 44-year-old woman with Long COVID remarked: "People do not have the same contact with me. I rarely hear from many of my friends or certain members of the family. Maybe it's because with my communication problems I no longer fulfil their needs."

COVID-related cognitive-communication difficulties also had the effect of altering the roles of many individuals within the family. Most respondents to the online survey and participants in the study were women in their forties who had school-age children (Cummings, 2023a, 2023b). Prior to Long COVID, they had assisted their children with homework and regularly attended parent-teacher evenings. The pandemic placed additional educational burdens on parents who became responsible for their children's home schooling. The cognitive-communication difficulties of adults with Long COVID left them struggling to help their children with homework, perform home schooling, and discuss their children's academic progress with teachers. The daily conversations that parents have with their children about events at school were also compromised. One 45-year-old woman with Long COVID reported: "[I] find I have 'tuned out' of conversations, e.g., in the car when [my] child [is] telling me about the day at school." Once a context for conversation about events that had taken place during the day, family meals were a struggle for parents with Long COVID. The digestion of food prompted such a marked deterioration in the communication abilities of one woman with Long COVID that she was unable to talk to her family after an evening meal:

> "Of all the things Long COVID has taken away from me, it's the ability to speak properly after an evening meal. An evening meal has always been a family time for us to share what's happened in the day. The energy involved in digestion affects my cognitive ability and language. Therefore, I am unable to speak after we've eaten food."

While speech-language pathologists await the research that is needed to devise effective interventions for adults with Long COVID, they can undertake a vital education and advocacy role in relation to these clients. Many adults with Long COVID and cognitive-communication difficulties try unsuccessfully to receive ill health retirement from work. Others undertake phased returns to work that are unrealistic given the type of difficulties they are experiencing. More often than not, such phased returns end in failure.

Many adults with Long COVID could resume some form of economic productivity if employers undertook appropriate adjustments to address their difficulties. However, for this occur, employers and occupational health teams must have a proper understanding of cognitive-communication difficulties in Long COVID. Also, they must be aware that Long COVID does not only involve physical symptoms such as respiratory difficulties and post-exertional malaise but also difficulties with language and communication that may outlive physical problems and prevent a return to work. Speech-language pathologists have the knowledge and skills that are needed to articulate the communication needs of adults with Long COVID to employers and occupational health teams. They also have a professional duty to advocate for these clients who, on account of their communication challenges, cannot present their individual circumstances clearly and fully in speech and writing to employers.

Although it is now three years since the start of the COVID-19 pandemic, it is still the case that many adults with Long COVID are trying to manage debilitating physical and cognitive symptoms with little in the way of effective healthcare to support them. Long COVID clinics are struggling to keep pace with demand, at least in the UK. Many adults with Long COVID have had no access to these clinics or have received an initial assessment with little or no follow-up. Adults with Long COVID frequently report feeling abandoned and dismissed by health providers. They have been forced to manage their own recovery and navigate their way through complex care pathways that are not always responsive to their needs. As one participant in the study by Cummings (2023a) remarked, "it really feels like it's down to me to make a diagnosis and request treatment".

Notwithstanding these various challenges, there are also some positive developments in this Long COVID journey. At a time when health services were under considerable strain because of the pandemic, patients with Long COVID began organizing themselves into online groups. These groups are now well established and developed and are providing essential support and information for people with Long COVID. The Long Covid Nurses & Midwives UK group is a case in point (https://teamlcnmuk.wixsite.com/lcnmuk). The bodies that represent health professionals in the UK are assessing the type of clinical services that might best address the needs of people with Long COVID. At the time of writing, the author is contributing to the development of clinical guidelines for Long COVID by the Royal College of Speech and Language Therapists (RCSLT) in the UK.

There is still much work to be done. The Royal College of Speech and Language Therapists (2022) reported that only 13.8% of therapists who provide speech and language therapy to people with Long COVID work within a specially commissioned/funded or dedicated Long COVID service (note: this is 13.8% of 111 responses within a wider group of 676 respondents to an online survey). While professional bodies continue to advocate for better clinical services for people with Long COVID, they are also providing patients and clinicians with vital resources on Long COVID (e.g., RCSLT (2023) Long COVID podcast). These efforts must continue apace if we are to assist those who already have Long COVID, and if we are to have services in place for those who will develop this condition following future waves of SARS-CoV-2 infection.

5. Summary

This article has examined cognitive-linguistic difficulties in adults who do not make a full recovery from SARS-CoV-2 infection. So-called Long COVID or post COVID-19 condition affects a significant number of adults and children who contract SARS-CoV-2, with many continuing to experience debilitating physical and cognitive symptoms several months and even years after the onset of infection. The cognitive-linguistic difficulties of adults with Long COVID in three areas were examined: discourse informativeness; confrontation naming; and verbal fluency. Language difficulties in each of these domains were related to cognitive inefficiencies following COVID-19 illness. To reflect the cognitive basis of these difficulties, they were categorised as a cognitive-communication disorder, a diagnostic label that is already familiar to speech-language pathologists. These difficulties have a profound impact on daily functioning, compromising employment, social relationships, and family role, among other domains. The article examined the role of speech-language pathology within the management of adults with Long COVID and cognitive-communication difficulties. It also emphasized the need for specialist clinical communication services for this new and growing population of clients.

Data Availability

The authors do not have permission to share data.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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