

COVID-19 AND SPEECH-LANGUAGE PATHOLOGY

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Louise Cummings

Against the backdrop of large infection rates and deaths during the COVID-19 pandemic, it is easy to lose sight of the fact that it is individuals who have been most impacted by the SARS-CoV-2 virus. This chapter focuses on four such individuals. They are all women who developed COVID-19 during the first wave of the pandemic in the UK. Each has gone on to develop Long COVID. However, this is where the similarity between them ends. Three speak English as a first language. The fourth woman is a native speaker of Romanian and has a good level of English proficiency. All but one woman enjoyed good health prior to her COVID illness. Although all four women have Long COVID, only three of them report cognitive-linguistic difficulties as part of their illness. The variation between these cases is a salient reminder that COVID-19 affects people from all linguistic, social, and health backgrounds. The language profiles of these women are examined alongside the onset and development of their COVID illnesses.

Case Study 1 48-year-old voice artist

Background

Amy (not her real name) is 48;5 years old. She is married and has two children, a son aged 15 years and a daughter aged 17 years. Amy is university educated. In 1995, she obtained a BA degree in journalism and media communications. Amy has had a portfolio career in media, wellness, and business since 2013. She is currently a professional voice artist and a skincare and beauty trainer for a company in the UK and

Ireland. She is also a part-time business coordinator for a structural engineering company. Amy has previously worked as a commercial model, a stage and TV presenter, and an actor. Prior to 2013, she worked as a radio news announcer (1993–1995) and a PR communications coordinator (1996–1999). Between 1999 and 2013, Amy volunteered as a women’s pastor and provided resources to women working in prostitution. She was also a case worker with the Snowdrop Project, which helps women rescued from human trafficking. In terms of interests and hobbies, Amy describes herself as an artist and painter and a writer and blogger (e.g., she has written audio plays). She also voices fan fiction audio drama characters.

Prior to contracting COVID-19, Amy describes her overall state of health as “okay,” although she has struggled with histamine intolerance and imbalanced hormones. In 1977, she had foot surgery to remove extra cartilage. In 2012, Amy had LASIK eye surgery. She had breast implants in 2014. In October 2019, Amy had a thyroid function test and was found to have subclinical (borderline) hypothyroidism. She started to take an iodine supplement. By the end of 2019, her thyroid function was back to normal and has remained normal in several subsequent tests. Amy had an abnormal smear test followed by several biopsies 18 months prior to her participation in the author’s COVID language study. She recently underwent a loop procedure to treat abnormal cervical cells. Amy has had imbalanced hormones since 2012 and is working with a specialist GP on bioidentical hormones.

Amy has a well-balanced diet despite having numerous food sensitivities. Her sensitivities to certain foods have heightened significantly since becoming infected with COVID-19 in March 2020. She is sensitive to wheat (and gluten), eggs, soy, nuts, and dairy. Amy is on a strict low-histamine and low-inflammatory diet and is working with a health coach in a trial programme through Mount Sinai Hospital in New York. She avoids caffeine. Amy takes vitamin and mineral supplements including methyl B complex, vitamin C, zinc, and multi-minerals. She also takes low-histamine probiotics and 1,500 mg of cannabidiol (CBD) oil twice a day. She does not smoke or vape. Amy stopped drinking alcohol three years ago because of alcohol intolerance related to the perimenopause. Even when she did consume alcohol, she had less than one drink a fortnight. Amy is 5 feet and 7 inches in height and weighs 58 kg, giving her a BMI of 19.9 (normal weight). Since her eye surgery in 2012, she has had 20/20 vision for distance but uses reading glasses. Her hearing is normal.

Amy first developed symptoms of COVID-19 on 13 March 2020. She had a low-grade fever. Her 15-year-old son developed aches, fatigue, and slight chest pain three days earlier. Amy's husband and daughter also became unwell. Amy thinks her son contracted the virus at the orthodontist's office a week before he developed symptoms. She made nine attempts to get her family tested for the virus but was unsuccessful as there was no access to these tests at the start of the pandemic in the UK. Amy remained at home during her illness. She had one visit from paramedics and made telephone calls to the non-emergency 111 service and her GP. Amy had one medical examination during her first eight weeks of illness. She took several medications to treat the symptoms of COVID-19 (see *Medication*).

Amy describes her recovery from COVID-19 as "slow and non-linear." She had a productive cough for 8–10 weeks. She reports that her lungs have continued to feel as if she is breathing through a straw. Amy has had several medical investigations following her illness. In July 2020, she had a chest X-ray, but nothing abnormal was detected. Amy was examined by an ENT specialist on 13 July 2020. Fibreoptic laryngoscopy revealed some evidence of mild reflux. Vocal cord movements were symmetrical and there was no evidence of malignancy. Amy was referred to Speech and Language Therapy. On 22 September 2020, she had CT pulmonary angiography. On 24 September, Amy had a pulmonary function test. She had an abnormal ECG at the end of September. These pulmonary and cardiac investigations revealed some heart inflammation but no lung damage due to COVID-19. However, a 24-hour ECG conducted on 14 October and an ECG conducted on 25 November were both normal. Amy had a range of blood tests (e.g., thyroid function, inflammation markers) in July, September, and October 2020, all of which produced normal results.

Clinical symptoms

Amy experienced a wide range of symptoms during acute COVID illness. Several symptoms have persisted to the present day. She had moderate to severe breathing difficulties. They started on day 9 of her illness and caused asthma-like issues even though she has never had asthma. Amy is still having breathing difficulties. Her mild to moderate symptoms included fever, coughing, fatigue, aches and pains, headache, chest pain, and laryngitis. Amy had a low-grade fever on days 9 to 14 of her illness. On day 21, she developed a chest infection

for which she took antibiotics. Her fever increased at this stage and remained high between days 21 to 25. Amy developed mild to moderate coughing in the second week of her illness. She experienced aches for the first two weeks of her illness. Some 12 weeks later, she then had aches in her muscles, hands, and feet. She took electrolytes for several weeks which helped her. Amy has had headaches, sometimes migraines, on an almost daily basis. She has experienced fluctuating mild to moderate chest pain. Recent investigations are linking this to heart inflammation rather than to lung damage. Amy had mild to moderate laryngitis for 11 weeks. She has a “raspy” voice, especially with exertion.

Amy has also had several mild symptoms during her COVID-19 illness. At around 12 weeks, she developed a rash on one of her feet after using hair dye. She had never had a reaction like this in the past. She had a sore throat which she attributes to coughing. She also had a 2-week period of cramps and diarrhea. Amy reports mostly mild fatigue that has extended beyond the acute phase of her illness. She needs to take naps every afternoon to function and must go to bed by 9:30 p.m.

Amy believes that COVID-19 has had an impact on her mental health. She reports that this “chronic, mystery illness has been a challenge for me and my family.” Amy’s son has had four relapses in his recovery, all seemingly triggered by strenuous physical education or athletics, and missed 16 days of school. This has been a source of stress to her. She has had to give up most of her voice over work and describes this as a huge loss to her. In July 2020, Amy started to receive counselling twice a month. This has been “incredibly helpful” to her as she comes to terms with the impact of COVID-19 on her and her family’s health and livelihood.

Daily activities

Amy’s daily activities have been affected by COVID-19. Prior to her illness, she worked 35–40 hours a week. She was also a speaker at wellness conferences which required her to travel about once a month. For the first three months of her illness, Amy could not work at all as she was experiencing coughing, fatigue, and problems with breathing. Until the fifth month of her illness, she was only able to work about 10 hours a week. She can now work for about 15 hours a week but

must take a nap every afternoon. Amy is spending a lot more time at home with her husband and two teenage children since contracting COVID-19. Before March 2020, she engaged in regular exercise. Amy did kickboxing once a week for fitness and high-intensity interval training once or twice a week. She also did some yoga. Currently, she is not able to undertake exercise.

It is also difficult for Amy to undertake household chores. She describes how her heart and lungs “flare up” when she unloads a full dishwasher or takes laundry in a basket downstairs. She can walk for no more than 5 minutes or climb two flights of stairs without the exertion affecting her lungs, creating chest pain, and leaving her severely out of breath. Amy tries to pace herself and schedules rest into her day. She plans her activities carefully, doing one thing a day like work or health appointments. Although Amy’s social activities have changed since March 2020, she is still very connected to her friends. She used to meet female friends for coffee or brunch and male friends for coffee. Since March, she has had a few socially distanced meetings with a small group of women in her garden. Amy has a large social network of friends in the US – she is a dual British American national – and is very active on Instagram, Twitter, and LinkedIn. She has also blogged about her experience of COVID-19 and has talked about her recovery from the virus to the media.

Medication

Amy took prescribed medications before her COVID-19 infection. They included bioidentical hormone replacement therapy: biestrogen 0.5 mg, testosterone 1.25 mg and DHEA 2.5 mg in 0.5 ml (1 pump daily in the morning with Sundays off), and progesterone 50 mg in 0.5 ml (one pump twice daily). Amy was prescribed several medications for the treatment of her COVID-19 symptoms. Around day 23 of her illness, she started taking the corticosteroid Prednisone when she developed a chest infection. Amy has taken 1 puff of Fostair (100/6 micrograms per actuation) morning and night since September 2020. Between April and July 2020, she used an Albuterol inhaler (as needed and once in morning and afternoon) and a steroid inhaler, Clenil Modulite 100 micrograms per actuation (once morning and evening). For migraines, Amy takes Sumatriptin 50 mg as needed (also taken pre-COVID).

Communication

Amy has not noticed any significant change in cognition or language following COVID-19. She reports sometimes forgetting what she had gone into another room to pick up or the names of characters from movies, but she believes she was experiencing these problems a bit before her illness due to the perimenopause. She does not report any difficulty remembering what others have just said to her in conversation or the topic of a conversation. She can follow what others are saying in conversation and has no difficulty following the plot in a story or a film. Her ability to read and write has been unaffected by COVID-19. Amy had laryngitis for 11 weeks and still has a fluctuating “raspy” voice. As a professional voice artist, she has been trying to protect her voice as much as possible. She still displays a strong desire to communicate with others and does so multiple times every day.

For her voice problems, Amy has so far received two one-hour sessions of speech and language therapy. During the first session, Amy completed a detailed questionnaire with the therapist. Her responses were used to exclude acid reflux, identified through fiberoptic laryngoscopy, as a cause of her vocal problems. Amy had coughed persistently between March and July 2020 to clear debris from her lungs, and it was felt that this was a more significant cause of her vocal difficulties. Amy practiced voice techniques with the therapist, several of which caused chest pain and were not further pursued. The yawn-sigh technique, however, was helpful and is used by Amy before events where she must talk for long periods of time (e.g., Zoom meetings). Amy has observed a pattern in her vocal problems. Her voice will be normal for a few days, with her problems emerging again after physical exertion.

The author spoke to Amy online on 21 October 2020. It was 11:00 a.m. in the UK. The 12 language tasks described in chapter 5 were conducted during a 50-minute interaction. Amy’s scores on these tasks are shown in Table 13.1. Also shown are the means and standard deviations (SD) for healthy participants and COVID (experimental) participants with cognitive-linguistic issues in the study. The reader is referred to Table 13.2 in the Appendix for age, gender, and educational profiles of participants in all comparison groups.

Amy was assessed 7 months and 8 days after the onset of her COVID illness. Despite not reporting cognitive-linguistic difficulties, she fell below the mean performance of healthy participants in eight of 12 tasks. This may simply reflect her pre-morbid cognitive-linguistic performance and is not necessarily indicative

TABLE 13.1 Amy's raw scores on tasks in the study

<i>Task</i>	<i>Amy's scores[§]</i>	<i>Healthy participants Mean (SD)</i>	<i>COVID participants Mean (SD)</i>
Sam and Fred (immediate recall)	8.5/14	9.7 (± 1.9)	7.7 (± 2.0)
Sam and Fred (delayed recall)	6.5/14	9.3 (± 2.0)	6.5 (± 2.2)
Cookie Theft picture description	9.5/12	7.7 (± 1.2)	6.9 (± 1.4)
Sentence generation	5/6	5.2 (± 0.8)	5.0 (± 1.0)
Letter fluency (F-A-S)	60	48.0 (± 10.8)	37.0 (± 11.5)
Category fluency (animals)	19	25.8 (± 4.7)	21.7 (± 6.6)
Category fluency (vegetables)	23	15.3 (± 3.7)	15.1 (± 4.4)
Flowerpot Incident narration	8.5/20	13.8 (± 2.9)	12.3 (± 2.7)
Cinderella narration	29/50	32.0 (± 5.7)	26.9 (± 7.0)
Procedural discourse (sandwich)	5/8	6.6 (± 0.9)	6.4 (± 0.9)
Procedural discourse (letter)	7/8	6.5 (± 1.4)	6.2 (± 1.3)
Confrontation naming	17/20	17.6 (± 2.0)	17.7 (± 1.8)

[§] Figures are raw scores

of any impairment. Amy's performances on delayed recall, category fluency for animals, Flowerpot Incident narration, and sandwich-making discourse were greater than 1 standard deviation below the mean of healthy participants. In the four tasks where Amy performed above the mean of healthy participants, her Cookie Theft picture description and letter fluency performances were greater than 1 standard deviation above the mean and her category fluency for vegetables was greater than 2 standard deviations above the mean.

What is interesting is that whilst Amy's scores fell for the most part below the mean scores of healthy participants, she displayed better performance relative to people who reported cognitive-linguistic difficulties (so-called "brain fog") since their COVID illness. On six of 12 tasks, Amy exceeded the mean performance of these COVID participants. Amy registered particularly strong performances relative to COVID participants in letter fluency (2 standard deviations above COVID mean), Cookie Theft picture description, and category fluency for vegetables (both between 1 and 2 standard deviations above the COVID mean). On a further three tasks, her performance was the same as the mean scores of COVID participants. In only three tasks – category fluency for animals, Flowerpot narration, and sandwich-making procedural discourse – did Amy's scores fall below the mean scores of COVID participants. Her score for animal fluency fell within 1 standard deviation of the mean score of COVID participants, whilst her scores for Flowerpot narration and sandwich-making discourse were between 1 and 2 standard deviations below the mean. This level of performance relative to COVID participants in the study is consistent with Amy's self-report that her cognitive-linguistic functioning had not been negatively impacted by her COVID infection.

Case Study 2 52-year-old occupational health physician

Background

Pauline (not her real name) is 52;11 years old. She is divorced and has no children. Pauline has 18 years of formal education. She has pursued a career in medicine, obtaining her medical degree (MBChB Medicine) in 1990. In 1994, Pauline became a member of the Royal College of General Practitioners in the UK. She became a member of the Faculty of Occupational Medicine in 2002. Currently, Pauline is a trainer of communication skills to medical students, doctors, scientists, and allied health professionals. She was a Consultant in Occupational Medicine in one of her earlier roles.

Prior to contracting COVID-19, Pauline had several health difficulties. She has hypermobile Ehlers-Danlos syndrome (EDS). This is a genetic condition that causes joint problems, colitis, and other gastrointestinal disorders, bladder, autonomic nervous system, skin, and immune problems. EDS has made Pauline prone to serious bacterial infections (she is described as having “immune dysfunction”). She has had many episodes of bacterial sinusitis and multiple chest infections since she was 13 years of age. Between 1998 and 2009, Pauline received immunoglobulin treatment to prevent infections. On six occasions between 1990 and 2013, Pauline required surgery for infections in her nasal sinuses. Between December 2019 and March 2020, she received intravenous antibiotics to treat a heart and spine infection. Pauline has experienced recurrent sepsis. In 2012, she developed a spinal infection that resulted in sepsis and encephalopathy. She had to stop working at this point. In 2012, Pauline was diagnosed with dyspraxia. This is developmental in nature. Her neck is also unstable due to infection and EDS.

Pauline has a normal body weight for her age, height, and gender. She does not smoke or vape and has one glass of white wine (125ml) every two weeks. Before her spinal cord/spine problems, Pauline used to be very active. She did three hours of pilates every week. She describes her diet as “pretty well balanced,” although she thinks she could probably eat less chocolate. Because of malabsorption related to EDS, Pauline is prescribed a range of vitamin and mineral supplements. She takes vitamin D (60,000 units/week); vitamin C (1 g twice a day); vitamin B complex (1 g once a day); magnesium (magnaspartate) (243 mg twice a day); and omega 3 (twice a day). She also takes

probiotics. Pauline is allergic to the iodine contrast that is used in certain X-rays but has no food allergies. Her vision is near-normal in one eye while the other eye is very long-sighted. She has high-frequency hearing loss in both ears. Also, her left eardrum does not work well because of damage sustained in a past infection.

Pauline has a wide range of friends whom she met on a regular basis before the national lockdown in the UK. Many of her social activities were through church activities and exercise classes. Since formally retiring in 2012 on grounds of ill health, Pauline believes she has been able to achieve a healthy work-life balance. She has undertaken small amounts of work and pursued hobbies while managing her health limitations. Pauline is active on Facebook and has recently started campaigning for people with Long COVID along with other illness groups. She has several interests, including painting and drawing, playing the piano, music, and going to art galleries and the theatre.

Pauline first experienced symptoms of COVID-19 on 18 March 2020. Her nose was congested, and she had a “strange” dry, parched throat which was not sore. She was tested late for the virus on 5 May, 22 May, and 5 June 2020, all of which returned negative results. Pauline thinks she may have been exposed to the virus either at work – “loads of people were ignoring guidance and coming to work with fevers, cough and sore throat” – or through nurses who were administering intravenous antibiotics to her daily for the treatment of a spinal infection. However, she cannot be sure how she contracted the virus because although many of her nurses had coughs, they treated her before 5 March 2020, which was too early for the onset of her symptoms on 18 March 2020.

Pauline received some medical support during her acute COVID illness. On day 10 of her illness, she was admitted to Accident & Emergency with severe diarrhoea, vomiting and a high fever. From day 11 onwards, she was under the supervision of her usual bowel disease specialist team and GP. During her acute illness, Pauline took paracetamol and antibiotics. She developed bacterial sinusitis in the first 10 days of her illness and took Co-amoxiclav 625 mg three times daily for a week. Since her acute phase of illness, Pauline has had several medical investigations. She had two chest X-rays on 29 March 2020 and in early September. Nothing abnormal was detected on both occasions. In September 2020, she had a cardiac MRI, which added no new findings beyond the aneurysm of the left coronary artery detected

in 2018 and the sinus of Valsalva aneurysm detected in 2015. On 9 August 2020, Pauline had an echocardiogram, which revealed a new tricuspid valve regurgitation. She continues to experience low oxygen saturation on exertion. Between March and May 2020, Pauline had appointments with her inflammatory bowel disease team for COVID colitis. In July 2020, she had a further routine review. Pauline's colitis is a severe systemic inflammatory response to infection, according to her Consultant Gastroenterologist.

Clinical symptoms

Pauline experienced a wide range of symptoms during acute COVID illness. Five symptoms were severe: loss of taste and smell; gastrointestinal problems; aches and pains; headache; chest pain or pressure. Before contracting COVID, Pauline had an inflammatory bowel condition related to EDS. She developed severe colitis during COVID-19 infection. Between days 10–20 of her illness, she experienced severe aches and pains, leading her to beat her legs to get rid of it. Pauline had migraine-like headaches. These were worst on day 10 but also occurred in episodes later in her illness. Pauline had retrosternal chest pain briefly on day 10 and then severely from 4–6 months on exertion. She had moderate fever and moderate breathing difficulties. Pauline's breathing difficulties were most noticeable around 4 months onwards when she had more exertion, as she was too ill earlier in her illness to move much.

Pauline also had five mild symptoms: coughing, fatigue, sore throat, conjunctivitis, and skin rash. Her coughing was very mild and intermittent. Pauline experienced fatigue. In the first eight weeks of her illness, she described this as sleepiness rather than fatigue. Pauline still has a sore throat. She had conjunctivitis which became intermittent later in her illness. Pauline experienced a skin rash of varied appearance several months into her illness. She also had a hoarse voice.

Pre-COVID, Pauline had cognitive problems related to an episode of sepsis in 2012. She had short-term memory difficulties and struggled with organisation and planning. Remembering conversations, faces and names was difficult for her. Pauline could not manage a diary or write an invoice correctly. Her sense of direction was poor, a problem related to her dyspraxia. Pauline's cognitive difficulties have changed, and some have worsened since contracting COVID-19. Before her illness, Pauline struggled to remember the content of conversation but could at least remember that a conversation had taken place. Since her

COVID illness, she has no recollection of conversations even having taken place. She has noticed that her friends are commenting on this lapse of memory more often now. With flare-ups of her COVID symptoms, she can feel quite “woolly” as she weighs up what she should be doing. She feels “inanimate” and can sit rooted to the spot for hours even though she is not drowsy. Pauline finds it immensely difficult to start doing anything. This is not related to low mood and is out of character for her as she is usually good at prioritising and initiating things. It is noteworthy that since completing intravenous antibiotics for a bacterial infection in March 2020, two of Pauline’s close friends had independently remarked that the cognitive difficulties she experienced pre-COVID had lessened. She was better able to complete sentences, was less confused, and was more alert than she had normally been.

Pauline believes her acute COVID illness and the restrictions used to control the virus have had a detrimental impact on her mental health. She describes being “very confused” in the first three weeks of her illness and states that she was “not fully with it” for eight weeks. She was able to cope with the 3-month national lockdown because she was so unwell. She also did painting, which kept her “sane and happy” despite being ill. However, in the last 3–4 months, she has felt angry and irritable which is out of character for her. This is because she feels lonely, cooped up, and does not agree with the COVID restrictions that have been put in place.

Pauline describes her recovery from COVID-19 as a pattern of episodic recovery and relapse following a 3-month period in which she was very ill. She is generally slightly better after each relapse. In her last major relapse in June 2020, she was very unwell again, with low blood pressure, “weird behaviour,” and confusion for days. She then felt much better but thinks her white cell count must have dropped as she developed an infection of the chest and sinuses with *Pseudomonas*, a bacterium that affects people with immune suppression. Since October 2020, Pauline has experienced normal energy and most of her symptoms have gone. However, she still has severe chest pain, breathlessness, and low oxygen saturation, all on exertion. She reports that “something is definitely not right.”

Daily activities

Pauline’s COVID illness and its consequences have compromised her daily activities. Because of lockdown, she has not been able to work.

But if circumstances had been normal, she would not have been able to do any work for 4 months on account of her illness. There has been a significant impact of her illness on her ability to engage in social and leisure activities. Pauline has been unable to see her family. She was initially housebound with a spinal infection and was then infectious with COVID and too unwell to visit relatives. Pauline cannot undertake household chores. Until recently, she needed carers four times a day as she has been too ill to cook and care for herself.

Medication

Because of her pre-existing health problems, Pauline takes a wide range of prescribed medications. For the treatment of hypotension, she has been prescribed fludrocortisone (200 mg). For her colitis, she takes Asacol MR (1.6g three times daily) and Salofalk enema (2 g at night). Pauline takes several medications to maintain chest health. For the treatment of bronchiectasis, she uses nebulised hypertonic saline 6% once in the morning. Pauline takes Mucodyne (375 mg twice a day) to manage mucus in her respiratory tract. Occasionally, she uses a Ventolin inhaler. To manage bladder and gut problems (mast cell activation disorder/histamine intolerance), Pauline takes loratidine (10 mg twice a day), famotidine (20 mg at night), ketotifen (2 mg at night), and sodium chromoglycate (200 mg three times daily). She also uses rotating antibiotics. Pauline has been prescribed the anti-depressant sertraline (100 mg at night). For pain relief, she takes pregabalin (75 mg reducing to 50 mg twice a day); amitriptyline (25 mg at night); and paracetamol (1 g twice a day). Skin problems on her hands and feet are treated with Diprobace cream, Cetraben ointment and Tracolimus ointment. Pauline uses Dermol lotion to wash her skin.

Communication

Pauline reports that COVID-19 has exacerbated some cognitive difficulties that she developed following an episode of sepsis in 2012 and created some additional cognitive problems. She struggles to find words that she wants during conversation. She reports that she cannot remember the names of things and people such as the names of her friends' husbands. She also cannot remember what others have just said in conversation and the topic of conversation although

both skills were already somewhat affected pre-COVID. Pauline can also have difficulty following what others are saying in conversation, especially if the interaction is formal and new information is being conveyed. However, she can manage to follow informal conversation. Pauline's ability to read and write was already affected by sepsis. However, her reading is now "even worse," and she cannot concentrate on either reading or writing. She cannot follow a plot in a story or film, although this was also an area of some difficulty pre-COVID.

Pauline has retained a strong desire to communicate with others. She is "always happy to talk." Pauline's illness and lockdown have reduced the frequency of her communication with others. She reported that after the first 3–4 months, she had almost forgotten how to speak. It was not until she started speaking with others again that she realised just how poor her language skills had become. She would stop speaking and swap syllables and words around. She could not pronounce certain words at all.

The author spoke to Pauline online on 26 October 2020. The session took place at 10:00 a.m. UK time and lasted 50 minutes. Pauline spoke at length about her COVID illness. She completed the 12 language tasks in the study. Her scores on these tasks are shown in Table 13.3, alongside means and standard deviations (SD) for healthy participants and COVID control participants in the study.

Pauline was assessed 7 months and 8 days after the onset of her COVID illness. She reported a deterioration of pre-existing cognitive difficulties following her COVID infection. This was reflected in her test performance. Pauline fell below the mean of healthy participants in 9 of 12 tasks. She was greater than 2 standard deviations below the mean on immediate recall, letter fluency, and category fluency for animals, and greater than 1 standard deviation below the mean on delayed recall and Cinderella narration. Pauline's category fluency for vegetables, Flowerpot Incident narration, and sandwich-making and letter writing discourses were all within 1 standard deviation below the mean. In the three tasks with best performance – Cookie Theft picture description, sentence generation, and confrontation naming – she returned performances that were just above the mean of healthy participants.

A similar pattern of performance was also recorded relative to COVID controls who did not report cognitive-linguistic difficulties following their COVID illness. Pauline performed below the mean of COVID controls on 8 of 12 tasks. An area of considerable difficulty was immediate recall, which fell between 3 and 4 standard deviations below the mean of these controls. Pauline's letter and category fluency for animals fell between 1 and 2 standard deviations below the mean

TABLE 13.3 Pauline's raw scores on tasks in the study

<i>Task</i>	<i>Pauline's scores[§]</i>	<i>Healthy participants Mean (SD)</i>	<i>COVID controls Mean (SD)</i>
Sam and Fred (immediate recall)	5.5/14	9.7 (± 1.9)	10.4 (± 1.5)
Sam and Fred (delayed recall)	6/14	9.3 (± 2.0)	9.7 (± 1.9)
Cookie Theft picture description	8/12	7.7 (± 1.2)	7.7 (± 0.9)
Sentence generation	6/6	5.2 (± 0.8)	5.4 (± 0.8)
Letter fluency (F-A-S)	25	48.0 (± 10.8)	53.2 (± 14.4)
Category fluency (animals)	14	25.8 (± 4.7)	23.4 (± 6.6)
Category fluency (vegetables)	13	15.3 (± 3.7)	17.1 (± 3.4)
Flowerpot Incident narration	13/20	13.8 (± 2.9)	12.8 (± 2.9)
Cinderella narration	25/50	32.0 (± 5.7)	31.8 (± 5.1)
Procedural discourse (sandwich)	6/8	6.6 (± 0.9)	6.8 (± 0.9)
Procedural discourse (letter)	6/8	6.5 (± 1.4)	7.2 (± 1.4)
Confrontation naming	19/20	17.6 (± 2.0)	18.2 (± 1.3)

[§] Figures are raw scores

of COVID controls, a better performance than that observed relative to healthy participants. This pattern of cognitive performance below the mean of both healthy participants and COVID controls – with marked difficulties in immediate recall, letter fluency, and category fluency for animals – is consistent with Pauline's reports of a further deterioration in her cognitive functioning post-COVID.

A question of some interest is whether Pauline's COVID illness had caused new cognitive difficulties or had exacerbated her pre-existing cognitive problems. Pauline's immediate recall, letter fluency, and category fluency for animals were particularly weak areas of performance. The performance of COVID participants in the study was significantly weaker than healthy participants on all three of these tests, amongst others (see chapter 5). But whilst these difficulties had a COVID-related onset for the other COVID participants in the study, for Pauline they appeared to involve a worsening of her pre-existing difficulties. On 13 February 2015, Pauline underwent a neuropsychological assessment. This assessment, which took place after her earlier health problems, revealed significant impairments in areas of attention and memory. Although Pauline's immediate recall of story material was better than some other aspects of memory, her score was in the low average range. However, Pauline's performance on immediate recall of story material following COVID infection was lower still, with her score between 2 and 3 standard deviations below the mean of healthy participants. This suggested that, rather than giving rise to new cognitive difficulties, her COVID illness had caused some further deterioration of her cognitive abilities.

Case Study 3 48-year-old medical practice manager

Background

Angela (not her real name) is 48;7 years old. She is married and has two daughters aged 18 and 19 years. Both daughters are currently at university. Angela has been the manager of her husband's private medical practice since 2007. She has 18 years of formal education. In 1994, Angela graduated with a Master of General Arts. In 1998, she obtained a Montessori Diploma. Between 1998 and 2004, Angela worked as an Early Years teacher. Angela enjoys walking, reading, cooking, and travelling. She also likes going to the theatre and visiting art galleries. She describes herself as very sociable. When asked about her work-life balance, she reported having "more life than work." Angela is active on social media, using Facebook and Instagram to keep in touch with others.

Before contracting COVID-19, Angela enjoyed "very good" health. She is 5 feet and 10 inches in height and weighs 10 stone and 11 lbs, giving her a BMI of 21.7 (normal weight). She attended the gym three to four times per week where she lifted free weights and did cardiovascular exercise. Angela also walked for an hour every day with her dog. She described herself as being the fittest she has ever been. Angela has never smoked or vaped. She has one to two drinks (gin and wine) most evenings. Angela has had two surgeries to date, one in 2003 to remove a varicose vein and a tonsillectomy in 2007. She has asthma and was diagnosed with trigeminal neuralgia in 2016. Angela takes daily vitamin B12 (5,000 mg) and prescribed medications (see *Medication*). She has no allergies to food or medication and eats a well-balanced, mainly vegetarian diet, consisting of large amounts of fruit and vegetables. Angela does not eat junk food or takeaways but thinks that she could reduce her sugar intake as she "loves a chocolate biscuit." She has normal hearing, but her vision is myopic.

Angela remained at home throughout her COVID illness. Her first symptom was a slightly raised temperature of 37.8 degrees on 13 March 2020. This was followed by a cough on 15 March. After nine days of illness, Angela had a "major crash" and became bedbound. She developed breathing complications and silent hypoxia. Her O₂ saturation level was 93%, and her peak flow measurement was 300 litres per minute. An ambulance was sent to deliver oxygen to her at home. She opted to remain at home as her husband is a doctor and

the local hospital was full. She was so unwell that she has no memory of a full week during this time. Because Angela contracted the virus prior to widespread testing in the UK, she did not receive a PCR swab for COVID-19. She believes she contracted the virus through her work as a medical practice manager. Her husband runs an acute gynaecology unit at a major teaching hospital and was treating emergency patients with no COVID screening and very little personal protective equipment. Most of his unit was infected with the virus. Some of his colleagues tested positive on PCR swabs that were performed at the hospital.

Angela had three phone calls with her GP during her acute COVID illness. On 27 August 2020, she had a chest X-ray and nothing abnormal was detected. Blood tests for rheumatoid factors, c-reactive protein, urea and electrolytes, clotting factors, white cell counts, and D-dimers were conducted on 7 September and produced negative results. Thirteen days after she first became unwell, Angela took two three-day courses of azithromycin (500 mg per day for 3 days) for secondary pleurisy. Her regular asthma medication (see *Medication*) had to be increased. Angela received five sessions of physiotherapy for tendonitis and sore joints that she developed during her acute illness.

When asked to reflect on her recovery from COVID-19 to date, Angela reported that she is about 90% recovered on a good day. However, sometimes she is “back to square one” and is so poorly that she must go to bed.

Clinical symptoms

Angela has had a wide range of COVID symptoms. During her acute illness, she had severe breathing difficulties. Her oxygen saturation level dropped to 93% and her peak flow measurement was low. She experienced severe chest pain: “It felt like I had hit a steering wheel in a car crash.” Angela has had severe fatigue which continues unabated. She describes herself as exhausted. Several of Angela’s symptoms were moderate in nature, including coughing, loss of taste and smell, aches and pains, and headache. Angela’s cough started lightly and then deteriorated. It lasted for 16 weeks in total. After 3 weeks of illness, Angela experienced a loss of taste and smell. She had rheumatic pains in her wrists and ankles and Achilles tendonitis. She also had a “crushing” headache behind her eyes. Angela’s mild symptoms

included a slight fever, with her temperature recorded at 37.8 degrees. She also had mild gastrointestinal problems, an upset stomach, for a few days. Angela experienced restless legs as she was beginning to recover.

Angela reports cognitive difficulties following her illness. She is very forgetful. She forgets to undertake day-to-day tasks. Errands are only half completed, and things that she has told others she would do are left undone. Angela has difficulty planning and organising her day. Because of limited energy, a lack of motivation and forgetfulness, she is never quite sure that she will be able to complete all her tasks in a day. In terms of the impact of COVID-19 on her mental health, Angela reports that she was “quite traumatised” by not being able to breathe.

Daily activities

Angela reports a significant impact of COVID-19 on her daily activities. Her ability to undertake work duties has been compromised by “brain fog.” She reports that this feels as if there are “blank spots” in her brain and that she must search for memories and information that she knows she has. She is forgetful and is easily distracted. Angela was physically very active before her illness and undertook some form of exercise every day. Since her illness, she has been unable to exercise. Although Angela can undertake household chores, she must do so more slowly than before her illness. She now finds large social gatherings intimidating because she does not have the energy and motivation to interact with others.

Medication

Angela uses Nabiximols (trade name Sativex), an oromucosal spray, three times daily for pain management. For the treatment of asthma, Angela takes one puff twice daily of Symbicort Turboinhaler 200/6 inhalation powder.

Communication

Angela has noticed some changes in her language and communication skills following her COVID illness. She reports that she “definitely needs to reach for names in her memory and trips up with

words.” She does not think that she processes things well. She finds that her mind is inclined to wander during conversations. This affects her ability to remember the topic of a conversation and to follow what others are saying in conversation. She can still follow the plot in a story or film. Angela’s writing has been unaffected by her illness but her reading concentration is much shorter. Her desire to participate in conversation depends on how fatigued she is feeling. She reports a reduction in the frequency with which she communicates with others: “I am definitely less social than I was.”

The author spoke to Angela online on 3 December 2020. It was 11:00 a.m. in the UK. The meeting lasted one hour. Angela spoke at length about the impact of COVID on her health and on her family. Her scores on the 12 language tasks in the study are shown in Table 13.4, alongside means and standard deviations (SD) for healthy participants and COVID control participants in the study.

Angela was assessed 8 months and 21 days after the onset of her COVID illness. Although she reported cognitive-linguistic difficulties following her COVID infection, her performance relative to healthy participants was above average in 9 of 12 tasks. Her category fluency performance was particularly exceptional, with the generation of animal names between 1 and 2 standard deviations above the mean and the generation of vegetable names over 3 standard deviations above the mean. But against this strong category fluency performance, there was very poor verbal recall. Angela’s immediate and delayed recall were between 2 and 3 standard deviations below the mean. Her performance on Cookie Theft picture description was equally poor, with Angela’s score again between 2 and 3 standard deviations below the mean of healthy participants.

Relative to COVID controls with no self-reported cognitive difficulties, Angela’s performance on immediate recall and Cookie Theft picture description was poorer still. She performed between 3 and 4 standard deviations below the mean on immediate recall and her picture description was 3 standard deviations below the mean. Her category fluency performance remained equally exceptional relative to COVID controls.

Angela’s self-reported cognitive-linguistic difficulties following COVID infection appear to be confirmed by her poor immediate and delayed recall of verbal material and reduced ability to be informative during picture description. She displayed above average performance relative to healthy participants and COVID controls with no self-reported cognitive-linguistic deficits in other areas. However, it is worth remarking that even this above average performance may be reduced relative to her pre-morbid cognitive-linguistic performance.

TABLE 13.4 Angela's raw scores on tasks in the study

<i>Task</i>	<i>Angela's scores[§]</i>	<i>Healthy participants Mean (SD)</i>	<i>COVID controls Mean (SD)</i>
Sam and Fred (immediate recall)	5/14	9.7 (±1.9)	10.4 (±1.5)
Sam and Fred (delayed recall)	5/14	9.3 (±2.0)	9.7 (±1.9)
Cookie Theft picture description	5/12	7.7 (±1.2)	7.7 (±0.9)
Sentence generation	6/6	5.2 (±0.8)	5.4 (±0.8)
Letter fluency (F-A-S)	58	48.0 (±10.8)	53.2 (±14.4)
Category fluency (animals)	33	25.8 (±4.7)	23.4 (±6.6)
Category fluency (vegetables)	28	15.3 (±3.7)	17.1 (±3.4)
Flowerpot Incident narration	16/20	13.8 (±2.9)	12.8 (±2.9)
Cinderella narration	33.5/50	32.0 (±5.7)	31.8 (±5.1)
Procedural discourse (sandwich)	7/8	6.6 (±0.9)	6.8 (±0.9)
Procedural discourse (letter)	7/8	6.5 (±1.4)	7.2 (±1.4)
Confrontation naming	18/20	17.6 (±2.0)	18.2 (±1.3)

[§] Figures are raw scores

Case Study 4 31-year-old former college employee

Background

Susie (not her real name) is 31;11 years old. She is single and has no children. Susie has 16 years of formal education. In 2008, she graduated from the Facultatea de Stiinte Economice Juridice si Administrative at the University of Pitesti in Romania. She studied hair art design at Blondi Hair Design Academy Wella in Bucharest between July and December 2010 and worked in several hair salons in Romania between 2008 and 2014. Susie moved from Romania to Sweden in March 2014 and lived there until June 2018. While in Sweden, she worked as a runner, bartender, and staff manager in different clubs in Stockholm. She also did freelance work with fashion TV and other companies, was a chef's assistant, and worked as a game master at Quest Room in Stockholm. Susie had an internship at Bagpipe Creative Collective in Sweden between 2015 and 2017. She was a marketing assistant between April 2017 and June 2018, a role in which she promoted artists and worked as a talent scout.

Susie moved to the UK in June 2018. She was a general assistant at University College London between August 2018 and February 2019. She then worked for nearly two years as an assistant manager/barista at Baxterstorey at Central Saint Martins, University of the Arts London. Susie attended the Oakley Academy in London in June 2019 to undertake training in hair extensions. She has not worked since February 2020 when University of the Arts London closed due to the pandemic. Susie then lost her job in October 2020 as part of COVID-related redundancies. Susie is a native Romanian speaker. She also speaks English and Spanish fluently as second languages. Susie started to learn English at school in Romania when she was seven years old.

Susie enjoyed “very good” health prior to September 2019, when she developed a severe ear infection. She was off work for 2 months and had to take four courses of antibiotics, none of which treated her infection. During this time, she experienced fatigue, anxiety, and vertigo. In February 2020, she was prescribed two further antibiotics and a steroid spray for her ears. She was admitted to hospital in the same month with pneumonia. Susie was prescribed another course of antibiotics, which successfully treated her chest infection. A short time later, her COVID symptoms started.

Susie reported no chronic health problems prior to contracting COVID-19. She is 168 cm in height and weighs 69 kg, giving her a BMI of 24.4 (normal weight). Susie stopped smoking three years ago and does not drink alcohol. In 2016, she had an appendectomy. In the same year, she also had a miscarriage. Susie is taking prescribed medication for anxiety and irritable bowel syndrome (see *Medication*). She has no food allergies but is allergic to Stemetil, which she was prescribed by an emergency room doctor for sickness and dizziness. On 26 September 2020, Susie was admitted to hospital following an oculogyric crisis related to the taking of two 5 mg Stemetil tablets. On the way to hospital in the ambulance, she began to choke due to inflammation of her throat and severe jaw clenching. Susie does not currently take vitamins and minerals, although she has taken zinc, folic acid, and oregano oil in the recent past. She reports impaired hearing and vision. Susie experiences tinnitus and has days when her hearing is poor. She has not had an audiological assessment. She describes her vision as “blurry” and reports oculomotor problems.

Susie first developed symptoms of COVID-19 in the middle of February 2020. She was talking to a friend on the telephone one evening when she suddenly became dizzy and had “a weird feeling in [her]

body different from anxiety.” She became pale, could no longer talk, and thought she would pass out. She recovered after two hours. The following morning, Susie woke up, went into the kitchen, and started talking to her housemates. She suddenly experienced a sharp pain in her chest and could not breathe. She described how the pain was like a sharp knife moving very quickly all over her chest. She could no longer talk and retired to her room to lie down. Susie reported then feeling as if something was moving close to her. She took it in her hands and looked at it, but it was simply her phone. When she returned to normal again, she looked at her phone and it was midnight. Susie describes herself as having lost consciousness during this time. She called the hospital and was given advice. Susie did not want to go to hospital as she was afraid of being intubated. She was continuously short of breath over the following days. She was also powerless, had muscle pains and spasms, nausea, and diarrhea, and experienced a loss of taste and smell, headaches, dizziness, and hearing loss.

During her acute COVID illness, Susie received no medical supervision. Her only medical monitoring during her recovery has been through her participation in the COVERSCAN study, a joint research initiative of Perspectum, Oxford University Hospitals NHS Trust and the Mayo Clinic. This study is mapping how COVID-19 is affecting the health of multiple organs (lungs, heart, kidney, liver, pancreas, and spleen). On 10 September 2020, Susie had a scan of her liver and heart. Her liver was healthy with a fat content of 4.3% (normal). Her cardiac scan showed normal left ventricular pumping function and no evidence of inflammation. Her blood pressure, body mass index, oxygen saturation, and blood investigations were also normal. Susie was not tested for the virus at the start of the pandemic in the UK as tests were in scarce supply but was given a clinical diagnosis of COVID-19 infection. After her acute illness, Susie received seven swab tests for the virus and an antibody test, all of which produced negative results. She cannot be certain how she contracted the virus. Her symptoms emerged one week after she was sent home from work on account of pneumonia, so her workplace is a possible setting in which exposure occurred. However, she also lives with eleven other people. After her first week of symptoms, she discovered that one of her housemates had been in bed unwell for a week. Susie does not know anyone who had a positive COVID-19 test result. When asked to describe her recovery from COVID-19 to date, she replied that she has “not recovered.”

Clinical symptoms

Susie has had a wide range of COVID symptoms. Her most severe symptoms included a loss of taste and smell (anosmia), breathing difficulties, gastrointestinal problems, fatigue, aches and pains, and chest pain/pressure. Apart from anosmia, Susie is still experiencing each of these symptoms. She had chest pain and pressure every day for the first four months of her illness. She has a relapse of this symptom every couple of weeks. Susie also had moderate fever, sore throat, and headache. Other moderate symptoms included ear pain, muscle spasms, and unusual sensations. These sensations were dizziness, strange perception of colours, and popping sounds from her nose. The dizziness Susie experienced was quite unlike the dizziness that you might experience if you get out of bed quickly. Despite drinking three litres of water every day, Susie was constantly thirsty, and her lips and skin were unusually dry. Susie also had mild coughing and skin rashes on her hands as part of her COVID illness. Other symptoms included kidney pain, heartburn, hair loss, and fluctuating low and high temperatures. Susie is also experiencing sleeplessness. She reported that on two occasions, she slept for 22 hours and 27 hours continuously, presumably due to extreme fatigue related to insomnia.

Susie reports cognitive problems following her COVID illness. She thinks that 80% of her ability to remember things has been affected by her illness. She must write things down or she will forget them. Susie describes how she cannot remember words in English and the other languages that she knows. Some of her memory lapses are potentially dangerous (e.g., leaving the door of the gas cooker open). She reports that her ability to plan and organise her day has also been compromised by as much as 80%. She postpones a lot of plans, sometimes even taking a bath to avoid doing them. Every time she plans to do something, she feels weak and powerless. Susie's anxiety has not increased during her illness apart from three or four "anxiety crises" when she was in great pain.

Daily activities

COVID-19 has had a significant negative impact on Susie's daily activities. Before her illness, Susie occasionally went to the gym and did swimming. She also walked 2–4 km every day. She has been unable to undertake any exercise since her illness. Every time she tries to exercise,

she experiences a relapse in her COVID symptoms. Susie had a well-balanced diet before her illness. Her diet has been adversely affected as her reduced energy has left her unable to cook meals for herself. She often does not have an appetite for food as well. Her reduced energy has left her unable to meet friends socially. Before her COVID illness, Susie enjoyed crafting and painting, but she has also been unable to pursue these hobbies in recent months. Susie participates in online COVID groups where she shares her symptoms with others. But beyond this, she makes limited use of social media as she is trying to relax.

When asked about the impact of her illness on her ability to perform tasks and undertake duties, Susie chose to quantify her difficulties. Her COVID illness has adversely affected 90% of her ability to perform work duties, 90% of her ability to pursue social and leisure activities, and 90% of her ability to undertake household chores.

Medication

During her COVID illness, Susie used a Salbutamol 20 ug inhaler. She has been prescribed Citalopram 10 mg once daily for anxiety and takes Buscopan for the treatment of irritable bowel syndrome. Susie takes paracetamol 500 mg four times daily for relief of her COVID symptoms.

Communication

Susie reports some cognitive and language disturbances following COVID-19. She forgets the names of people she has known for a long time as well as new names. Susie cannot remember what others have just said in conversation. By way of example, she recounted how a doctor gave her an address to remember, then asked her for her name, and finally asked her to recall the address. She could only recall one part of the address. When she starts to talk about something, she tends to lose what she wanted to say. She does not always understand what others are saying in conversation. This did not happen to her pre-COVID. Although she can still read and write, she struggles to remember what she has read after a few seconds. She cannot follow a plot in a film or story. Her desire to participate in conversation with others is reduced because of limited energy. She is communicating with other people with reduced frequency.

The author spoke to Susie online on 9 November 2020. It was 11:00 a.m. in the UK. The conversation lasted 1 hour and 10 minutes, during which time Susie described the significant impact of Long COVID on her daily life. Susie's performance on the language tasks described in chapter 5 is shown in Table 13.5, alongside means and standard deviations (SD) for the healthy L2 English speakers in the study.

Susie was assessed approximately 9 months after the onset of her COVID illness. Her self-reported cognitive-linguistic difficulties following her COVID illness are consistent with a pattern of poor performance in all areas. Susie performed below the mean of healthy L2 English speakers on all 12 tasks used in the study. Her strongest performances were in procedural discourse and confrontation naming, where her scores fell within 1 standard deviation below the mean scores of healthy L2 English speakers. Susie's category fluency for animals and vegetables and her immediate recall of the Sam and Fred story were between 1 and 2 standard deviations below the mean for healthy participants. Susie was not able to attempt delayed recall of the story. Sentence generation and letter fluency were between 2 and 3 standard deviations below the mean scores of healthy participants.

It is interesting that Susie's worst performances were recorded in the discourse production tasks in the study. Her scores for informativeness on these tasks ranged from between 3 and 4 standard deviations below the mean (Flowerpot Incident and Cinderella) to between 4 and 5 standard deviations below the mean (Cookie Theft). Reduced discourse informativeness was a consistent feature of the COVID participants in the study who spoke English as a first language but not COVID participants who spoke English as a second language (see chapter 5). Susie's profile

TABLE 13.5 Susie's scores on the tasks in the study

<i>Task</i>	<i>Susie's scores[§]</i>	<i>Healthy L2 English speakers Mean (SD)</i>
Sam and Fred (immediate recall)	5.5/14	8.6 (\pm 1.9)
Sam and Fred (delayed recall)	0/14	8.4 (\pm 1.8)
Cookie Theft picture description	2/12	6.6 (\pm 1.1)
Sentence generation	2/6	4.6 (\pm 1.1)
Letter fluency (F-A-S)	14	37.0 (\pm 10.3)
Category fluency (animals)	10	18.6 (\pm 4.6)
Category fluency (vegetables)	5	10.4 (\pm 3.2)
Flowerpot Incident narration	6/20	12.4 (\pm 1.7)
Cinderella narration	14/50	34.2 (\pm 5.9)
Procedural discourse (sandwich)	4/8	4.6 (\pm 0.9)
Procedural discourse (letter)	5/8	6.1 (\pm 1.4)
Confrontation naming	12/20	13.1 (\pm 4.0)

[§] Figures are raw scores

of reduced informativeness across discourse production tasks sets her apart from other L2 English speakers with COVID. One possible explanation of this difference is that other L2 speakers of English with COVID were further into their recovery at the point of testing than Susie was – Susie was tested at 268 days (or 9 months) after the onset of her symptoms whilst the average time between symptom onset and testing for L2 English speakers with COVID was 385 days (or 13 months). Whatever ultimately explains Susie's worse discourse performance relative to other L2 English speakers with COVID, her marked difficulties in this area are indicative of the extent of her cognitive debilitation some 9 months after the onset of her COVID illness.

APPENDIX

TABLE 13.2 Characteristics of study participants

<i>Study group</i>	<i>N</i>	<i>Age (mean)</i>	<i>Age (range)</i>	<i>Gender (M/F)</i>	<i>Education (years)</i>
COVID experimental participants	69	49.1 years	24.0–64.3 years	5 M/64 F	29 under 17 years 40 over 17 years
COVID control participants	11	46.5 years	30.9–60.6 years	3 M/8 F	4 under 17 years 7 over 17 years
Healthy participants	26	48.2 years	18.1–64.6 years	10 M/16 F	7 under 17 years 19 over 17 years
L2 English control participants¹	13	38.3 years	18.3–60.8 years	3 M/10 F	1 under 17 years 12 over 17 years

¹ First languages of participants: Mandarin Chinese; Cantonese Chinese; French; Spanish; Dutch