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Characterising the Basic Emotions in Long COVID

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Abstract

Several studies around the world have established that Long COVID is associated with profound affective changes. However, these affective symptoms are often exclusively characterized through the clinical terms of depression and anxiety. Therefore, our study aims to characterise the range of affective states experienced by individuals with Long COVID from a basic-emotion perspective based on Panksepp's emotional taxonomy.

Our study utilised the newly developed Affective Neuroscience State Scale (ANSS), along with other mood-relate measures, to measure self-reported affective states in four pre-existing groups, using an online survey. Participants included individuals who; (1) report having had COVID-19 and are currently experiencing Long COVID symptoms, (2) report having recovered from Long COVID, (3) had COVID-19 but no Long COVID symptoms, (4) report never having had COVID-19. Our study was consistent with previous literature, finding elevated levels of anxiety and depression in people with Long COVID. Additionally, it was found that Long COVID can be characterised by high RAGE, FEAR, PANIC, and GRIEF activation. However, positive social emotions such as SEEKING, PLAY, CARE, and LUST seem to be relatively spared. These results do seem to point to a unique emotional profile in Long COVID and could potentially lay the groundwork for future rehabilitation/treatment programs for Long COVID individuals.

Keywords: Post-COVID-19, Long COVID, Panksepp, affect, Basic/primary-emotion processing

Characterising Basic Emotions in Long COVID

'Long COVID' is a term describing the post-viral syndrome that many people experience after the acute phase of COVID-19 infection (Berenguera et al., 2021; Crispo et al., 2021; Roth & Gadebusch-Bondio, 2022; The Lancet, 2021). Several studies have established that long COVID is related to profound affective changes, most commonly characterised in terms of depression and anxiety (Fernández-de-las-Peñas et al., 2021; Mazza et al., 2020; Sanwald et al., 2022). Evidence suggests that these emotional issues may be the result of brain alterations, specifically in certain emotion-processing networks (Douaud et al., 2022; Najt et al., 2021). As a result, using the 'affective neuroscience' perspective that employs basic emotions to characterise emotional changes in Long COVID could provide important information about the extent of affective disturbances in Long COVID (Panksepp, 1982; Sanwald et al., 2022). Characterising affective symptoms of long COVID through this perspective has the potential to aid in our collective understanding of the syndrome.

Long COVID and its Symptoms

Since much about the post-COVID consequences remains unknown, there seems to be no agreed-upon definition for "Long COVID " (Berenguera et al., 2021; Roth & Gadebusch-Bondio, 2022). This term loosely refers to an array of symptoms that linger or emerge months after the initial onset of the acute stage of COVID-19 infection (Asadi-Pooya et al., 2022; Crispo et al., 2021; The Lancet, 2021). Long COVID is also associated with marked neurocognitive impairments such as ageusia, anosmia, extreme fatigue, dysexecutive issues, and affective symptoms (Barizien et al., 2021; Bungenberg et al., 2022; Krishnan et al., 2022; Raveendran et al., 2021). Long COVID sufferers also report a variety of mood disturbances (Bourmistrova et al., 2022; Mazza et al., 2020; Rogers et al., 2020). However, this is most often exclusively identified through psychometric assessments of anxiety, depression, and post-traumatic stress disorder (PTSD).

According to Mazza and colleagues (2020), of 402 long COVID patients, 28% had PTSD, 31% suffered from depression, 42% experienced anxiety, and 40% had insomnia. In addition, a meta-analysis by Rogers and colleagues (2020) revealed that studies reported similar prevalence rates for PTSD (32.2%) but differed in depression (14.9%) and anxiety (14.8%) rates. However, studies investigating the affective component of long COVID often use different diagnostic tools to measure affective change, which could explain the differences in the prevalence rates of these disorders (Bourmistrova et al., 2022). Nevertheless, the findings from the literature indicate that there do appear to be affective changes in long COVID patients, even if the prevalence of these changes is unclear.

Understanding Emotional Issues in Long COVID through Anxiety and Depression

Anxiety and depression are pertinent issues among long COVID patients. However, relying exclusively on the measurement of affect through the lens of clinical disorder limits our understanding of affective changes in Long Covid. For instance, "depression" refers to mood disorders characterised by a persistent feeling of sadness, loss of interest, fatigue, and a reduced ability to concentrate (American Psychiatric Association [APA], 2013). "Anxiety" is an umbrella term for disorders involving persistent feelings of fear, nervousness, apprehension, or worry, accompanied by the reduced ability to concentrate and process thoughts normally (APA, 2013). While these constructs are useful for establishing the prevalence of clinically relevant mood disturbances in long COVID, they cannot capture other potential types of affective changes that are less relevant to depression and anxiety. Thus, within the current literature, the evaluation of feelings in long COVID is limited in scope and curtails potential opportunities to describe the spectrum of emotional disturbances.

The idea that there could be a spectrum of emotional disturbance is supported by recent brain imaging studies that demonstrate that COVID-19 affects the primary emotional processing areas of the brain (Douaud et al., 2022). Najt and colleagues (2021) conducted a meta-analysis of brain imaging studies of COVID patients, which revealed significant abnormalities in the basal ganglia, cingulate gyrus, hippocampi, insula, amygdala, and the medial temporal lobe, among others. These affected brain regions are all part of the limbic system, which is the brain’s primary emotional processing area (Duerden et al., 2013; Panksepp, 1982, 2003). Corroborating these findings, a recent study from the University of Oxford discovered substantial decreases in the grey matter within the limbic system by comparing brain imaging before and after COVID-19 infection (Douaud et al., 2022). Furthermore, this study also found grey matter reductions in the orbitofrontal cortex, a component of the frontal region thought to be essential for emotional regulation.

These findings suggest that COVID-19 appears to be a neurotropic virus capable of infecting and altering the emotion-processing regions within the brain. Thus, exclusively using clinical constructs such as anxiety and depression will not capture the full spectrum of emotional changes.

Understanding the Emotional Symptoms of Long COVID using Panksepp's Taxonomy

An alternative approach to understanding the scope of emotional changes experienced by long COVID patients is through the lens of affective neuroscience, specifically Panksepp's taxonomy (Panksepp, 1982). Panksepp's affective taxonomy consists of seven primary-process (also referred to as basic) emotional systems associated with respective subcortical

brain networks, which were identified through direct brain-stimulation studies (Davis & Montag, 2019; Panksepp et al., 2011). These emotional systems include SEEKING, CARE, PLAY, and LUST on the positive side, FEAR, PANIC, GRIEF (previously termed SADNESS) and RAGE on the negative side (Davis & Montag, 2019; Panksepp, 1982, 2003).

Panksepp proposes that these emotions underpin mammals' survival instincts and cause global changes in arousal in response to the organism's needs (Davis & Montag, 2019; Panksepp, 1982, 2003). For instance, FEAR and RAGE are emotions that often trigger automatic reflex-like responses to alert us to potential threats in the environment. Of similar importance, LUST motivates us to reproduce, and SEEKING motivates us to search for resources (Davis & Montag, 2019). These are just a few instances illustrating the significance of basic emotion in mammals' survival, which enables us to survive in unpredictable environments (Panksepp, 1982, 2003).

These emotional systems have previously been used to understand psychiatric and affective disorders (Davis & Montag, 2019). Several studies argue that disorders such as depression and anxiety emerged from disturbances in the brain's PANIC/GRIEF, FEAR, and SEEKING systems (Davis & Montag, 2019; Fuchshuber et al., 2019). Anxiety disorders, for example, are thought to arise from persistent activation in PANIC/GRIEF neural circuits and inhibition of the SEEKING system (Fuchshuber et al., 2019; Panksepp et al., 2011). This activation and inhibition of these systems are associated with elevated amygdala activation and/or a corresponding inactivation of the prefrontal cortex (Panksepp et al., 2011; Sanwald et al., 2022). Similar evidence suggests that depression can be understood in terms of decreased SEEKING and increased FEAR and SADNESS when compared to healthy controls (Montag et al., 2017; Sanwald et al., 2022).

Panksepp's taxonomy has been used to develop psychometric tools such as the Affective Neuroscience Personality Scales (ANPS), which assesses individual differences in tendencies to experience the various emotions in various contexts (Davis & Panksepp, 2011; Davis et al., 2003). For instance, these scales have been useful in measuring emotion-based personality traits associated with conditions such as anxiety disorders, depressive disorders as well as a range of personality disorders (PD), namely schizoid, schizotypal, paranoid, borderline, narcissist, obsessive-compulsive, and avoidant and dependent PD, among others (Geir et al., 2014; Sanwald et al., 2021, 2022). Personality measures, such as the ANPS, provide useful insights into individual variances in emotional life, which may contribute to a better understanding of the etiology of clinical disorders (Sanwald et al., 2021).

Although investigating relationships between these emotion-based personality traits and Long COVID symptoms would be interesting, an instrument capable of measuring discrete affective states would better address the current gap in our understanding of the affective dimension of Long COVID. However, there is no literature on a validated tool of this nature to the best of our knowledge. The recently developed Affective Neuroscience State Scale (ANSS) seems to be the only scale based on Panksepp's Taxonomy, to our knowledge, that could measure discrete state emotions. However, the scale is currently in the final stages of development by Solms and colleagues, with ongoing studies underway to validate it in clinical and non-clinical populations. Overall, this review identified a gap within the current literature in terms of understanding the spectrum of emotional symptoms associated with long COVID from basic emotions or Panksepian perspective. Therefore, the aim of this study is to contribute to our understanding of Long COVID (LC) by characterising the range of affective states that Long COVID patients experience from a basic-emotions perspective. To do so, we have utilised a novel instrument, the ANSS, which measures subjective emotional states as conceptualised in Panksepp's basic emotion taxonomy (Panksepp, 1982).

Research Questions and Hypotheses

The main research questions in this study are "What are the basic emotional characteristics of Long COVID?" and "Can the ANSS offer additional information about the affective profile of Long COVID compared to the existing literature which focuses on depression and anxiety?" To address these overarching questions, three sub-questions were proposed, and their corresponding hypotheses are as follows:

1. Do individuals with Long COVID differ in their reported experiences of basic emotional states compared to the other control groups?
    a. The *Long COVID group* will score higher on the subscales measuring PANIC, GRIEF, and FEAR, and lower on the subscales for SEEKING, PLAY, CARE, RAGE, and LUST on the ANSS compared to other groups.
2. Do individuals with Long COVID differ in their report of overall negative and positive affect?
    a. The *Long COVID group* will score higher on the negative affect and lower on the positive affect compared to other groups.
3. Are the *Long COVID group's* anxiety and depression scores consistent with the literature?

a. Based on the literature, the *Long COVID group* will have higher depression scores compared to the other groups.
b. Based on the literature, the *Long COVID group* will have higher anxiety scores compared to the other groups.

Method

Design and Setting

This study forms part of a larger research initiative investigating the neuropsychological aspects of long COVID (HREC REF 482/2021). A quasi-experimental non-equivalent group design was employed as we were investigating four pre-existing groups. To ensure large-scale distribution, this study took place online. Additionally, Ethical approval was granted for all study procedures by the University of Cape Town (UCT) Department of Psychology Research Ethics Committee (reference: PSY2022-039; see Appendix A).

Participants

Participants were recruited via purposive and snowballing sampling using digital adverts (see Appendix B for adverts). Research email invitations were also published on the UCT's online Student Research Participation Programme (SRPP) site (see Appendix C). All participants were required to be between the ages of 18 and 65. To avoid a potential confounding impact of cognitive decline on affect, individuals over the age of 65 or with any prior diagnosis of cognitive or developmental impairment (such as variants of ADHD, ADD, autism, or FASD), central nervous system disease, evident neurological injury, or post-ICU neuropathy diseases were excluded from participation. In addition, participants were also excluded based on prescription medication for psychiatric conditions to account for pre-morbid disturbance in affect.

Group Assignment

Our study investigated four distinct, pre-existing groups. Participants were divided into their respective groups based on self-reported COVID-19 status. The groups were defined as follows:

1. *Long COVID group*: Those who reported having previously experienced a COVID-19 infection and are currently experiencing persisting symptoms associated with Long COVID.
2. *Recovered LC*: Those who reported having previously experienced a COVID-19 infection with persisting symptoms associated with Long COVID. However, reported no longer experiencing these symptoms at the time of this study.

3. *Only COVID*: Those who reported having previously experienced a COVID-19 infection, but no persisting symptoms related to Long COVID.
4. *No COVID*: Those who suspected never being infected with COVID-19, and never having had a positive COVID-19 diagnosis.

All participants who stated they had previously contracted COVID-19 (i.e., Groups 1-3) were required to specify the type of test (Polymerase Chain Reaction [PCR], antigen test, or other) they had undergone to confirm their diagnosis as well as their COVID -and if applicable, long COVID symptoms. As a result, out of the 741 participants we recruited, 62 were removed because they claimed they had COVID but had false-negative COVID-19 tests, as well as another 130 were removed because they thought they had COVID but never got tested. An additional seven participants were also excluded for answering the survey twice, and four for failing to meet the inclusion criteria. As a result, 538 participants—out of the original 741—were included in the final analysis, of whom 97 were *Long COVID* (18%), 104 were *Recovered LC* (19%), 145 *Only COVID* (27%), and 192 were *No COVID* (36%).

Materials and Measures

Affective Neuroscience State Scale (ANSS)

The ANSS is a self-report instrument recently developed by Solms and a panel of experts in the field of affective neuroscience and personality measurement. It is intended to measure the presence and intensity of Panskepp's basic emotions (Panksepp, 1982). The ANSS is divided into eight subscales, measuring positive (LUST, SEEKING, PLAY, CARE) and negative (ANGER, FEAR, GRIEF, PANIC) affective states. Each subscale consists of 5 descriptive words that capture each affective state. Using a 5-point Likert scale (1 to 5) participants are required to rate the extent to which they have experienced the specified feeling state over the past week (see Appendix D). Each subscale has its own total score, ranging from 5 to 25. Higher scores relate to a higher emotional state in that dimension. The ANSS is currently undergoing validation in a separate study, but the findings of the present study may contribute to this process.

The International Positive and Negative Affect Schedule Short Form (I-PANAS-SF)

The I-PANAS-SF (Appendix E) is a multi-item scale used to assess individuals' affective traits (Karim et al., 2011). This version was created for use in multicultural settings, with fewer ambiguities and opportunities for misinterpretation, and has been found to be a valid and reliable scale for such settings (Thompson, 2007). The measure is a 5-point Likert scale which has ten items, five of which measure Positive affect (PA) and five of which

measure negative affect (NA; Thompson, 2007; Watson et al., 1988). PA and NA scores range from 5 to 25, with higher scores indicating higher levels of PA/NA (Thompson, 2007).

Beck's Depression Inventory (BDI-II)

The *BDI-II* (Appendix F) was used to measure the severity of an individual's depressive symptoms (Beck et al., 1996). It consists of 21 items, each rated on a 4-point Likert scale, with total scores ranging between 0 and 63. The scores are as follows: minimal to no depression (0 - 13); mild to moderate depression (14 - 19); moderate to severe depression (20 - 28); and severe depression (29 - 63; Beck et al., 1996). The BDI-I and BDI-II have been used and validated in South African populations (Makhubela & Mashegoane, 2016; Saal et al., 2018).

Beck's Anxiety Inventory (BAI)

The *BAI* (Appendix G) was used to provide estimates of the severity of an individual's anxiety symptoms (Beck et al., 1988). The scale has 21 items on a 4-point Likert scale, with total scores ranging from 0 to 63. Cut-off scores are as follows: minimum anxiety (0 - 7), mild anxiety (8 - 15), moderate anxiety (16 - 25), and severe anxiety (26 - 63). The BAI has been used and validated in the South African context (Bantjes et al., 2019; Beck et al., 1988).

Biographic, demographic, and COVID characteristics

The biographic and demographic survey (Appendix H) was included to acquire information regarding participants' age, gender, level of education, home language, and estimated income. A series of COVID-related questions (Appendix I) were included to establish COVID-19 status for group assignment. If the participant reported having had COVID-19, they were asked follow-up questions regarding the test that was used to confirm COVID status. These participants were provided with a checklist of symptoms associated with Long COVID and then asked to indicate whether or not any of the symptoms persisted after recovery from their acute COVID-19 infection. Participants were further given an option to indicate whether any of these symptoms had resolved after a period of time.

Procedure

Data Collection

All data was gathered using two 20-minute online surveys administered by Sogolytics, a password-controlled platform that complies with the General Data Protection Regulation (GDPR) and was utilised in accordance with the Protection of Personal Information Act (POPIA). While each survey had its own advertisements (see Appendix B), links to both surveys were included in the electronic email invitations distributed to the UCT psychology students (see Appendix C). The first survey was designed for those who had

previously contracted COVID-19 (n = 355), whereas the second survey was for those who believed they had never contracted COVID-19 (n = 386).

Both surveys included a general overview of the study and required participants to complete an informed consent section (Appendix J) before gaining access to the rest of the questionnaire. UCT psychology students received one SRPP point upon completion. Both surveys ran from September 13th to October 6th, 2022. Thereafter, all participants were sent a debriefing email (see Appendix K) which thanked them for their time and provided a list of local mental health resources and the contact information of local Long COVID support groups.

Data Management and the Statistical Analysis

All data wrangling was performed using MSExcel, such group assignment and the removal of ineligible participants. Additionally, there were no missing data points due to forced-response formatting of online surveys. Each participant was assigned a code to ensure confidentiality. All responses were stored on a password-protected hard drive using 2-factor authentication, that only the researcher involved had access to.

The data was then exported to the statistical program RStudio version 4.1.2, where descriptive and inferential statistical analyses were conducted. All statistical analyses were conducted at a 95% confidence level ($\alpha = .05$). Normality and homogeneity of variance assumptions relevant to one-way analysis of variance (ANOVA) were investigated using the Shapiro-Wilk test of normality and Levene's test of homogeneity of variance. While ANOVA is robust to violations of normality, violations of homogeneity of variance can be more impactful (Schmider et al., 2010), In the case where homogeneity of variance assumptions were violated, we conducted non-parametric versions of the tests (i.e., Welch's ANOVA). Lastly, we estimated the effect sizes using eta-squared , and interpreted them as per the convention, small (d = 0.2), medium (d = 0.5), and large (d = 0.8; Cohen, 2014).

Descriptive statistics

Descriptive statistics were generated for all sample characteristics (See table 1), as well as the different groups based on the affective measures used (See Tables 2 - 4).

Investigating Sub-Question 1. To determine whether individuals with Long COVID differed in their reported experience of basic emotional states compared to the other groups, we conducted separate one-way ANOVA, comparing the between-group differences for the different subscales of the ANSS. Although the data violated the normality assumption for all subscales, the one-way ANOVA is robust to this type of violation. However, we conducted Welch's ANOVA for one of the subscales (FEAR) as the data for this subscale violated both

assumptions of normality and homogeneity of variance. Therefore, we conducted a total of seven one-way ANOVAs and one Welch's ANOVA.

Investigating Sub-Question 2. To determine whether individuals with Long COVID differ in their report of negative and positive affect compared to the other groups we conducted two separate one-way ANOVAs comparing the between-group differences for the total positive and total negative subscale of the I-PANAS-SF. The data did violate the normality assumption but not the homogeneity of variance assumption.

Investigating Sub-Question 3. To investigate whether anxiety and depression scores of the *LC group* are consistent with prevalence rates documented in the literature, we firstly conducted a one-way ANOVA comparing the between-group differences on the BDI total scores, as only the normality assumption was violated. Secondly, we conducted Welch's ANOVA comparing the between-group differences on the BAI total scores, as these violated both assumptions of the one-way ANOVA.

Results

Descriptive Statistics of the Sample

The *LC group* (n = 97) ranged between the ages of 18 to 60 years (M = 26.28, SD = 11.62), with 79 females in the sample (81%). Additionally, 70 participants within this group were undergraduates (72%). The *Recovered LC group* (n = 104) had an age range between 18 and 58 years (M = 23.87, SD = 8.81), from which 83 participants were female (80%) and 75 were undergraduate students (72%). The *Only COVID group* (n = 145) ranged between the ages of 18 to 62 years (M = 23.66, SD = 8.61), from this sample 112 participants were female (77%), and 118 were undergraduate students (81%). The *No COVID group* (n = 192) had an age range between 18 to 65 years (M = 21.83, SD = 5.96), with 162 participants from this sample being female (84%), and 165 (86%) were undergraduate students (See Table 1 for further details). All correlations between outcome variables can be viewed in Figure 13 - 15 in Appendix L.

Testing Sub-Question 1

Hypothesis 1a: Comparing Groups on their Total Scores for the Subscales of the ANSS

The one-way ANOVA for between-group differences in the SEEKING subscale showed there were differences between groups ($F(3, 534) = 3.60$, $p = .014$, $\eta 2 = .02$, MSerror = 15.93). Thus, post-hoc testing using the Tukey-Kramer test was conducted. This showed that there were differences between the *LC group* and the *Recovered LC groups* ($t = -3.16$, $p = .009$). The effect size was very small (Eta2 = .02, CI [0.00, 1.00]). None of the other groups showed any significant differences, as the between-group p-values were above .05. See

Figure 1, and Table 5 (in Appendix M) for more details. The findings therefore suggest that while SEEKING scores were lower in individuals reporting Long Covid compared to those who report having recovered from Long Covid, there did not appear to be any meaningful difference in SEEKING between Long Covid sufferers and control groups.

The one-way ANOVA for between-group differences in the PLAY subscale showed no that there were no statistically significant differences between the groups ($F(3, 534) = 2.22$, $p = .085$, $\eta 2 = .01$, MSerror = 17.74). This finding suggests that feeling of PALY were represented equally across all groups. No further analyses were conducted. See Figure 2 for more details.

The one-way ANOVA for between-group differences in the GRIEF subscale showed that there were statistically significant differences between the groups ($F(3, 534) = 4.84$, $p = .002$, $\eta 2 = .03$, MSerror = 22.17). Thus, post-hoc testing using the Tukey-Kramer test was conducted. This showed that there were differences between the *Long COVID group* and the no COVID group ($t = 3.45$, $p = .003$), and the *Long COVID group* and the *Only COVID group* ($t = 2.77$, $p = .03$), as well as the *Long COVID group* and the recovered from *Long COVID group* ($t = 3.31$, $p = .006$). However, none of the other groups showed any significant differences, as the between-group p-values were above .05. Additionally, the effect size was very small (Eta2 = .03, CI [0.01, 1.00]). See Figure 3, and Table 5 (in Appendix M) for more details. The findings here therefore suggest that individuals suffering from Long Covid experience significantly higher rates of GRIEF.

Table 1

Descriptive Statistics of the Sample based on Group (N = 538)

	Group			
Variable	Long COVID (LC) (*n* = 97)	Recovered LC (*n* = 104)	Only COVID (*n* = 145)	No COVID (*n* = 192)
Age (*M*, *SD*)	26.28 (11.62)	23.87 (8.81)	23.66 (8.61)	21.83 (5.96)
Students in undergrad (*f*, %)	70 (72%)	75 (72%)	118 (81%)	165 (86%)
Female (*f*, %)	79 (81%)	83 (80%)	112 (77%)	162 (84%)

Table 2

Descriptive Outcomes for Hypothesis 1a: ANSS (N = 538)

	Group			
ANSS Subscales	Long COVID (LC) (*n* = 97)	Recovered LC (*n* = 104)	Only COVID (*n* = 145)	No COVID (*n* = 192)
SEEKING (*M, SD)*	11.40(3.89)	13.18(4.21)	12.58(3.83)	12.67(4.04)
CI	[10.63-12.18]	[12.37-13.99]	[11.96-13.20]	[12.10-13.24]
PLAY (*M, SD*)	11.21 (4.33)	12.39 (4.38)	12.55 (4.30)	12.27 (3.99)
CI	[10.34- 12.07]	[11.55- 13.24]	[11.85- 13.25]	[11.70- 12.83]
GRIEF (*M, SD)*	12.41(4.73)	10.21(4.94)	10.70(4.87)	10.39(4.44)
CI	[11.47- 13.35]	[9.26- 11.16]	[9.91- 11.50]	[9.76- 11.02]
RAGE (*M, SD)*	11.84(4.74)	9.98(4.35)	10.07(4.33)	9.08(3.70)
CI	[10.89- 12.78]	[9.14- 10.82]	[9.36- 10.77]	[8.56- 9.61]
PANIC (*M, SD)*	15.01(5.20)	13.83(5.02)	12.75(4.97)	12.91(4.98)
CI	[13.98- 16.04]	[12.86- 14.79]	[11.94- 13.56]	[12.21- 13.62]
FEAR (*M, SD)*	9.71(4.68)	8.17(4.47)	7.63(3.46)	8.48(4.32)
CI	[8.78- 10.64]	[7.31- 9.03]	[7.06- 8.19]	[7.87- 9.09]
CARE (*M, SD)*	16.07(4.63)	16.08(4.18)	15.59(4.22)	15.83(4.65)
CI	[15.15- 16.99]	[15.27- 16.88]	[14.90- 16.27]	[15.17- 16.49]
LUST (*M, SD)*	10.56(5.14)	10.85(4.81)	10.92(4.95)	9.99(4.91)
CI	[9.53- 11.58]	[9.92- 11.77]	[10.11- 11.72]	[9.30- 10.69]

Note. **Confidence Intervals (CI) reported at 95%.**

Table 3

Descriptive Outcomes for Hypothesis 2a: I-PANAS-SF (N = 538)

	Group			
Variable	Long COVID (LC) (*n* = 97)	Recovered LC (*n* = 104)	Only COVID (*n* = 145)	No COVID (*n* = 192)
Positive (*M, SD*)	13.24(3.58)	13.99(3.87)	14.52(4.16)	14.47(4.14)
CI	[12.52-13.95]	[13.25-14.73]	[13.84-15.19]	[13.89-15.06]
Negative (*M, SD*)	11.74(3.72)	11.46(4.14)	10.77(3.65)	10.99(3.71)
CI	[11.00-12.48]	[10.67-12.26]	[10.18-11.37]	[10.47-11.52]

Note. **Positive = Positive total scores from the I-PANAS-SF; Negative = Negative total scores from the I-PANAS-SF; Confidence Intervals (CI) reported at 95%.**

Table 4

Descriptive Outcomes for Hypothesis 3a & : BDI and BAI (N = 538)

	Group			
Variable	Long COVID (LC) (*n* = 97)	Recovered LC (*n* = 104)	Only COVID (*n* = 145)	No COVID (*n* = 192)
BDI (*M, SD*)	20.57(10.86)	15.23(10.33)	13.01(10.06)	13.95(10.28)
CI	[18.41-22.73]	[13.25-17.22]	[11.37-14.64]	[12.49-15.40]
BAI (*M, SD*)	20.99(12.69)	16.18(12.43)	12.10(10.44)	12.12(10.49)
CI	[18.46-23.51]	[13.79-18.57]	[10.40-13.80]	[10.64-13.60]

Note. **BDI = Becks Depression Inventory; BAI = Becks Anxiety Inventory; Confidence Intervals (CI) reported at 95%.**

The one-way ANOVA for between-group differences in the RAGE subscale showed that there were statistically significant between-group differences ($F(3, 534) = 9.22$, $p < .001$, $\eta 2 = .05$, MSerror = 17.65). Post-hoc testing using the Tukey-Kramer test was conducted. This showed that there were differences between the Long COVID group and the no COVID group ($t = 5.26$, $p < .001$), and the Long COVID group and the only COVID group ($t = 3.20$, $p = .008$), as well as the Long COVID group and the recovered from Long COVID group ($t = 3.13$, $p = .010$). None of the other groups showed any significant differences, as the between-group p-values were above .05. The effect size was very small (Eta2 = .05, CI [0.02, 1.00]). See Figure 4, and Table 5 (in Appendix M) for more details. These suggest that the Long Covid reported significantly higher rates of RAGE compared to the other groups.

The one-way ANOVA for between-group differences in the PANIC subscale showed that there were statistically significant between-group differences ($F(3, 534) = 4.98$, $p = .002$, $\eta 2 = .03$, MSerror = 25.23). Post-hoc testing using the Tukey-Kramer test was conducted. This showed that there were differences between the Long COVID group and the no COVID group ($t = 3.36$, $p = .004$), and the Long COVID group and the only COVID group ($t = 3.43$, $p = .004$). However, none of the other groups showed any significant differences, as the between-group p-values were above .05. Additionally, the effect size was very small (Eta2 = .03, CI [0.01, 1.00]). See Figure 5, and Table 5 (in Appendix M) for more details. The findings here indicate that experiences of PANIC were more prevalent in the Covid sufferers

compared to control groups. However, it appears that rates of PANIC were similar between current Long COVID sufferers and those who report having recovered from Long COVID.

The one-way ANOVA for between-group differences in the CARE subscale showed that there were no statistically significant between-group differences ($F(3, 534) = 0.34$, $p = .794$, $\eta 2 < .01$, MSerror = 19.74). This suggests that all groups reported similar experiences of CARE. No further analyses were conducted. See Figure 6 for more details.

The one-way ANOVA for between-group differences in the LUST subscale showed no statistically significant between-group differences ($F(3, 534) = 1.19$, $p = .314$, $\eta 2 < .01$, MSerror = 24.45). This suggests that all groups reported similar experiences of LUST. No further analyses were conducted. See Figure 7 for more details.

The Welch's ANOVA for the between-group differences in the FEAR subscale showed that there were significant differences between the groups ($F(3, 254.47) = 4.88$, $p = .003$). We then conducted the Games-Howell post-hoc test, which showed that there were significant differences between the Long COVID and the only COVID group ($t = -2.08$, $p = 0.001$). No other between-group differences were significant as the p-values were above .05. See Figure 8, and Table 5 (in Appendix M) for more details.

Hypothesis 2a: Comparing Groups on their Total Scores for Negative and Positive Affect

A one-way ANOVA was performed, with group as the IV and positive affect on the I-PANAS-SF total scores as the DV. This analysis showed there were no differences between groups ($F(3, 534) = 2.57$, $p = .054$, $\eta^2 < .01$, MSerror = 15.97). This finding indicates that all groups reported similar rates of positive affect. No further analysis was done. See Figure 9 for more details.

A one-way ANOVA was performed, with group as the IV and negative affect on the I-PANAS-SF total scores as the DV. This analysis showed there were no differences between groups ($F(3, 534) = 1.62$, $p = .18$, $\eta^2 < .001$, MSerror = 14.3). This finding indicates that all groups reported similar rates of negative affect. No further analysis was done. See Figure 10 for more details.

Testing Sub-Question 2

Hypothesis 3a: Comparing Groups on BDI Total Scores

A one-way ANOVA was performed, with group as the independent variable (IV) and BDI total scores as the dependent variable (DV). This analysis showed there were differences between groups ($F(3, 534) = 11.83$, $p < .001$, $\eta 2 = .06$, MSerror = 106.84). Thus, the post-hoc Tukey-Kramer test was conducted, which showed that there were differences between the

Long COVID group and the no COVID group ($t = 5.14$, $p < .001$), and the Long COVID group and the only COVID group ($t = 5.58$, $p < .001$), as well as the Long COVID group and the recovered from Long COVID group ($t = 3.66$, $p = .001$). There was no difference between the other groups as the p-values were greater than .05. Additionally, the effect size was very small (Eta2 = .06, CI [0.03, 1.00]). These findings appear to indicate that depression rates were significantly higher in individuals suffering from Long Covid. See Figure 11, and Table 5 (in Appendix M) for more details.

Figure 1

Bargraph depicting SEEKING Scores by Group

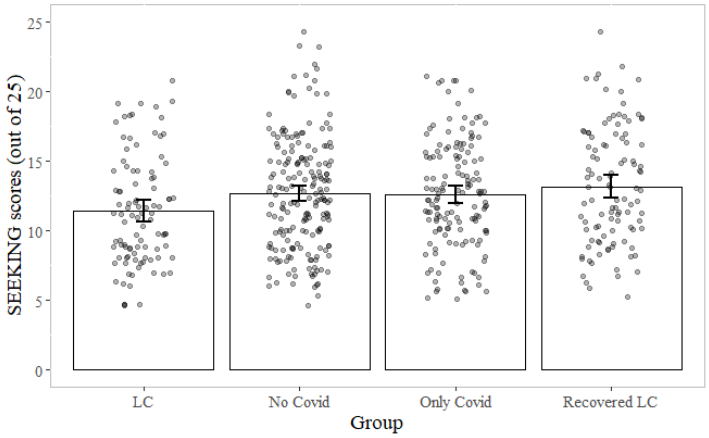


Figure 2

Bargraph depicting PLAY Scores by Group

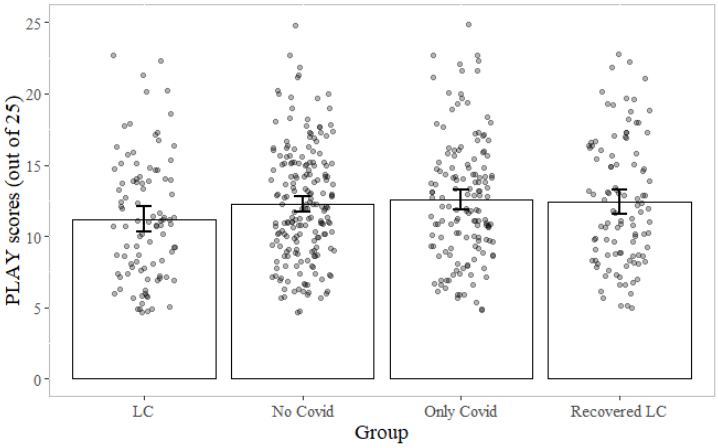


Figure 3

Bargraph depicting GRIEF Scores by Group

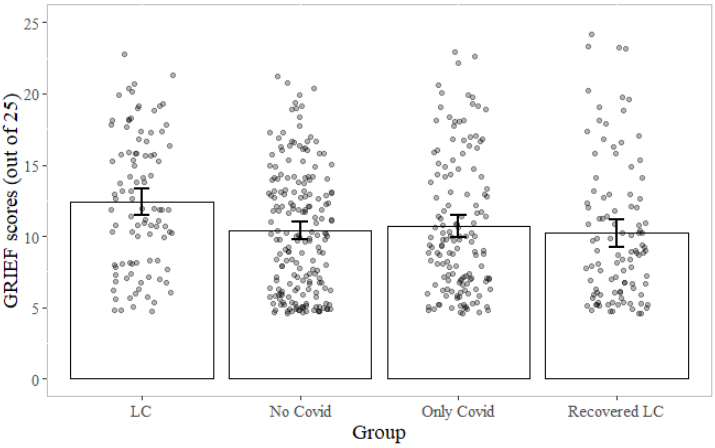


Figure 4

Bargraph depicting RAGE Scores by Group

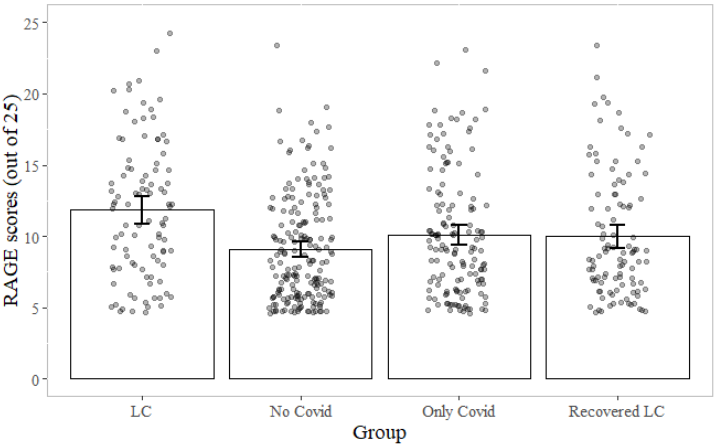


Figure 5

Bargraph depicting PANIC Scores by Group

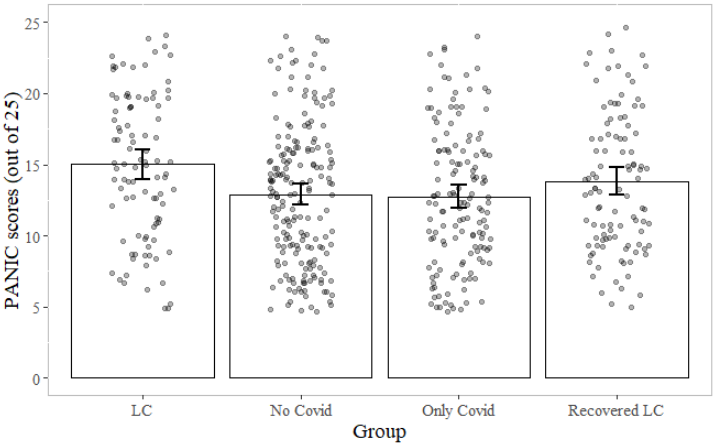


Figure 6

Bargraph depicting CARE Scores by Group

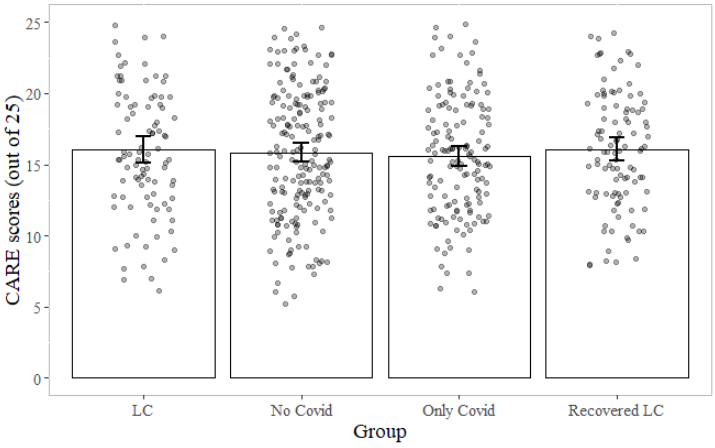


Figure 7

Bargraph depicting LUST Scores by Group

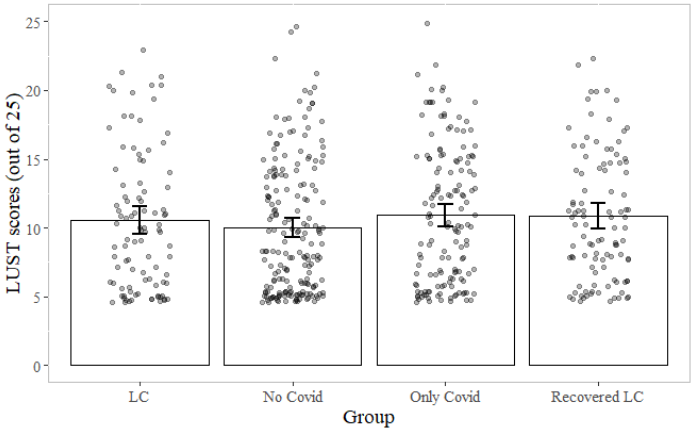


Figure 8

Bargraph depicting FEAR Scores by Group

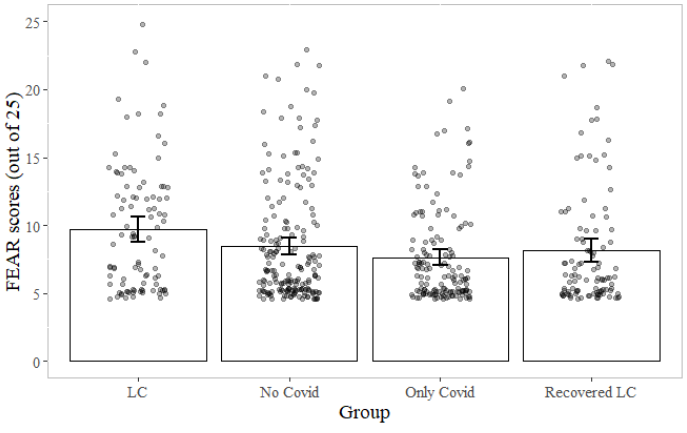


Figure 9

Bargraph depicting I-PANAS Positive Scores by Group

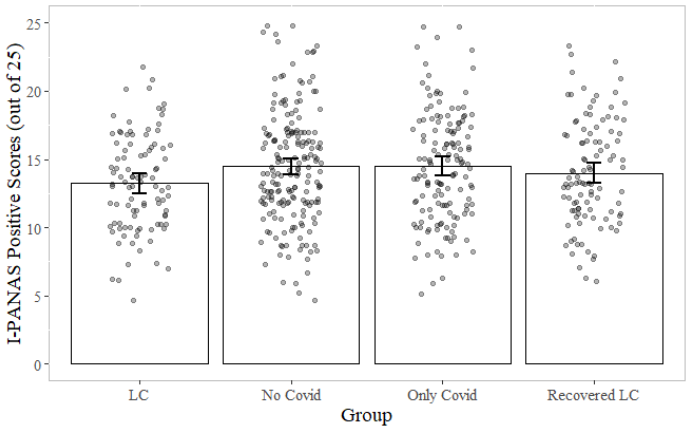


Figure 10

Bargraph depicting I-PANAS Negative Scores by Group

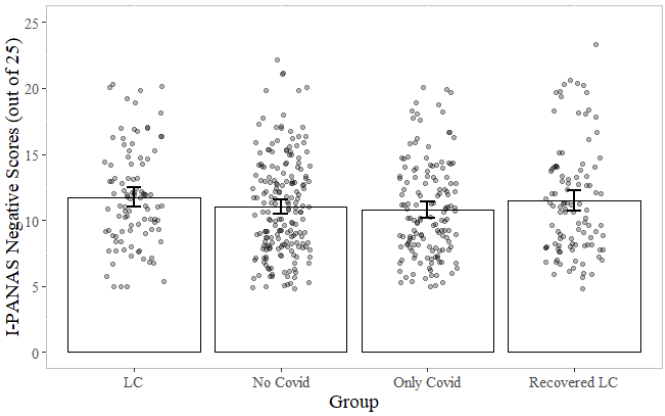


Figure 11

Bargraph depicting BDI Scores by Group

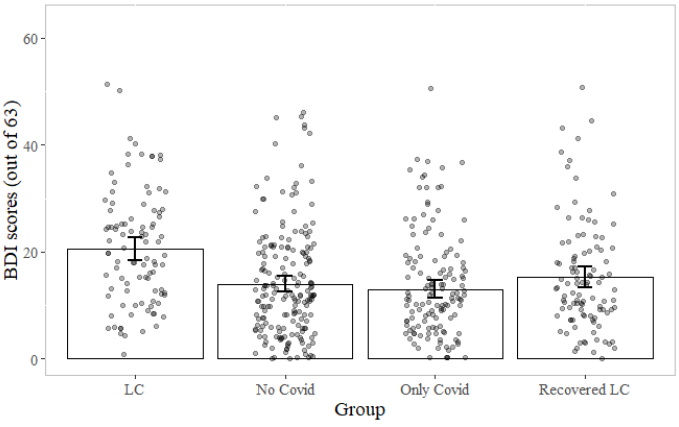
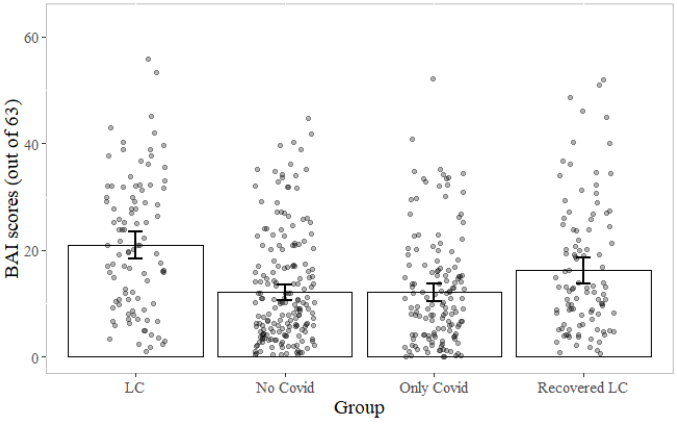


Figure 12

Bargraph depicting BAI Scores by Group



Testing Sub-Question 3

Hypothesis 3b: Comparing Groups on BAI Total Scores

The Welch's ANOVA for the between-group differences in the BAI total scores showed that there were significant differences between the groups ($F(3, 251.34) = 14.47$, $p < .001$). We then conducted the Games-Howell post-hoc test, which showed that there were significant differences between the Long COVID and the no COVID groups ($t = -8.87$, $p < .001$), and between the Long COVID and only COVID groups ($t = -8.89$, $p < 0.001$), as well as between the Long COVID and the recovered from Long COVID groups ($t = -4.81$, $p = .036$). Additionally, there were significant between group differences between the no COVID and the recovered from Long COVID groups ($t = 4.06$, $p = .026$), and the only COVID and the recovered from Long COVID groups ($t = 4.09$, $p = .034$). Lastly there was no significant difference between the no COVID and Only COVID groups ($t = -0.02$, $p = .999$). See Figure 12, and Table 5 (in Appendix M) for more details.

Discussion

It is clear that there are affective changes in the Long COVID population, with increasing rates of anxiety and depression reported (). However, evaluating affect through the lens of anxiety and depression may not adequately capture the overall affective change of Long COVID patients. Consequently, the aim of this study was to understand the affective changes in Long COVID through a Basic Emotions perspective.

Firstly, we predicted that the *LC group* would score higher on the ANSS subscales measuring PANIC, GRIEF, and FEAR, and lower on the subscales for SEEKING, PLAY, CARE, RAGE, and LUST compared to other groups. Secondly, we predicted that the *LC group* would score higher in comparison to other groups, on overall negative affect and lower on overall positive affect, as measured by the I-PANAS-SF. Third, we predicted that the *LC group* would have higher depression scores, as measured by the BDI, in comparison to the other groups (Rogers et al., 2020; Mazza at al., 2020). Fourth, we predicted that the *LC group* would have higher anxiety scores, as measured by the BAI, compared to the other groups (Rogers et al., 2020; Mazza at al., 2020).

Our first hypothesis was partially confirmed. Our study discovered that certain basic emotions were higher in the *LC group* than in the *Only COVID* and *No COVID* groups. These emotions included GRIEF, PANIC, FEAR, and RAGE, which are frequently characterized as representing more internalized emotions associated with depression and anxiety. In contrast, the *LC group's* scores on more social basic emotions such as SEEKING, PLAY, CARE, and LUST did not differ significantly from the other groups. We also found no statistically

significant differences between-group differences in the positive or negative subscale of the I-PANAS-SF. The *LC group* did, however, score much higher on both the BDI and the BAI than did the other groups.

Our findings confirm aspects of the international literature on Long COVID and reveals nuanced ways in which emotional changes in long covid might not be fully captured by focusing just on anxiety and depression.

As expected, our findings were in line with literature indicating that individuals with Long COVID present with higher levels of anxiety (Rogers et al., 2020; Mazza at al., 2020). Anxiety is typically characterised as an extreme and persisting activation of the PANIC/GRIEF systems and the inhibition of the SEEKING system (Davis & Montag, 2019; Fuchshuber et al. 2019). Our ANSS results were partially consistent with this view of anxiety, as we found that there were higher activations of the PANIC and GRIEF systems in individuals with Long COVID.

Notably, although the *LC group* in our study had the lowest average in SEEKING, this was not statistically significant when compared to the groups who never experienced Long COVID symptoms. This suggests that the higher reported rates of anxiety are indicative of changes within the PANIC and GRIEF systems, but not in the SEEKING System. This may provide support that Long COVID anxiety does not seem to have the same aetiology as anxiety disorders, as their SEEKING system seems intact in comparison to other groups. Alternatives to Long COVID individuals with clinical anxiety include potential biological reasons for this particular mood change, such anomalies in the limbic system discovered in brain imaging studies (Douaud et al., 2022).

Our study also corroborated literature reporting that Long COVID is associated with high levels on the BDI (). From a basic emotions perspective, depression has been characterised by high activation of the FEAR, GRIEF, and RAGE systems and low activation of the PLAY and SEEKING system (Brienza et al., 2022). In our analysis, the *LC group* had the highest scores in FEAR, GRIEF, and RAGE subscales, which were statistically significant from the other groups. Although the *LC group* scored lowest in both PLAY and SEEKING, there was no statistically significant difference when compared to the *No Covid* and *Only COVID group*. Similar to anxiety, this suggests that the depressive symptoms related to Long COVID may not present the same as depressive disorders.

Despite having high scores on depression and anxiety measures, the *LC group's* performance on the ANSS suggest that their affective presentation is not entirely consistent with how depression and anxiety is thought to present from a basic emotion's perspective.

Depression and anxiety are often related to reduced social contact and withdrawal, which would be seen as a reduction in systems such as SEEKING, PLAY, and CARE, which was not observed in this study. This suggests that the emotional profile associated with Long COVID may be more complicated than simply a depression and anxiety picture. While participants may be presenting with similar symptoms related to anxiety and depression, the emotional experience of Long COVID may be better explained through the interaction between basic emotional systems. Additionally, using the basic emotions perspective allows us to differentiate the unique emotional experience of Long COVID from a clinically approach which many people may experience as stigmatising (Roth & Gadebusch-Bondio, 2022).

It is of note that on the BAI, the *Recovered LC group* scored lower than the Long covid group on average, yet still higher than the *No Covid* and *Only COVID* groups. They showed similar performance on the BDI, again scoring lower than the *LC group*, but higher than the other groups. This can be interpreted to suggest that that the past experience of long COVID still leaves individuals more vulnerable to increased anxiety and depressive reactions. An organic aetiology of this is supported by research demonstrating that the immune system is affected to some degree as a result of COVID-19 infection (Berkenbosch et al., 1987), and potentially triggering a cascade of biological changes that could induce elevated symptoms of anxiety and depression. However, this might be attributed to the stressor of having Long COVID for a long period of time, as well as the fear of reinfection or relapse, among other things.

Analysis of the SEEKING system scale performance also may yield support for the idea that Long Covid sufferers are experiencing a general dampening of their central arousal system. Firstly, we found that the *Recovered LC group* had statistically higher scores in SEEKING than the *LC group*. This suggests that Long COVID might be associated with an inhibited SEEKING system. Therefore, we might infer that the elevation of corticotropin releasing factor may be quite strongly responsible for the changes in mood in individuals with Long Covid (CRF; Berkenbosch et al., 1987; Sapolsky et al., 1987).This makes sense because "sickness behavior" and the immunological response are both consistent with illness-induced cytokine response, which is associated to upregulation of CRF and a general dampening of the central arousal (dopaminergic) system. This can be observed by the fact that the *LC group* had the lowest average SEEKING score. However, it is important to note that our findings are tentative and there may be sampling biases at play.

In light of the significant difference in anxiety and depression scales, it is surprising that we did not observe a similar pattern in the positive and negative affect (PA and NA, respectively) of the I-PANAS-SF. While our findings demonstrate strong positive correlations between the negative emotions of the I-PANAS-SF and both BDI and BAI, the I-I-PANAS-SF result does not reflect the overall pattern of the *LC group* scoring significantly and substantially higher than the other groups on the BDI and BAI. This could reflect how depression and anxiety may not fully capture the emotional experience of Long COVID patients. It could also show how the affective changes of long covid are not necessarily presenting like depression and anxiety, despite high values on depression anxiety scales.

Studies evaluating the positive and negative emotions experienced in daily life have found the I-PANAS-SF to be helpful (Meimann, 2016). Our research suggests that it is also possible that describing the emotional components of positive and negative emotions in general may not capture the specifics of their emotional profile. As a result, the changes in emotional disturbances we are observing cannot be generalized to Positive and Negative Affect, as determined by the I-PANAS-SF.

A further addition to the emotional profile of Long COVID is the addition that the *LC group* experienced high levels of RAGE in our study. The *LC group* had a higher mean score on RAGE compared to all other groups and was statistically significant. This suggests that RAGE is unquestionably a key component of Long COVID 's emotional experience. However, it is not apparent if the RAGE experience in Long COVID is connected to a neurobiological change or if it is a psychological response to experiencing sickness, loss, or having a chronic condition with no known cure (Zalcman & Siegel, 2006).

Lastly, our findings indicate the *LC group* had no significant difference on the PLAY, CARE, and LUST systems compared to other groups. Although these results were contradictory to our hypothesis, they added an important dimension to the affective profile of Long COVID. The commonality between PLAY, CARE and LUST are that they are strong positive social emotions (). These positive social emotions are interconnected in the motivations for interpersonal relationships.

These findings display the major difference between the depression associated with Long COVID and clinical depression, as it is common for clinically depressed individuals to withdraw from social activities (Sanwald et. al., 2022). This is why we originally hypothesized that these systems would be lower in individuals with Long COVID, as we would expect them to be lower in depressed individuals (Rogers et al., 2020). Therefore, this does seem to show why it is important to explore the affective changes in Long COVID from

a more nuanced perspective, as it seems that Long COVID does not affect the positive social emotions (i.e., PLAY, CARE and LUST).

While this study is largely consistent with the literature that showed increases in anxiety and depression, we are able to provide a more detailed description of the affective changes that are experienced by individuals with Long COVID. By exploring the affective changes through a basic emotions' perspective, using the ANSS, we were able to construct a unique emotional profile of affective changes in Long COVID. What this study found is that Long COVID seems to be characterised by increases in the FEAR, PANIC, GRIEF, and RAGE systems, while the social emotions such as PLAY, CARE, and LUST seem to be unaffected. Because the study may have been impacted by sample bias, evaluating the SEEKING method was more challenging. However, by utilizing the social emotions that were spared to strengthen the individuals' social support networks, which may act as a buffer against the consequences of the other emotional disturbances. Therefore, these results might be used to assist people with Long COVID in rehabilitation settings.

Limitations and Recommendations for Future Research

This study has several limitations in relation to sample characteristics. Firstly, our sample comprised 81% females and 80% undergraduate psychology students. This is because due to feasibility and time constraints, we were forced to recruit the majority of our sample via UCT SRPP site. Future studies should control these variables as it is known that females are more likely to get COVID-19, and university students are more likely to report higher anxiety and depressive symptoms compared to other populations.

Secondly, our group assignment was based on self-reported COVID-status. However, in order to control for this, all participants who reported previously COVID-19 infection were required to specify the type of test (PCR, antigen test, or other) they had undergone to confirm their diagnosis. They were then assigned to their respective groups (i.e., Only *COVID, LC, Recovered LC*) based on reported symptoms presentation. Future studies should control for COVID-19 infection status directly by performing antigen tests on the sample.

Furthermore, this study relied primarily on self-reported measures (BDI, BAI, I-PANAS-SF, and ANSS). The requirement for self-report measures arises from the fact that emotions are inherently subjective. Future studies could be strengthened by the addition of biomarker measurements.

Lastly, the ANSS is a newly developed measure that has yet to be validated. However, it is currently undergoing validation in a separate study but the findings here will contribute to this process.

Significance

This study has attempted to aid in the description of affective changes that occur in Long COVID by creating a unique emotional profile for individuals with Long COVID. Further, this profile grounds subjective mood changes in brain neurobiology by using the basic emotions perspective (Panksepp et al., 2011). Second, it enables a comprehensive and nuanced description of affective experience that could be useful in designing personalised rehabilitation programmes that harness the spared social emotions (Panksepp et al., 2011). Further, these results can be used to contextualise the findings of brain imaging studies to provide a broader understanding of affective symptoms of long COVID, which has been lacking in current research.

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Appendix A

Ethical Approval

UNIVERSITY OF CAPE TOWN

Department of Psychology

University of Cape Town Rondebosch 7701 South Africa
Telephone (021) 650 3417
Fax No. (021) 650 4104

21 September 2022

Aaniyah Anthony and Luca Schuler
Department of Psychology
University of Cape Town
Rondebosch 7701

Dear Aaniyah and Luca

I am pleased to inform you that ethical clearance has been given by an Ethics Review Committee of the Faculty of Humanities for your study, *Characterising Basic Emotions in Long COVID*. The reference number is PSY2022-039.

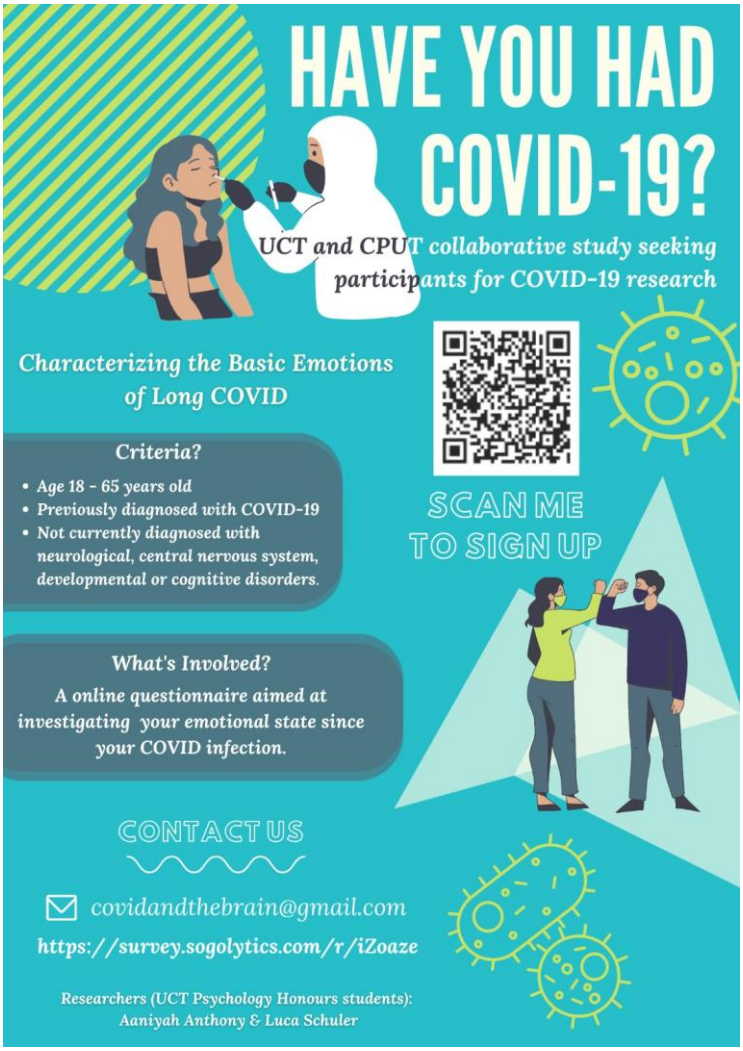
I wish you all the best for your study.

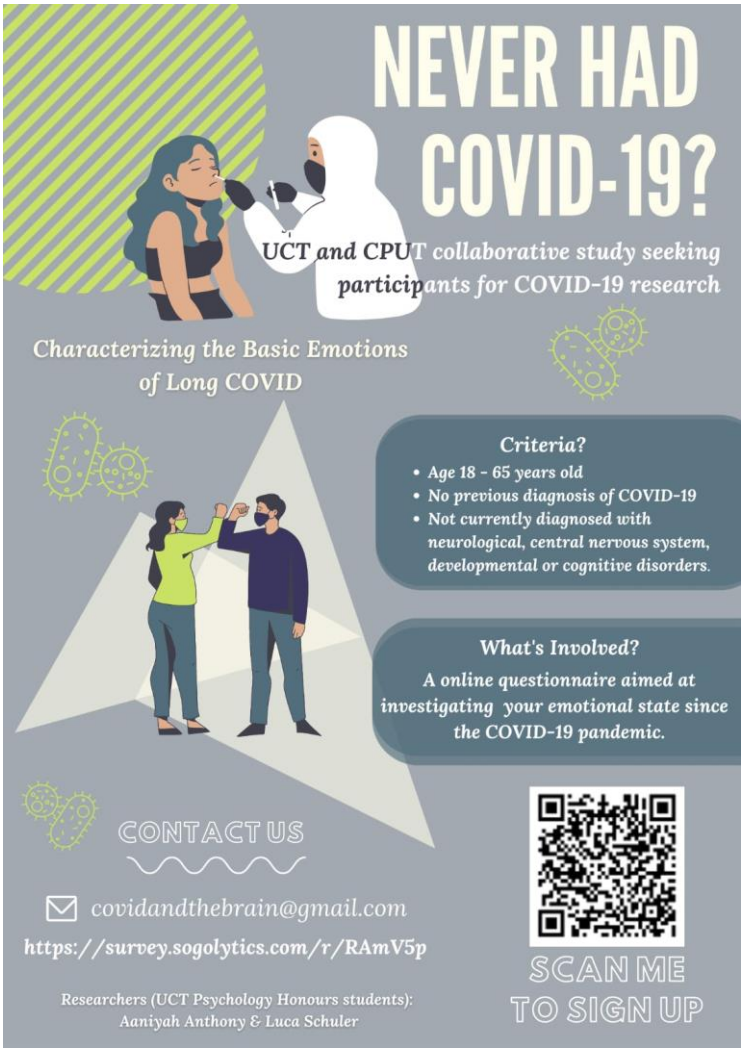
Yours sincerely

Lauren Wild (PhD)
Associate Professor
Chair: Ethics Review Committee

Appendix B

Adverts for Study





Appendix C

Email Invitation for SRPP

Title: EARN 1 SRPP POINT – Characterising Basic Emotions in Long COVID

Dear UCT Students,

We would like to invite you to participate in a voluntary study about the long-term effects of the COVID-19 virus. This study aims to investigate the emotional aspects of long COVID. **However, you do not need to have had COVID-19 to participate!**

The survey should take a maximum of **20 minutes** to complete, and it is likely you will finish far sooner. You will earn **1 SRPP point** for your participation in the study. Please only complete the questionnaire once.

Who can participate in this study?

Anyone who is:

- Between the ages of 18 and 65 years old.
- Not currently diagnosed with neurological disorders, central nervous system disorders, developmental disorders or cognitive disorders. Examples of such diagnoses include but are not limited to a diagnosis of: ADHD, dementia, brain damage (caused either by a stroke or a traumatic head injury), intellectual disabilities, autism, a recent diagnosis of Major Depressive Disorder, foetal alcohol syndrome, or epilepsy.

Participation is voluntary and may be withdrawn at any time before and during the questionnaire without having to state a reason, without any prejudice or any other consequence. All the data will be kept strictly confidential. Participants will not be identified by name or other identifier.

Survey Links

If you **had COVID-19**, please follow the link below:

https://survey.sogolytics.com/r/iZoaze

If you think you **have NOT had COVID-19**, please follow the link below:
https://survey.sogolytics.com/r/RAmV5p

If you are experiencing any distress while answering the questionnaire, please contact the researchers at the email addresses listed below:

Researchers:
Aaniyah Anthony antaan001@myuct.ac.za
Luca Schuler schluc008@myuct.ac.za

Supervisor:
Donné Minné donneminne.za@gmail.com
Altay Turan trnalt001@myuct.ac.za

This study has been approved by the UCT Psychology Research Ethics Committee as well as the faculty of Health Science Ethics Committee.

Thank you for your time.
Your participation will be appreciated.
Sincerely,
Aaniyah Anthony – Researcher Hons Psychology
Luca Schuler – Researcher Hons Psychology
Altay Yüce Turan – Researcher and Candidate Neuropsychologist at UCT
Donné Minné – Researcher and HPCSA Registered Neuropsychologist

Mental Health Referral sources

If you are needing a referral to a psychologist, psychiatrist or support group, we encourage you to call The South African Depression and Anxiety Group (SADAG) on 011 234 4837 or 0800 20 50 26 and speak to a trained counsellor who can assist you further. Or alternatively email Zane on zane@sadag.org
You are also encouraged to email one of the Principal Investigators in this study, Dr Donné Minné, who is a registered neuropsychologist with the HPCSA and who will be able to provide you with a consultation should you be requiring one.
Donneminne.za@gmail.com

(PS 0150380)

We would also like to draw your attention to a number of other mental health support resources available to you:

Dr Reddy's Help Line

0800 21 22 23

Cipla 24hr Mental Health Helpline

0800 456 789

Pharmadynamics Police &Trauma Line

0800 20 50 26

Adcock Ingram Depression and Anxiety Helpline

0800 70 80 90

ADHD Helpline

0800 55 44 33

Department of Social Development Substance Abuse Line 24hr helpline

0800 12 13 14

SMS 32312

Suicide Crisis Line

0800 567 567

SADAG Mental Health Line

011 234 4837

Akeso Psychiatric Response Unit 24 Hour

0861 435 787

Cipla Whatsapp Chat Line

(9am-4pm, 7 days a week)

076 882 2775

24 hour Healthcare Workers Care Network Helpline

0800 21 21 21

SMS 43001

NPOWERSA Helpline

0800 515 515

SMS 43010

For affordable counselling, please contact the Counselling Hub

021 462-3902 (landline) or 067 235-0019 (mobile)

For non-appointment enquiries please email info@counsellinghub.org.za

Appendix D

Affective Neuroscience State Scale

Indicate the extent you have felt this way over the **PAST WEEK.**

(a)Energetic --Select--

(b)Playful --Select--

(c)Blue --Select--

(d)Irritable --Select--

(e)Panicky --Select--

(f)Fearful of harm --Select--

(g)Caring --Select--

(h)Lustful --Select--

(i)Inquisitive --Select--

(j)Competitive --Select--

(k)Sad --Select--

(l)Aggressive --Select--

(m)Worried --Select--

(n)Afraid of danger --Select--

(o)Compassionate --Select--

(p)Erotic --Select--

(q)Optimistic --Select--

(r)Fun-loving --Select--

(s)Depressed --Select--

(t)Short-tempered --Select--

(u)Unsettled --Select--

(v)Physically threatened --Select--

(w)Kind --Select--

(x)Seductive --Select--

(y)Motivated --Select--

(z)Jolly --Select--

(aa)Hopeless --Select--

(ab)Intolerant --Select--

(ac)Insecure --Select--

(ad)Scared for my safety --Select--

(ae)Nurturing --Select--

(af)Turned-on --Select--

(ag)Eager --Select--

(ah)Ready for a game --Select--

(ai)Despairing --Select--

(aj)Angry --Select--

(ak)Anxious --Select--

(al)Frightened --Select--

(am)Empathetic --Select--

(an)Sexually aroused --Select--

Appendix E

The International Positive and Negative Affect Schedule Short Form (I-PANAS-SF) Question, Measure, and Item Order (adapted from Thompson, 2007)

38. Thinking about yourself and how you've felt over the past week, to what extent do you generally feel the following? Rate it on a scale from 1 to 5, where 1 represents never, and 5 always

* (a) Upset	--Select--
* (b) Hostile	--Select--
* (c) Alert	--Select--
* (d) Ashamed	--Select--
* (e) Inspired	--Select--
* (f) Nervous	--Select--
* (g) Determined	--Select--
* (h) Attentive	--Select--
* (i) Afraid	--Select--
* (j) Active	--Select--

Appendix F

Beck Depression Inventory-2 (adapted from Beck et al., 1996)

This questionnaire has 21 groups of statements. Please read each statement carefully, before selecting out the one statement in each group which most appropriately describes the way you've felt over the past two weeks, including today. If multiple statements apply to your experience, pick the one that has the highest number in the relevant group. Do not choose multiple answers for any group, including item 16 (sleep pattern changes), or item 18 (Changes in Appetite).

16. Sadness

- 0. I do not feel sad.
- 1. I feel sad much of the time.
- 2. I am sad all the time.
- 3. I am so sad or unhappy that I can't stand it.

17. Pessimism

- 0. I am not discouraged about my future.
- 1. I feel more discouraged about my future than I used to.
- 2. I do not expect things to work out for me.
- 3. I feel my future is hopeless and will only get worse.

18. Past Failure

- 0. I do not feel like a failure.
- 1. I have failed more than I should have.
- 2. As I look back, I see a lot of failures.
- 3. I feel I am a total failure as a person.

19. Loss of Pleasure

- 0. I get as much pleasure as I ever did from the things I enjoy.
- 1. I don't enjoy things as much as I used to.
- 2. I get very little pleasure from the things I used to enjoy.
- 3. I can't get any pleasure from the things I used to enjoy.

20. Guilty Feelings

- 0. I don't feel particularly guilty.
- 1. I feel guilty over many things I have done or should have done.
- 2. I feel quite guilty most of the time.
- 3. I feel guilty all of the time.

21. Punishment Feelings

- 0. I don't feel I am being punished.
- 1. I feel I may be punished.
- 2. I expect to be punished.
- 3. I feel I am being punished.

22. Self-Dislike

- 0. I feel the same about myself as ever.
- 1. I have lost confidence in myself.
- 2. I am disappointed in myself.
- 3. I dislike myself.

23. Self-Criticalness

- 0. I don't criticise or blame myself more than usual.
- 1. I am more critical of myself than I used to be.
- 2. I criticise myself for all my faults.
- 3. I blame myself for everything bad that happens.

24. Suicidal Thoughts or Wishes

- 0. I don't have any thoughts of killing myself.
- 1. I have thoughts of killing myself, but I would never carry them out.
- 2. I would like to kill myself.
- 3. I would kill myself if I had the chance.

25. Crying

- 0. I don't cry any more than I used to.
- 1. I cry more than I used to.
- 2. I cry over every little thing.
- 3. I feel like crying, but I can't.

26. Agitation

- 0. I am no more restless or wound up than usual.
- 1. I feel more restless or wound up than usual.
- 2. I am so restless or agitated, it's hard to stay still.
- 3. I am so restless or agitated that I have to keep moving or doing something.

27. Loss of Interest

- 0. I have not lost interest in other people or activities.
- 1. I am less interested in other people or things than before.
- 2. I have lost most of my interest in other people or things.
- 3. It's hard to get interested in anything.

28. Indecisiveness

- 0. I make decisions about as well as ever.
- 1. I find it more difficult to make decisions than usual.
- 2. I have much greater difficulty in making decisions than I used to.
- 3. I have trouble making any decisions.

29. Worthlessness

- 0. I do not feel I am worthless.
- 1. I don't consider myself as worthwhile and useful as I used to.
- 2. I feel more worthless as compared to others.
- 3. I feel utterly worthless.

30. Loss of Energy

- 0. I have as much energy as ever.
- 1. I have less energy than I used to have.
- 2. I don't have enough energy to do very much.
- 3. I don't have enough energy to do anything.

31. Changes in Sleeping Pattern

- 0. I have not experienced any change in my sleeping.

- 1a. I sleep somewhat more than usual.
- 1b. I sleep somewhat less than usual.
- 2a. I sleep a lot more than usual.
- 2b. I sleep a lot less than usual.
- 3a. I sleep most of the day.
- 3b. I wake up 1-2 hours early and can't get back to sleep.

32. Irritability

- 0. I am not more irritable than usual.
- 1. I am more irritable than usual.
- 2. I am much more irritable than usual.
- 3. I am irritable all the time.

33. Changes in Appetite

- 0. I have not experienced any change in my appetite.
- 1a. My appetite is somewhat less than usual.
- 1b. My appetite is somewhat greater than usual.
- 2a. My appetite is much less than before.
- 2b. My appetite is much greater than usual.
- 3a. I have no appetite at all.
- 3b. I crave food all the time.

34. Concentration Difficulty

- 0. I can concentrate as well as ever.
- 1. I can't concentrate as well as usual.
- 2. It's hard to keep my mind on anything for very long.
- 3. I find I can't concentrate on anything.

35. Tiredness or Fatigue

- 0. I am no more tired or fatigued than usual.
- 1. I get more tired or fatigued more easily than usual.
- 2. I am too tired or fatigued to do a lot of the things I used to do.
- 3. I am too tired or fatigued to do most of the things I used to do.

36. Loss of Interest in Sex

- 0. I have not noticed any recent change in my interest in sex.
- 1. I am less interested in sex than I used to be.
- 2. I am much less interested in sex now.
- 3. I have lost interest in sex completely.

Appendix G

Beck Anxiety Inventory (adapted from Beck et al., 1988)

37. This questionnaire is designed to measure how you've been feeling over the past week, including today. Please rate how much you have been bothered by each symptom, on a 4-point scale where 0 represents *Not at all,* to 3 representing, *Severely -I could barely stand it.*

	0 (Not at all)	1 (mildly but it didn't bother me much)	2 (Moderately, it wasn't pleasant at times)	3 (Severely, I could barely stand it)
* (a) Numbness or tingling	○	○	○	○
* (b) Hands trembling	○	○	○	○
* (c) Feeling hot	○	○	○	○
* (d) Shaky	○	○	○	○
* (e) Wobbliness in legs	○	○	○	○
* (f) Fear of losing control	○	○	○	○
* (g) Unable to relax	○	○	○	○
* (h) Difficulty breathing	○	○	○	○
* (i) Fear of the worst happening	○	○	○	○
* (j) Fear of dying	○	○	○	○
* (k) Dizzy or lightheaded	○	○	○	○

*(l) Scared	○	○	○	○
*(m) Heart pounding or racing	○	○	○	○
*(n) Indigestion or discomfort in abdomen	○	○	○	○
*(o) Unsteady	○	○	○	○
*(p) Faint	○	○	○	○
*(q) Terrified	○	○	○	○
*(r) Flushed	○	○	○	○
*(s) Nervous	○	○	○	○
*(t) Sweating (not due to heat)	○	○	○	○
*(u) Feelings of choking	○	○	○	○

Appendix H

Biographic and Demographic Questionnaire

Biographic Information

4. What is your full (legal) name? (First name(s) Surname)

Characters Remaining: 100

5. What is your student number, if applicable? (Necessary for UCT SRPP)

Characters Remaining: 100

6. What is your phone number?

Characters Remaining: 100

7. What is your email address?

Characters Remaining: 100

8. Are you currently taking any of the following medications? (Check all that apply)

- ☐ I am not taking any medication
- ☐ Antidepressants (e.g. Zoloft, Prozac, Sarafem, Celexa, Paxil, Brisdelle, Pexeva, Lexapro, Luvox, Viibryd)
- ☐ Anti-anxiety medication (e.g. Alzam, Azor, Xanax, Zopax, Lexotan)
- ☐ Allergy medication (e.g. antihistamines)
- ☐ Blood pressure medication
- ☐ Other (Please specify)

NEXT PAGE

Demographic Information

This section of the questionnaire records some important demographic information - please answer to the best of your ability. All data is strictly confidential.

9.How old are you?

Characters Remaining: 100

10.Which of the following best describes your gender?

--Select–

Options: Female, Male, Non-Binary, unlisted -please specify

11.What level of education have you received? (Choose the highest level you have received)

- Preparatory School (Grades 1-7)
- High School (Grades 8-12)
- Completed or enrolled for an undergraduate degree
- Completed or enrolled for a postgraduate degree
- Technical course or diploma equivalent

12.Are you currently employed?

- Yes
- No

13.What area do you live in? (City or Town)

Characters Remaining: 100

14.What is your estimated monthly household income?

- R0 - R1600
- R1600 - R7500
- R7500 - R17000
- R17000 - R30000

- R30000 - R60000
- R60000+

15.What is your home language?

--Select–

Options: Afrikaans, English, isiXhosa, isiZulu, Ndebele, Pedi, Sotho, Swati, Tsonga, Tswana, Venda, Other (Please specify)

Appendix I

COVID-19 Infection Questions

Long Covid is the term used to describe effects of COVID-19 that persist for much longer after the initial illness's period. Usually, people become sick and recover from COVID-19 within 4 weeks, but long COVID-19 symptoms have even been found in patients up to 6 months after the initial infection period. Common symptoms include fatigue, tiredness, and concentration problems. Other symptoms have also been found, such as organ damage, insomnia, and erectile dysfunction.

48. Have you been infected with COVID-19?

- ☐ Yes
- ☐ No

***If participants tick "No", end of survey/questionnaire.**
***If participants tick "Yes", the survey/questionnaire continues.**

49. When did you first get infected with COVID-19? Please give the month and year. (If unable to provide the month, please state the year)

100 Characters Remaining

50. Which of the following best describes the severity of your COVID-19 infection?

- ☐ I was able to recover at home
- ☐ I recovered at home, but should've gone to the hospital
- ☐ I was admitted to hospital care
- ☐ I received Oxygen therapy at hospital
- ☐ I was in critical care/ ICU at hospital
- ☐ Other (Please specify)

51. How long were you in hospital for?

- ☐ I was not hospitalised
- ☐ Less than 5 days
- ☐ a week
- ☐ 2-3 weeks

- more than a month
- Other (Please specify)

52. Do you think you are experiencing Long Covid?

- Yes
- No

52. Do you think you may have experienced Long Covid, and then later recovered?

- Yes
- No

53. If you are currently experiencing Long Covid now, what symptoms do you have?

Please tick all that apply

- I am not experiencing any symptoms
- Fatigue
- Sleeping Problems
- Muscle aches and pain
- Concentration problems (struggle to concentrate on tasks you could do before COVID-19)
- Attention problems
- Forgetfulness
- Difficulty breathing
- You feel like you 'think slower than you used to'
- You find it more difficult to think than before your COVID-19 infection
- Erectile Dysfunction
- Lack of smell/ issues with smell
- Lack of taste/ issues with taste
- Other (Please specify)

54. If you think you recovered from Long Covid, what symptoms did you experience? (if you think you still have Long Covid, please refer to the previous question)

- I never experienced any symptoms
- Fatigue
- Sleeping Problems
- Muscle aches and pain
- Concentration problems (struggle to concentrate on tasks you could do before COVID-19)
- Attention problems
- Forgetfulness
- Difficulty breathing
- You feel like you 'think slower than you used to'
- You find it more difficult to think than before your COVID-19 infection
- Erectile Dysfunction
- Lack of smell/ issues with smell
- Lack of taste/ issues with taste
- Other (Please specify)

55. Do you have any comments to make on your experience with Long Covid?

100 Characters Remaining

Appendix J

Online Questionnaire Information Sheet and Consent Form

Long Covid Online Questionnaire: Consent Form

We are a team of researchers studying the long-term effects of the COVID-19 virus. The overall purpose of this research is to characterise the emotional aspects that those with Long Covid present with. This questionnaire seeks to collect important data about your emotional state. All mandatory questions only require you to select an option or one-word answer. Additionally, this survey will assess your eligibility for the second phase of research if you wish to partake.

It should take a maximum of 25 minutes to complete, and it is likely you will finish far sooner. We have inserted break pages between sections for your convenience. You may use these break pages as an opportunity to take a break or take a break at any point during the survey; as long as you keep the browser tab open and return to the survey within an hour, your data will be retained.

There are risks involved with the questionnaire, as there are questions on mental health that will ask about suicidality, emotional strain, and stress. There are also questions about your overall physical and mental state. We have left our email contact at the bottom of this consent form; please email us if you experience distress while answering this questionnaire. We have also inserted links and contacts for mental health advocacy groups that can provide counselling at the end of this form and throughout the questionnaire.

This questionnaire will record some important data for this study, including your demographic information. Additionally, we will need your contact details to send you a debriefing email. None of this information will be disclosed to any person outside of this study. At study completion, records shall also be stored in a two-factor authenticated drive, only accessible to researchers.

After you complete the survey, you will receive a debriefing email thanking you for your participation, with a list of support contacts and a reiteration of the rationale of the study, and an invite to participate in the larger study if eligible. After this point, your contact information shall be removed from our database.

To start the survey, please give your consent below, and confirm that you meet the eligibility criteria. This is not binding - you may choose to stop the questionnaire at any time or request to remove yourself from the study at any time. The next section will then record biographic and demographic information before beginning the questionnaire. If any of this is unclear, please contact us at the email addresses listed below.

Thank you for your time.

Best

Aaniyah Anthony - Researcher and Honours Psychology Student at UCT

Luca Schuler - Researcher and Honours Psychology Student at UCT

Altay Yüce Turan - Researcher and Candidate Neuropsychologist at UCT

Donné Minné - Researcher and HPCSA Registered Neuropsychologist

Email Contacts:

antaan001@myuct.ac.za - Aaniyah Anthony

schluc008@myuct.ac.za - Luca Schuler

donneminne.za@gmail.com - Dr Donné Minné

trnalt001@myuct.ac.za - Altay Yüce Turan

Mental Health Referrals:

If you need a referral to a psychologist, psychiatrist or support group, we encourage you to call The South African Depression and Anxiety Group (SADAG) on 011 234 4837 or 0800 20 50 26 and speak to a trained counsellor who can assist you further. Or alternatively, email Zane at zane@sadag.org

You are also encouraged to email one of the Principal Investigators in this study, Dr Donné Minné, who is a registered neuropsychologist with the HPCSA and who will be able to provide you with a consultation should you be requiring one.

Donneminne.za@gmail.com

(PS 0150380) **We would also like to draw your attention to a number of other mental health support resources available to you:**

Dr Reddy's Help Line

0800 21 22 23

Cipla 24hr Mental Health Helpline

0800 456 789

Pharmadynamics Police & Trauma Line

0800 20 50 26

Adcock Ingram Depression and Anxiety Helpline

0800 70 80 90

Department of Social Development Substance Abuse Line 24hr helpline

0800 12 13 14

SMS 32312

Suicide Crisis Line

0800 567 567

SADAG Mental Health Line

011 234 4837

Akeso Psychiatric Response Unit 24 Hour

0861 435 787

Cipla Whatsapp Chat Line

(9am-4pm, 7 days a week)

076 882 2775

24 hour Healthcare Workers Care Network Helpline

0800 21 21 21

SMS 43001

NPOWERSA Helpline

0800 515 515

SMS 43010

For affordable counselling, please contact the Counselling Hub

021 462-3902 (landline) or 067 235-0019 (mobile)

For non-appointment enquiries, please email info@counsellinghub.org.za

1. I confirm that I...

- ☐ Am between the age of 18 and 60 years old

2. I am not currently diagnosed with neurological disorders, central nervous system disorders, developmental disorders or cognitive disorders. Examples of such diagnoses include but are not limited to a diagnosis of: Alzheimer's disease, dementia, brain damage (caused either by a stroke or a traumatic head injury), intellectual disabilities, autism, a recent diagnosis of Major Depressive Disorder, Foetal alcohol syndrome, or epilepsy.

- ☐ Yes

3. I have read the above, and I agree to my data and contact information being recorded for the purposes of this study

- ☐ Yes

Appendix K

Debriefing Email

Subject line: [Debriefing Email: Characterising the Basic Emotions of Long COVID]

Dear [insert name],

Hope you are well.

Debriefing Message:
This email serves as a debriefing message for the Long COVID study that you have participated in. Our study is aiming to better characterise the emotional aspects of Long Covid, through understanding the emotional symptoms participants present with. We would like to thank you for your participation in our study.

Analysis of the results is still in progress. However, we will contact you with a final aggregation of our study results so that you may see the outcome of your participation, and also to ensure you feel the final conclusions are acceptable in their depiction of people suffering from Long COVID.

If participation in our study has caused you any distress or if you have any other concerns or queries about the study, please contact covidandthebrain@gmail.com

Alternatively, you may contact the researchers at the email addresses listed below:

Altay Turan trnalt001@myuct.ac.za
Donné Minné donneminne.za@gmail.com
Aaniyah Anthony antaan001@myuct.ac.za
Luca Schuler schluc008@myuct.ac.za

Finally, we have reattached our counselling and psychotherapy links at the end of this email. Please feel free to utilise this list.

Once again, thank you for your participation.

Sincerely,
The Covid and the Brain Team

If you are needing a referral to a psychologist, psychiatrist or support group, we encourage you to call The South African Depression and Anxiety Group (SADAG) on 011 234 4837 or 0800 20 50 26 and speak to a trained counsellor who can assist you further. Or alternatively email Zane on zane@sadag.org
Dr Donné Minné, one of the Principal Investigators in this study, who is a registered neuropsychologist with the HPCSA will be able to provide you with advice regarding further consultation should you be requiring one. Donneminne.za@gmail.com (PS 0150380)

We would also like to draw your attention to a number of other mental health support resources available to you:

Dr Reddy's Help Line
0800 21 22 23

Cipla 24hr Mental Health Helpline
0800 456 789

Pharmadynamics Police &Trauma Line
0800 20 50 26

Adcock Ingram Depression and Anxiety Helpline
0800 70 80 90

ADHD Helpline
0800 55 44 33

Department of Social Development Substance Abuse Line 24hr helpline
0800 12 13 14
SMS 32312

Suicide Crisis Line
0800 567 567

SADAG Mental Health Line
011 234 4837

Akeso Psychiatric Response Unit 24 Hour
0861 435 787

Cipla Whatsapp Chat Line
(9am-4pm, 7 days a week)
076 882 2775

24 hour Healthcare Workers Care Network Helpline
0800 21 21 21
SMS 43001

NPOWERSA Helpline
0800 515 515
SMS 43010

For affordable counselling, please contact the Counselling Hub
021 462-3902 (landline) or 067 235-0019 (mobile)
For non-appointment enquiries please email info@counsellinghub.org.za

Appendix L

Correlation Plots for the Different Scales

Figure 13
Correlation Plot

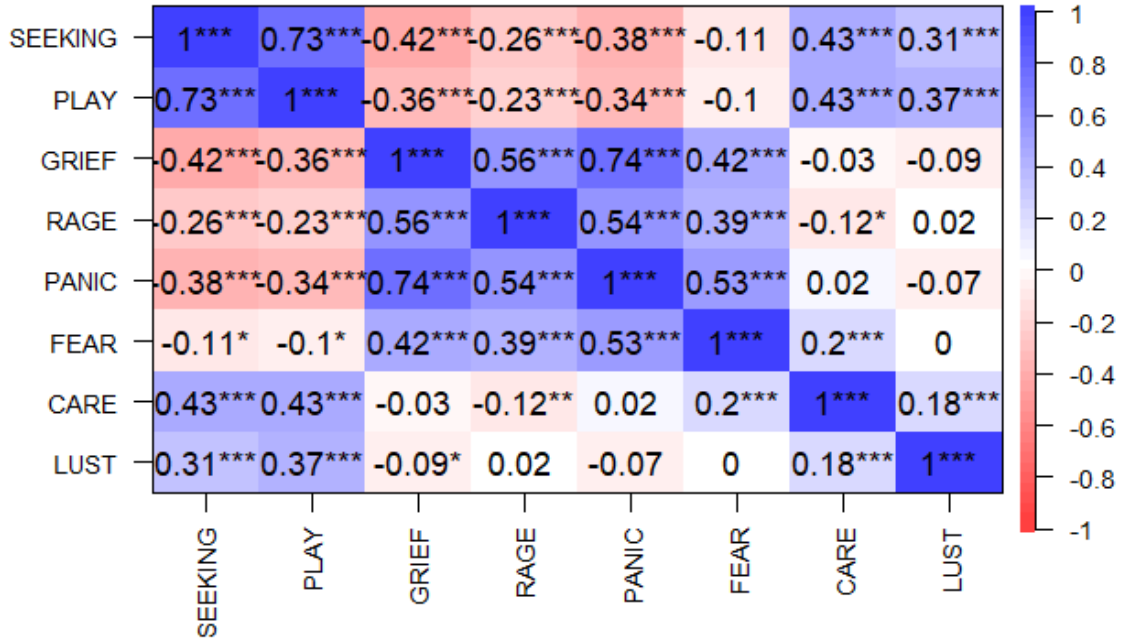


Figure 14
Correlation Plot

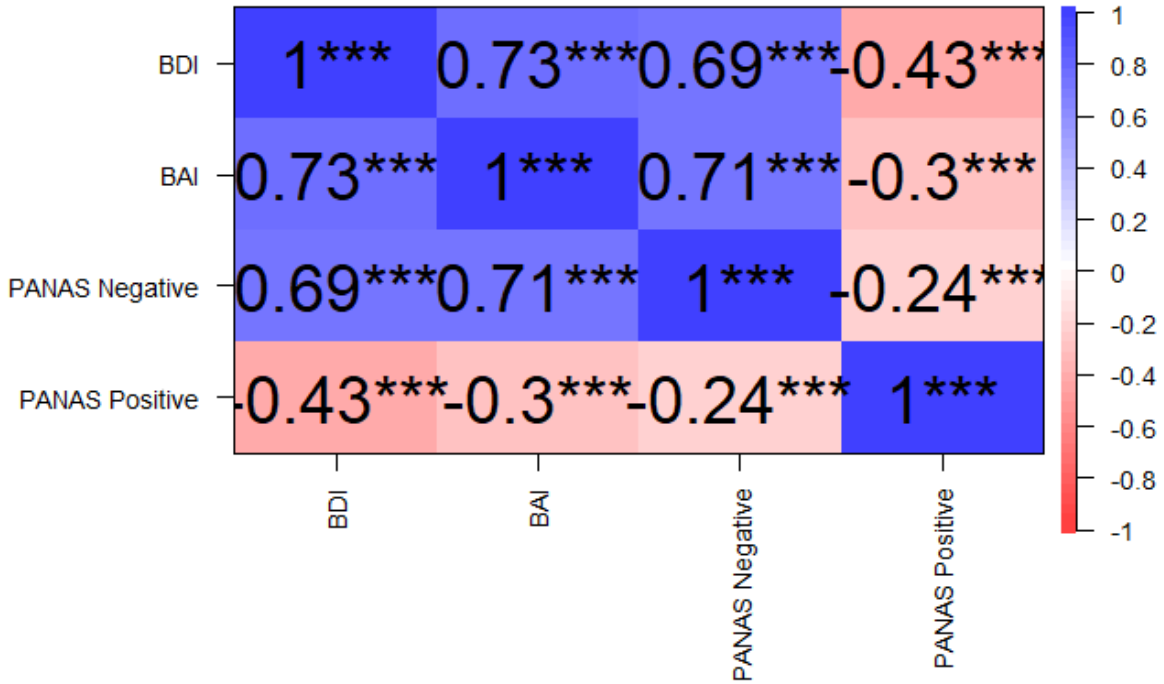
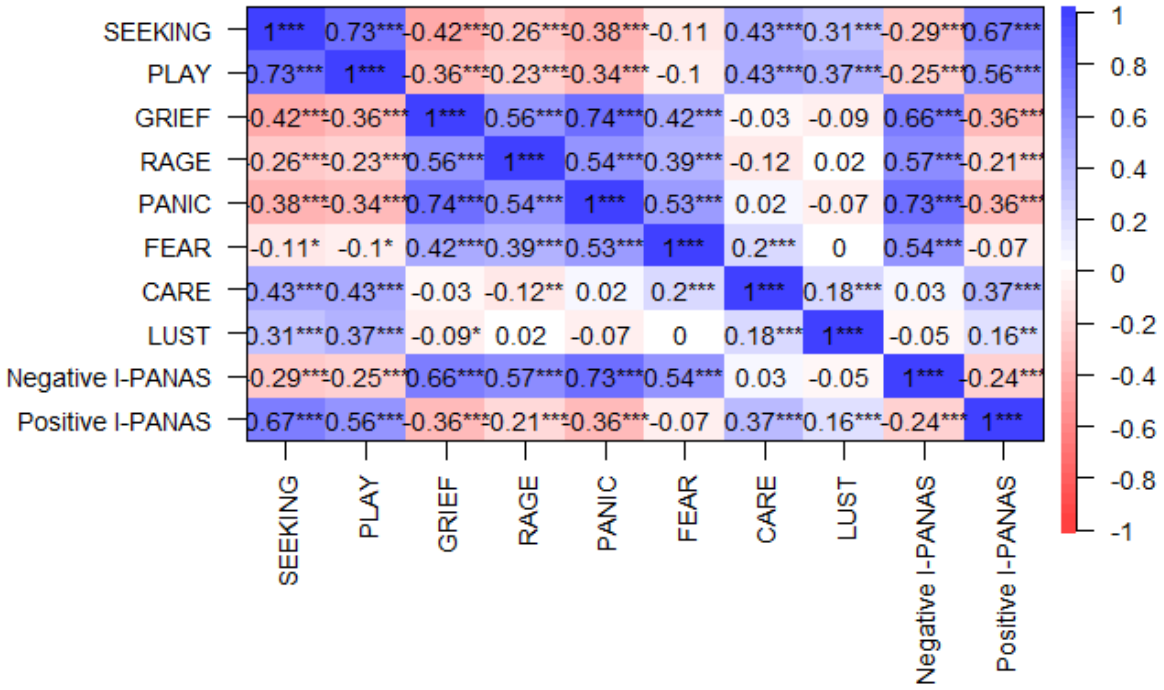


Figure 15
Correlation Plot



Appendix M

Table 5

Table depicting ANOVA comparisons across groups

One-way ANOVA between-group differences; Becks Depression Inventory-II

	Sum of Squares	*Df*	*Mean Square*	*MSerror*	*F*	*t*	p	η^2
One-way ANOVA	3790	3	1263.45	106.84	11.83		<.001	0.06
LC ~ No COVID		534			6.62	5.14	<.001	
LC ~Only COVID		534			7.56	5.58	<.001	
LC ~ Recovered LC		534			5.34	3.66	.002	
No COVID ~ Only COVID		534			0.94	0.83	.841	
No COVID ~ Recovered LC		534			-1.28	-1.02	.728	
Only COVID ~ Recovered LC		534			-2.22	-1.67	.338	

Welch's ANOVA between-group differences; Becks Anxiety Inventory

	Sum of Squares	*Df*	*Mean Square*	*MSerror*	*F*	*t*	p	η^2
Welch's ANOVA		3			14.47		<.001	
LC ~ No COVID		251.34				-8.87	.001	
LC ~Only COVID		251.34				-8.89	.001	
LC ~ Recovered LC		251.34				-4.81	.036	
No COVID ~ Only COVID		251.34				-0.02	.999	
No COVID ~ Recovered LC		251.34				4.06	.026	
Only COVID ~ Recovered LC		251.34				4.09	.034	

One-way ANOVA between-group differences; SEEKING

	Sum of Squares	*Df*	*Mean Square*	*MSerror*	*F*	*t*	P	η^2
One-way ANOVA	171.8	3	57.28	15.93	3.59		.014	.02
LC ~ No COVID		534			-1.27	-2.55	.053	
LC ~Only COVID		534			-1.18	-2.25	.0112	
LC ~ Recovered LC		534			-1.78	-3.16	.009	
No COVID ~ Only COVID		534			0.09	0.21	.997	
No COVID ~ Recovered LC		534			-0.51	-1.05	.719	
Only COVID ~ Recovered LC		534			-0.60	-1.18	.642	

One-way ANOVA between-group differences; GRIEF

	Sum of Squares	*Df*	*Mean Square*	*MSerror*	*F*	*t*	p	η^2
One-way ANOVA	321.7	3	107.24	22.17	4.84		.002	.03
LC ~ No COVID		534			2.02	3.45	.003	
LC ~Only COVID		534			1.71	2.77	.029	
LC ~ Recovered LC		534			2.20	3.31	.006	
No COVID ~ Only COVID		534			-0.31	-0.60	.931	
No COVID ~ Recovered LC		534			0.18	0.31	.989	

One-way ANOVA between-group differences; RAGE

	Sum of Squares	*Df*	*Mean Square*	*MSerror*	*F*	*t*	P	η^2
One-way ANOVA	488.5	3	162.84	17.65	9.22		<.001	.05
LC ~ No COVID		534			2.75	5.26	<.001	
LC ~Only COVID		534			1.77	3.20	.008	
LC ~ Recovered LC		534			1.85	3.13	.010	
No COVID ~ Only COVID		534			-0.99	-2.13	.144	
No COVID ~ Recovered LC		534			-0.89	-1.75	.297	
Only COVID ~ Recovered LC		534			0.09	0.16	.998	

One-way ANOVA between-group differences; PANIC

	Sum of Squares	*Df*	*Mean Square*	*MSerror*	*F*	*t*	P	η^2
One-way ANOVA	376.9	3	125.65	25.23	4.98		.002	.03
LC ~ No COVID		534			2.09	3.36	.005	
LC ~Only COVID		534			2.26	3.43	.004	
LC ~ Recovered LC		534			1.18	1.67	.341	
No COVID ~ Only COVID		534			0.16	0.29	.992	
No COVID ~ Recovered LC		534			-0.92	-1.49	.440	
Only COVID ~ Recovered LC		534			-1.08	-1.67	.343	

Welch's ANOVA between-group differences; FEAR

	Sum of Squares	*Df*	*Mean Square*	*MSerror*	*F*	*t*	P	η^2
Welch's ANOVA		3			4.88		<.003	
LC ~ No COVID		254.47				2.16	.139	
LC ~Only COVID		254.47				3.75	.001	
LC ~ Recovered LC		254.47				2.37	.085	
No COVID ~ Only COVID		254.47				2.02	.182	
No COVID ~ Recovered LC		254.47				0.58	.938	
Only COVID ~ Recovered LC		254.47				1.04	.726	