POLITECNICO DI TORINO

Master of Science in Computer Engineering

Master Degree Thesis

Recording and analysing data on the neurological consequences of Long Covid using a web app

Politecnico di Torino

Supervisors

Ch.ma Prof.ssa Gabriella Olmo

Dr. Vito De Feo

Dr. Helge Gillmeister

Candidate

Martina Caputo

ACADEMIC YEAR 2022/2023

October 2023

Abstract

Long COVID is a clinical syndrome characterised by the presence of certain symptoms related to SARS-CoV-2 infection, which occur or persist for weeks or months after recovery from the acute infection. The clinical picture may vary from patient to patient and the symptoms experienced are not always immediately traced back to the previous infection.

This study deals with the measurement, management and analysis of data on neurological consequences in individuals with long COVID, within the 'Happy Again' study (https://www.essex.ac.uk/research-projects/happy-again), a project developed by the University of Essex.

Within the 'Happy Again' platform (https://happyagain.essex.ac.uk/), participants can take part in a series of cognitive assessments. These assessments take place using questionnaires and a battery of sensory and cognitive tests, all designed to record behavioural markers that correlate with possible neuropsychological deficits.

The results of these tests, together with the answers to the questionnaires, are systematically stored in the database for subsequent analysis. My role initially consisted of ensuring the integrity of the database in the face of, for example, computer intrusion attempts or internet connection interruptions that could cause duplicate tests.

However, the heart of this thesis was the systematic analysis of the data, with a focus on the questionnaires and one of the tests, the word categorisation test.

I was also involved in synthesising new Long Covid severity indices by means of factor analysis.

My thesis consists of a comprehensive account of the work that led to the creation of the 'Happy Again' web application, detailing the evolution of the system's development, architectural choices and implementation strategies, highlighting the changes introduced, the data analysis, the implementation methods employed and the results obtained.

Index

Chapter 1

1.1 Introduction

In recent history, a novel and highly contagious virus known as COVID-19 has emerged, leaving an indelible mark on global health. The genesis of this virus came into sharp focus in December 2019 when Chinese health authorities, keenly aware of a growing mystery in the city of Wuhan, alerted the World Health Organization (WHO). This alert centered around a cluster of pneumonia cases that presented with no apparent cause, confounding experts, and setting the stage for a scientific and medical race against the unknown.

The days and weeks that followed saw a remarkable unravelling of the virus's genetic code. By January 2020, Chinese scientists had pinpointed a new coronavirus as the culprit behind the puzzling illness. WHO officially christened the respiratory disease as COVID-19, which stands for "Coronavirus Disease 2019." The virus itself received the name SARS-CoV-2 due to its close genetic resemblance to the severe acute respiratory syndrome coronaviruses, SARS-CoVs, that had previously threatened humanity.

The virus, seemingly relentless in its quest for global reach, quickly transcended international boundaries. Within weeks of its initial discovery, COVID-19 had become a ubiquitous presence, defying geographical limitations. This marked a pivotal moment in global health, a moment when the world collectively braced itself for the challenges that lay ahead.

March 11, 2020, stands out as a date etched in history, a momentous day when the WHO declared COVID-19 a pandemic [1]. The declaration, an acknowledgment of the virus's worldwide impact, serving as a reminder of the magnitude of the challenge humanity faced.

Fast-forwarding to September 2022, the world continues to grapple with the COVID-19 pandemic. Its effects have been profound, touching the lives of over 600 million individuals worldwide and leading to the tragic loss of approximately 6 million lives. The virus has exhibited a wide spectrum of clinical manifestations, from asymptomatic cases to severe respiratory distress and multiorgan failure. Fortunately, many individuals, irrespective of symptom severity, have successfully recovered from their infections, underscoring the resilience of the human body.

Yet, the story of COVID-19 extends far beyond its initial impact. As the pandemic unfolded, a new adversary emerged the shadow of "Long COVID" or "Post-COVID-19

Syndrome." This condition has left countless survivors grappling with a myriad of lingering symptoms that persist for weeks, months, or even longer after the initial infection.

In conclusion, the emergence of COVID-19 in late 2019 marked a turning point in global health, ushering in an era defined by unprecedented challenges and shared resilience. The ongoing battle against this novel disease underscores the vital importance of continued research, healthcare support, and vaccination efforts as we navigate the complex landscape of COVID-19 and its enduring impact on our world.

The spectrum of symptoms linked to the COVID-19 virus is quite varied. It spans from instances where no noticeable symptoms are present to more severe cases that can provoke acute respiratory distress syndrome and multiorgan failure, carrying a heightened risk of mortality. Fortunately, the majority of individuals who contract COVID-19 tend to recover within a relatively brief period, ranging from a few days to several weeks, regardless of the initial seriousness of their symptoms.

Yet, a puzzling facet of COVID-19 unfolds when we consider the experiences of some individuals. These individuals find themselves in the realm of "Long COVID" or "Post-COVID-19 Syndrome." This enigmatic condition presents a complex tapestry of symptoms that can persist for weeks, months, or even extend into a much longer timeframe. It's like a persistent shadow of the initial infection, affecting various organs and systems within the body.

The scientific community has pivoted its attention to the enigma of Post-COVID-19 Syndrome. While Long COVID's impact on the population is evident, and it's formally recognized as a clinical entity, ongoing research endeavors seek to delve deeper into its characteristics. These include unraveling the prevalence, nature, and severity of the persistent effects, as well as understanding how they might interconnect with variables such as the initial disease's severity and the presence of preexisting medical conditions.

The University of Essex, driven by these motivations, has initiated a project named 'Happy Again,' focused on investigating the health impacts on COVID-19 patients, spanning from physical to psychological aspects. Individuals affected by this syndrome can exhibit a wide range of symptoms, from the common, such as fever, cough, and cold, to more severe symptoms like shortness of breath or difficulty in performing daily tasks. Specifically, my contribution to this study aims to analyze the information gathered regarding the conditions and symptoms of patients to better understand cognitive and neurological aspects.

The primary goal of the research is to determine if these markers of cognitive functioning and neural integrity are influenced by COVID-19 and if such effects are systematically related to the experience and severity of persistent symptoms. By

addressing these issues, we can provide support to researchers, medical professionals, and rehabilitation therapists in better understanding which aspects of neural functioning to target for assessing risk and recovery, with the aim of restoring optimal mental and physical functioning after COVID-19.

The behavioral markers under study include response speed and accuracy to visual and auditory stimuli, the "temporal binding window" of sensory integration, sensory adaptation responses, and retention of verbal information. The project involves the development of a web application through which participants will be asked to perform various tasks and respond to surveys to collect the markers. The main idea was to deliver a fully developed, tested, and ready-to-use web application that benefits participants, allowing them to complete tasks from the comfort of their homes worldwide, and researchers, who gain access to a fully operational tool usable for future studies.

This work delineates my role within the collaborative research conducted in partnership with the University of Essex. Throughout this project, I had the opportunity to work within a team comprised of fellow students from the University of Essex. Each member of our team assumed specific responsibilities, with my primary focus encompassing data analysis. However, my involvement extended beyond this role to include aspects of security, maintenance, and innovation pertaining to the web application.

My initial contributions centered on the development of an administrative area, designed to facilitate the work of psychologists by providing them with streamlined access to the collected data. Subsequently, I worked on the implementation of user reminder systems aimed at prompting participants to complete their assigned tasks. The project then evolved to encompass robust security measures to safeguard against potential attacks or intrusions. This included the creation of a multi-layered security system incorporating one-time password (OTP) registration and CAPTCHA mechanisms.

In summary, my role within this research project was multifaceted, encompassing data analysis, security enhancement, and the development of user-friendly features within the web application. These efforts collectively contribute to the comprehensive investigation and analysis of cognitive functions and neural integrity in the context of COVID-19.

Chapter 2

2.1 Overview

COVID-19 is the disease caused by the SARS-CoV-2 coronavirus [2]. This virus primarily spreads through close human-to-human contact.

Coronaviruses represent a family of viruses known as Coronaviridae. What distinguishes these viruses is their appearance under a microscope – they exhibit a distinctive crown-like or coronal shape, attributed to the presence of club-shaped glycoprotein spikes on their envelopes. This unique feature is the origin of their name.

In terms of genetic makeup, coronaviruses possess a genome comprising a single strand of positive-sense RNA (ribonucleic acid). This genetic material serves as the blueprin for the virus's replication and functions as a vital component of its structure and life cycle.

2.1.1 SARS

Severe Acute Respiratory Syndrome (SARS) is a viral respiratory illness caused by a specific type of coronavirus known as SARS-associated coronavirus.

SARS is classified as an airborne virus, primarily disseminating through tiny saliva droplets, much like the transmission mode of the common cold and influenza. Notably, it marked the emergence of the first severe and highly transmissible novel disease in the 21st century. Moreover, it demonstrated a remarkable capacity to traverse international borders facilitated by global air travel networks.

In addition to direct airborne transmission, SARS can also be indirectly transmitted via contaminated surfaces that have been touched by individuals carrying the virus.

Coronaviruses, including those responsible for SARS, share common characteristics such as their ability to infect the respiratory system, leading to symptoms like fever, cough, and difficulty breathing. They are also known for their capacity to spread from person to person through respiratory droplets, making them contagious.

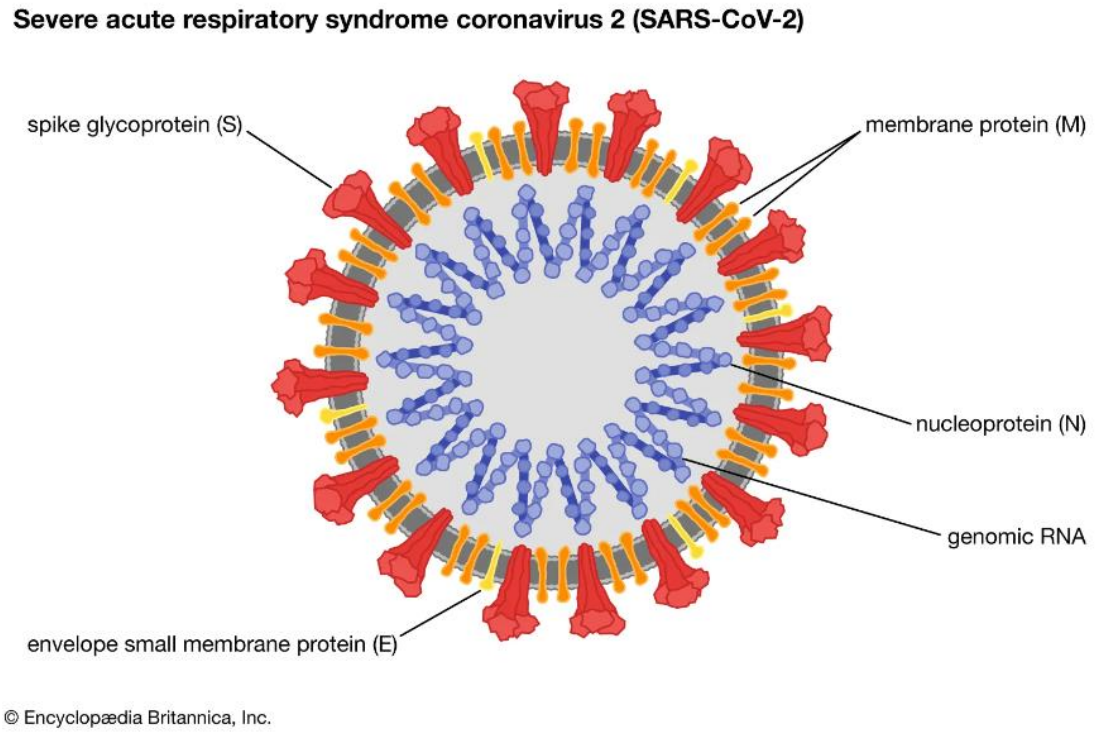


Figure 1. SARS-CoV-2 [3].

2.2 Symptomatology

COVID-19 symptoms vary among individuals and typically appear 5–6 days after exposure, lasting up to 14 days. Common symptoms include fever, chills, and a sore throat. Less frequent symptoms encompass muscle aches, fatigue, headache, cough, shortness of breath, and changes in taste or smell.

Urgent medical attention is necessary if experiencing severe breathing difficulties, confusion, chest pain, cold/clammy skin, or loss of speech/movement. Individuals with underlying health issues (e.g., immunosuppression, chronic conditions) should promptly seek medical advice when concerned about their COVID-19 condition.

Severe COVID-19 consequences may include death, respiratory failure, sepsis, blood clots, and organ damage (heart, liver, kidneys). In rare cases, children may develop an inflammatory syndrome a few weeks after infection.

Some COVID-19 survivors experience persistent symptoms, known as long COVID. Common long COVID symptoms include fatigue, breathlessness, and cognitive issues, impacting daily functioning like work and chores.

2.3 Coronavirus and the impact on the Nervous System: Understanding Neurological Aspects

Research findings indicate that the numerous neurological symptoms associated with COVID-19 may not be a direct result of the virus infiltrating the brain or nervous system. Instead, these symptoms are likely linked to the body's robust immune response when combating the infection. In some cases, the immune system's reaction to SARS-CoV-2 can be overly aggressive, potentially causing harm to various bodily systems.

Studies examining the cerebrospinal fluid, which envelops the brain, in individuals infected with SARS-CoV-2 have revealed alterations in the immune system. Notably, antibodies produced by the immune system to combat the virus have been detected in this fluid. These antibodies may also interact with the nervous system. Importantly, there is currently no substantial evidence of widespread viral infection occurring within the brain.

Understanding how the virus impacts the brain and other organs over the long term is an ongoing area of scientific investigation. Researchers are only beginning to delve into the role of autoimmune reactions and other mechanisms that may underlie the collection of symptoms some individuals experience post-recovery.

The ultimate question remains unanswered: whether any damage inflicted on the nervous system or other bodily organs leads to lingering effects that will naturally resolve with time, or if COVID-19 may establish a more enduring, possibly chronic, disorder.

The majority of individuals infected with the SARS-CoV-2 virus typically encounter either no symptoms or experience only mild to moderate manifestations linked to the brain or nervous system.

In contrast, a significant proportion of individuals requiring hospitalization due to the virus do present with symptoms associated with the brain or nervous system. These frequently observed symptoms among hospitalized patients encompass muscle discomfort, headaches, sensations of dizziness, and alterations in the sense of taste and smell.

COVID-19 has the potential to trigger seizures or significant strokes. Among those who need intensive care due to the infection, it is common to encounter muscular weakness, nerve damage, and various forms of pain syndromes [4].

These post-complications often manifest as an overwhelming sense of fatigue coupled with an array of associated symptoms. These may encompass difficulties in maintaining focus and memory, disruptions in sleep patterns, fluctuations in heart rate, persistent cough, shortness of breath, challenges in achieving restful sleep, an inability to engage in physical activities at previous levels, and discomfort in muscles, joints, and the chest region.

The precise mechanisms through which the infection gives rise to these enduring symptoms and why they affect certain individuals and not others remain a subject of ongoing investigation and remain shrouded in uncertainty. This research is actively exploring these aspects to gain a deeper understanding of the complexities surrounding post-acute complications of COVID-19.

2.4 Long Covid

As we discussed before, some individuals who have contracted the virus responsible for COVID-19 may encounter enduring repercussions from their infection, recognized as Long COVID or Post-COVID Conditions (PCC). Long COVID encompasses a wide spectrum of signs, symptoms, and health issues that persist or develop following the resolution of acute COVID-19 infection. This comprehensive definition of Long COVID has been collaboratively established by the Department of Health and Human Services (HHS), in partnership with the CDC and various other stakeholders.[5]

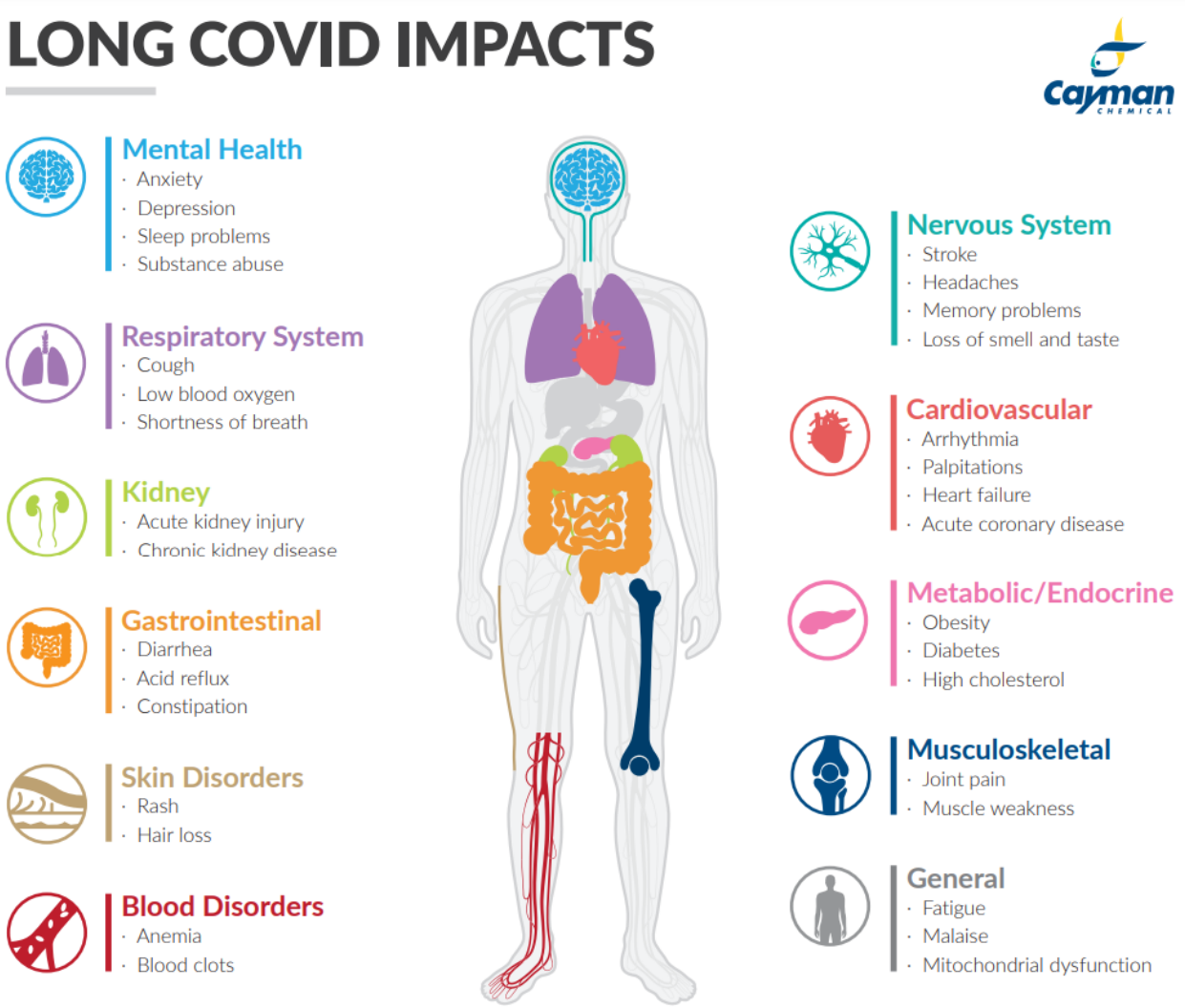


Figure 2. An umbrella of symptoms and comorbidities have been documented in relation to Long COVID [6].

Individuals grappling with Long COVID can endure a broad spectrum of symptoms that may persist for weeks, months, or even extend into years following the initial infection. Notably, these symptoms can exhibit a perplexing pattern, occasionally subsiding only to resurface later.

It is imperative to acknowledge that Long COVID does not manifest uniformly among all affected individuals. The constellation of symptoms can vary widely, with different types and combinations emerging, lingering, resolving, and reappearing over variable durations.

Commonly reported symptoms in individuals with Long COVID encompass:

General Symptoms :

1. **Persistent Fatigue**: Overwhelming tiredness or fatigue that significantly disrupts daily life.
2. **Post-Exertional Malaise**: Symptoms exacerbating following physical or mental exertion.
3. **Fever**: Occasional fever episodes.

Respiratory and Cardiac Symptoms:

1. **Breathing Challenges**: Difficulty in breathing or shortness of breath.
2. **Cough**: Persistent coughing.
3. **Chest Discomfort**: Chest pain.
4. **Heart Palpitations**: Experiencing a rapid or pounding heart rate.

Neurological Symptoms:

1. **Cognitive Impairment**: Difficulty with thinking or concentration, often referred to as "brain fog."
2. **Headaches**: Frequent or persistent headaches.
3. **Sleep Disturbances**: Problems with sleep patterns.
4. **Lightheadedness**: Dizziness upon standing up.
5. **Pins-and-Needles Sensations**: Abnormal tingling sensations.
6. **Altered Taste or Smell**: Changes in the sense of taste or smell.
7. **Mood Disorders**: Instances of depression or anxiety.

Digestive Symptoms:

1. **Diarrhea**: Frequent episodes of diarrhea.
2. **Abdominal Pain**: Stomach discomfort or pain.

Other Symptoms:

1. **Muscle or Joint Pain**: Aching in muscles or joints.
2. **Skin Rash**: Occurrence of rashes on the skin.
3. **Hair Loss**
4. **Menstrual Changes**: Alterations in menstrual cycles.

March 5, 2023, reports [7] indicate that Long COVID symptoms have been observed to last anywhere from three months to two years or more. The precise duration of the condition remains a subject of ongoing investigation and varies among affected individuals.

In the United Kingdom, as of the same date, it was estimated that approximately 1.9 million people were self-reporting as having Long COVID. Among these individuals:

- 92% had been experiencing Long COVID symptoms for a minimum of 3 months.
- 69% had been grappling with Long COVID symptoms for at least a year.
- 41% had been enduring Long COVID symptoms for a duration of at least two years.

These statistics highlight the significant and, in some cases, protracted impact that Long COVID can have on individuals' lives, reinforcing the importance of ongoing research and healthcare support for those affected.

2.5 The diagnosis

the diagnosis of Long COVID involves a multifaceted approach that does not rely on a single definitive test. Instead, it encompasses a thorough clinical evaluation and a meticulous examination of the individual's medical history and symptomatology.

The first step is a detailed medical history: The initial step in diagnosing Long COVID entails an in-depth exploration of the patient's medical history. This includes a comprehensive inquiry into their past COVID-19 infection, encompassing the nature and severity of initial symptoms and any complications encountered during the acute phase of the disease.

Healthcare practitioners engage in a meticulous assessment of the multitude of symptoms that the individual has been experiencing. Long COVID typically presents with a diverse array of symptoms affecting various bodily systems. This evaluation seeks to capture the full spectrum of these manifestations.

The diagnostic process for Long COVID necessitates the exclusion of other underlying medical conditions that could potentially account for the persistent symptoms. This may involve a battery of tests and screenings aimed at ruling out alternative diagnoses.

In certain instances, individuals grappling with Long COVID may be referred to specialists who possess expertise in managing the specific symptoms they are experiencing. This

interdisciplinary approach ensures that the diverse range of symptoms is addressed comprehensively.

Given the evolving and enduring nature of Long COVID, continuous monitoring of symptoms over an extended period is integral to its diagnosis. This extended observation helps in confirming the persistence of symptoms and tracking any changes that may occur over time. Healthcare providers may recommend periodic follow-up assessments to gauge the progress of the condition.

While there is no singular, definitive test for Long COVID, ongoing research is dedicated to the development of objective diagnostic tools and biomarkers that can facilitate its identification. Such potential diagnostic measures may encompass blood tests, advanced imaging studies, and other assessments designed to pinpoint specific physiological or biochemical alterations associated with Long COVID.

2.6 Behavioural Traits

It has been observed, within the clinical context, that individuals afflicted by COVID-19 may manifest neurological and cognitive ramifications. Consequently, a compelling imperative has arisen to harness a set of systematic and objective metrics, rooted in behavioral manifestations, for the comprehensive delineation of these repercussions.

In this pursuit, a concerted effort is dedicated to the scrutiny of an array of behavioral metrics, each of which serves as a window into the intricate tapestry of these effects:

1. **Responsiveness**: The velocity and precision with which individuals respond to both visual and auditory stimuli, ascertaining their cognitive acuity and processing capabilities.
2. **Temporal Integration**: Delving into the 'temporal binding window' within the realm of sensory integration, unraveling the nuances of how sensory information converges over time.
3. **Sensory Adaptation**: Exploring the adaptational responses exhibited by sensory faculties, shedding light on the adaptive mechanisms that come into play.
4. **Verbal Information Retention**: A comprehensive examination of the capacity to retain and retrieve verbal information, elucidating potential memory and cognitive deficits.

In order to meticulously capture these behavioral facets, the Happy Again web application employs a battery of scientifically validated behavioral assessments. A comprehensive exposition of each behavioral evaluation utilized within the application, elucidating the specific markers acquired through these assessments, is elaborated upon in the ensuing sections.

2.6.1 Word Categorization

The Word Categorization Task defines the so called ‘Memory Experiment’. The primary aim of this empirical study is to meticulously examine the implicit memory patterns in Covid-19 patients by analyzing their responses to item recognition confidence, focusing on Event-Related Potentials (ERPs) [8]. This multifaceted experiment is composed of two distinctive phases: Word Categorization and Word Recognition, each designed to delve into various aspects of memory and cognition.

Experimental Phases:

1. Word Categorization: In the initial stage, known as Word Categorization, participants are presented with a series of uppercase words sourced from the esteemed Medical Research Council Psycholinguistics Database. These words, characterized by an average length of 4.89 letters (with a range from 3 to 8 letters), serve as the stimuli for this phase. Participants are tasked with categorizing each word as representing either a living or artificial entity. This phase is bifurcated into two blocks, each comprising 65 distinct words. Participants respond with a binary choice, signaling 'yes' or 'no' based on the word's association with living or artificial objects.

2. Word Recognition: Subsequently, participants progress to the Word Recognition phase, called also Memory Task, where they confront a set of 130 words carried over from the Word Categorization task, alongside 70 entirely new words drawn from the same database. These words are presented in four separate blocks, with each block containing 50 words. Participants are initially required to indicate their confidence in recognizing each word on a 5-point scale, ranging from 'I'm sure it's new' to 'I'm sure it's old,' thereby offering a nuanced evaluation of their memory recall. If respondents rate a word as 'old' (i.e., they believe they have encountered it before), they are further prompted to identify the specific category it belongs to, based on the earlier distinctions of 'alive vs. not alive' or 'manmade vs. not man-made.' This categorization is carried out on a similar 5-point scale, ranging from 'I'm sure it's from alive list' to 'I'm sure it's from manmade list,' enabling a fine-grained assessment of their memory retrieval processes.

This experiment serves as an essential exploration into the intricate workings of memory and cognition, particularly within the context of Covid-19 patients. By scrutinizing item recognition confidence responses and their implicit memory implications, we aim to contribute valuable insights to the field of neuropsychology. Each phase of this study, from Word Categorization to Word Recognition, has been meticulously designed to unravel the nuances of memory retention and retrieval, ultimately shedding light on the cognitive repercussions of Covid-19.

2.6.2 Movement Perception

The primary aim of this experiment is to delve into the realm of multisensory awareness by assessing an individual's capacity to discern and interpret the speed and trajectory of objects within a visual scene. This intricate process involves the integration of sensory information from various sources, including visual cues, vestibular signals, and proprioceptive feedback.

The experiment commences with a critical phase where participants are instructed to maintain their gaze upon a central fixation point, presented briefly to establish a baseline for visual attention.

Subsequently, participants are exposed to a dynamic visual pattern that unfolds on the screen. This visual scenario introduces a layer of complexity, as it incorporates elements moving at varying speeds and directions. Importantly, after an approximately 3-second interval, a brief test stimulus is introduced, characterized by motion in a distinct direction.

Participants are then tasked with the pivotal role of identifying the perceived direction of motion. This critical element of the experiment requires participants to translate their multisensory inputs into a conscious perception of the motion's trajectory. It is essential to note that this dynamic pattern may initiate randomly either from the left or the right side, and this direction will remain consistent for half of the total trials. The remaining trials will involve motion in the opposite direction. This variation adds an additional layer of complexity to the task, necessitating the integration of multisensory cues to make accurate judgments.

The experiment is systematically repeated to ensure comprehensive data collection. In total, participants are subjected to 10 trials, each designed to capture the nuances of their multisensory perception capabilities.

2.6.3 Target Detection

This experimental task centers around the Posner Paradigm, a widely recognized framework for the investigation of visual attention dynamics. Within this paradigm, the primary objective is to probe participants' ability to swiftly detect and respond to target stimuli. Specifically, the stimuli in question consist of circles, each exhibiting a distinct contrast pattern, either darker on the upper or lower segment. Participants are tasked with precisely identifying the side of the circle displaying greater darkness.

The stimuli are strategically presented on either the left or right side of the screen, a crucial factor in this experiment. Participants are provided with cues that precede the appearance of the stimuli, serving as directional guides for their attention.

These directional cues come in two forms: valid and invalid. A valid cue accurately directs participants' attention toward the same side as the impending target stimulus. Conversely, an invalid cue purposefully misleads participants by pointing in the opposite direction of the forthcoming target. For instance, an arrow indicating the left side of the screen may precede a target appearing on the right side, posing a cognitive challenge for participants.

Adding an additional layer of complexity, some target stimuli are accompanied by the introduction of white noise sounds, functioning as distractor stimuli. These auditory elements serve to further test participants' capacity to discern and respond to the visual targets amidst competing sensory information.

The experiment unfolds in two distinct blocks, each originally designed to encompass 128 trials. However, a unique feature of this task is the incorporation of a learning mechanism. Upon the completion of each block, any trials answered incorrectly are systematically reintroduced until participants achieve perfect accuracy. This feature ensures a comprehensive evaluation of each participant's visual attention capabilities.

2.6.4 Loudness Perception

The primary objective of this assessment is to investigate the potential decline in sensory adaptation among individuals affected by Covid-19. This examination delves into the realm of loudness perception and how it evolves over time in response to auditory stimuli.

Participants are exposed to a continuous auditory stimulus—a soft, continuous pure tone characterized by its low volume, typically registering below 40 decibels SPL (Sound Pressure Level). [9] This auditory baseline sets the stage for the ensuing investigation.

To assess loudness perception and sensory adaptation, a high-pitched beep, interwoven with subtle white noise elements, is intermittently introduced into the soundscape. This dynamic auditory challenge unfolds over an approximate duration of 3 minutes.

At precise intervals of 20 seconds, this perceptual exploration takes shape as participants are prompted, a total of 9 times, to engage in a comparative analysis. They are tasked with evaluating whether the high-pitched beep they currently hear is of equal loudness to a predetermined reference beep or if it registers as quieter.

2.6.5 Flash Beep

This research endeavor centers on a Temporal Order Discrimination (TOD) task that aims to delve into the realm of multisensory integration, seeking a profound understanding of how individuals perceive the sequencing of auditory and visual stimuli.

Participants engage in a sensory sequencing assessment wherein they are presented with two distinct sensory cues—an auditory beep and a visual flash. The core objective is to determine the temporal order in which these cues were presented.

Adding a layer of complexity, the experiment introduces a variable known as Stimulus Onset Asynchrony (SOA), which encompasses a spectrum of 15 diverse temporal intervals, measured in milliseconds. These intervals span a range from -400 to 400 milliseconds (-400, -240, -200, -160, -120, -80, -40, 0, 40, 80, 120, 160, 200, 240, 400). The positive values signify instances where the visual flash preceded the auditory beep, while the negative values denote cases where the auditory beep preceded the visual flash. This variability in SOA creates a rich landscape for investigating the intricate dynamics of sensory integration.

To ensure a comprehensive exploration of multisensory integrity, participants undergo a total of 120 trials, each presenting a unique combination of auditory and visual stimuli. This extensive trial design allows for the collection of detailed data on individuals' ability to discern the temporal order of sensory events.

2.7 Questionnaires

In the pursuit of precision and the acquisition of a holistic comprehension of each participant's unique circumstances, a series of meticulously crafted questionnaires serve as invaluable instruments. These questionnaires play a pivotal role in this study, contributing to the comprehensive profiling of participants and the generation of profound insights into their conditions.

Unlike traditional questionnaires with predetermined fixed sets of questions, this study employs a dynamic approach. The number of questions within each questionnaire is not preordained; rather, it adapts and evolves in real-time, tailored to the participant's individual responses. This dynamic adaptation ensures that every questionnaire is a bespoke experience, modelled by the participant's previous answers.

These questionnaires serve as windows into the tapestry of each participant's experiences, thoughts, and perceptions. By presenting one question at a time and allowing responses to influence subsequent queries, a nuanced narrative unfolds. Participants are guided through a personalized journey that explores their cognitive processes, emotions, and unique perspectives.

One of the primary functions of these questionnaires is to facilitate precise participant targeting. Through a careful and deliberate inquiry process, the study gains access to valuable information that aids in the identification and selection of participants whose profiles align with the study's objectives.

In essence, these questionnaires are not just tools for data collection; they are dynamic instruments of inquiry, carefully designed to unlock the full spectrum of participant experiences and perceptions, ultimately enriching the study's outcomes and enhancing our understanding of the complex human factors at play.

2.7.1 Covid

Within the framework of this study, a comprehensive questionnaire has been meticulously crafted to unravel the multifaceted aspects of participants' encounters with Covid-19 and the enduring impact it may have left in its wake.

Overview of Questionnaire Components:

1. Covid-19 Encounter: At the heart of the questionnaire lies a series of inquiries designed to discern the nature of participants' interactions with Covid-19. Participants

are prompted to elucidate whether they have directly experienced Covid-19, specifying if it was confirmed through testing, suspected but not confirmed, or if they have remained untouched by the virus.

2. Multiple Episodes: The questionnaire also explores the possibility of recurrent Covid-19 encounters, inquiring if participants have faced the virus on multiple occasions.

3. Symptom Severity Assessment: Participants are tasked with reflecting upon the severity of their Covid-19 symptoms, considering the most severe episode they have endured. This allows for a nuanced evaluation of symptomatology.

4. Symptom Hierarchy: An innovative drag-and-drop interface is introduced, enabling participants to meticulously rank their experienced symptoms in order of severity, from the most debilitating to the least impactful.

5. Additional Symptoms: The questionnaire delves into the realm of additional symptoms, inviting participants to recount any symptoms beyond the conventional spectrum.

6. Recovery Duration: Duration of recovery becomes a pivotal point of inquiry, offering insights into the temporal aspects of participants' post-Covid-19 journey.

7. Vaccination History: The questionnaire inquires about participants' vaccination history, encompassing whether they have received the full array of available vaccinations or have opted to abstain.

8. Vaccination and Subsequent Infection: For those who have had Covid-19, an additional exploration is undertaken to ascertain if the infection occurred following vaccination.

9. Post-Covid-19 Syndrome Examination: A critical facet of the questionnaire revolves around the presence of Post-Covid-19 Syndrome, with options to validate a diagnosis, suspect without confirmation, or report a complete absence of symptoms extending beyond the 12-week threshold.

10. Coping Strategies: The questionnaire is attuned to the diverse strategies employed by participants in managing the enduring effects of Long Covid, including devices, medications, or therapeutic approaches.

11. Cataloging Long-Lasting Symptoms: A comprehensive list of potential long-lasting symptoms or effects is presented, allowing participants to select all that resonate with their experience.

12. Persistent Symptoms Inquiry: Participants are prompted to divulge if they continue to experience any of the aforementioned long-lasting symptoms.

13. Impact on Daily Life: A critical aspect of the questionnaire probes the extent to which enduring symptoms affect participants' daily lives, spanning from no discernible limitations to severe restrictions necessitating nursing care or support.

14. Participant Narratives: Finally, participants are afforded the opportunity to share their unique narratives, adding a qualitative layer to their journey with Covid-19 and its enduring effects.

In essence, this questionnaire transcends mere data collection, serving as a dynamic and insightful instrument that strives to illuminate the diverse dimensions of participants' experiences with Covid-19, enriching our comprehension of the intricate aftermath of this global health challenge.

In essence, this questionnaire transcends mere data collection, serving as a dynamic and insightful tool that seeks to illuminate participants' diverse experiences with Covid-19, enriching our understanding and leveraging this data for future factor analysis.

2.7.2 Quality of life

Within the framework of this study, the quality of life questionnaire has been designed to explore the multifaceted dimensions of participants' contentment and happiness across various facets of their lives.

1. Material Well-Being: This questionnaire delves into participants' feelings of contentment regarding their material comforts. It examines aspects such as their living environment, access to nourishing food, daily conveniences, and the security of their financial situation.

2. Health and Vitality: Participants' physical well-being and vitality.

3. Family and Interpersonal Relationships: The questionnaire scrutinizes the quality of relationships participants share with their parents, siblings, and other relatives.

4. Parenthood and Child-Rearing

5. Intimate Partnerships: Close relationships with spouses or significant others are examined, exploring the depth of emotional connection and contentment within these bonds.

6. Friendship and Social Circles

7. Contributions to Society

8. Civic Engagement: Participants' involvement in organizations and public affairs

9. Lifelong Learning: The questionnaire delves into the pursuit of knowledge and personal growth, including participation in educational pursuits and self-improvement.

10. Self-Understanding: Participants are invited to reflect on their awareness of themselves, encompassing their recognition of personal strengths, limitations, and a sense of life's purpose.

11. Employment and Vocational Satisfaction: Work-related contentment is explored, including participants' feelings about their jobs or in-home work responsibilities.

12. Creative Expression: The extent to which participants engage in creative self-expression is assessed, including their satisfaction with artistic and expressive outlets.

13. Social Activities: The questionnaire inquires about participants' satisfaction with their social lives, encompassing socializing, attending events, and participating in gatherings and parties.

14. Cultural and Entertainment Engagement: Participants' contentment with leisure activities such as reading, listening to music, and enjoying entertainment is examined.

15. Physical Activity and Recreation: The extent to which participants engage in active recreation and physical activities is explored.

16. Independence and Self-Sufficiency: The questionnaire investigates participants' sense of independence and self-sufficiency in daily life.

2.7.3 Fatigue

This questionnaire serves as a comprehensive tool to explore a spectrum of facets related to fatigue, energy levels, concentration, and cognitive abilities in participants. Through a carefully constructed series of questions, it delves into these critical dimensions using a response scale that ranges from “Better than usual” (3) to “Much worse than usual” (0).

Overview of Questionnaire Topics:

1. Fatigue Management: Participants are invited to reflect on their experiences with tiredness and the strategies they employ to manage it. This encompasses issues related to the need for more rest and feelings of sleepiness or drowsiness.

2. Initiation and Energy: The questionnaire delves into participants' ability to initiate tasks and their overall energy levels. It explores whether they encounter difficulties

starting activities and if they perceive a lack of energy, including muscle weakness and a sense of physical weakness.

3. Concentration and Cognitive Abilities: Participants' cognitive function is a central focus of the questionnaire. It probes their ability to concentrate, communicate effectively, and recall information. This includes making slips of the tongue when speaking, finding it challenging to locate the right words, and assessing memory performance.

2.7.4 Personality

This questionnaire serves as a robust tool designed to delve into various dimensions of participants' social behaviour, beliefs, thought perceptions, emotional expressions, and trust. It comprises a series of statements that invite participants to reflect on these diverse facets.

Overview of Questionnaire Topics:

1. Social Anxiety Assessment: Participants are encouraged to consider their experiences with social anxiety, specifically whether they sometimes avoid crowded places due to anxiety and if they feel nervous when meeting new people.

2. Eccentricity and Beliefs: The questionnaire explores perceptions of eccentricity and belief in paranormal phenomena. Participants are prompted to assess whether others perceive them as slightly eccentric and if they hold beliefs in telepathy, clairvoyance, and other psychic forces.

3. Thought Perception and Expression: Participants are invited to reflect on their thought perception and emotional expression. This includes inquiries about whether people comment on their unusual mannerisms and habits, if they have ever experienced thought perception related to telepathy, and if they struggle to express true feelings through speech and facial expressions.

4. Trust and Beliefs in Paranormal: The questionnaire delves into participants' trust-related concerns, such as worries about the loyalty or trustworthiness of friends or coworkers. It also assesses beliefs in paranormal phenomena like mind-reading, fortune-telling, and experiences with astrology, UFOs, ESP, or a sixth sense.

5. Social Interaction: Participants' social interaction patterns are explored, including tendencies to quickly shift topics during conversations, rambling during discussions, and difficulties in forming emotional closeness with others.

6. Perceptions and Self-Image: The questionnaire delves into perceptions of how participants are perceived by others, including whether people take notice of them while shopping, feel that others have ill intentions towards them, or experience the sensation of being watched or talked about by others. It also explores self-image by asking participants to rate themselves as an odd, unusual person and whether they possess eccentric (odd) habits.

7. Emotional Reservedness: Participants' emotional reservedness is investigated, including tendencies to keep their feelings to themselves and whether they often feel that others have ill intentions towards them.

Chapter 3

The Study

3.1 Introduction

This research endeavor seeks to provide a robust methodology for assessing the repercussions of Covid-19 on various facets of cognitive function and neural integrity. The primary objective is to determine whether these alterations are correlated with the persistence and severity of symptoms experienced by individuals post-infection. To achieve this, we are embarking on the creation of a comprehensive system that welcomes participants worldwide, aged 18 and above, to engage in a series of activities and tasks, the results of which will undergo thorough evaluation by a consortium of dedicated researchers and medical experts.

By extending participation to a global community, we aspire to attain a more encompassing and representative dataset. This approach ensures that the findings gleaned from this research reflect the collective experiences and impacts of Covid-19 on a global scale, transcending the confines of a single region or country.

Participants are encouraged to engage in a diverse array of tasks and questionnaires thoughtfully designed to elicit valuable data. These data points are intended to serve as valuable insights for medical practitioners and researchers alike. Leveraging cutting-edge technology, our project endeavors to streamline and expedite the data collection process, all the while maintaining the highest standards of data quality.

3.1.2 System Framework and Research Endeavor

The primary aim of this study is to elucidate the intricate effects of COVID-19 on various facets of cognitive function and neural integrity. Our mission is to uncover whether these changes correlate with the persistence of post-infection symptoms. To facilitate this mission, we have established a dynamic platform accessible to a diverse range of users aged 18 and above, enabling them to partake in an array of activities.

Registered users will gain access to our interface that presents an assortment of five distinct tasks and five questionnaires, each to be undertaken at the participant's

discretion. One key aspect of our methodology is the utilization of responses from a normative sample, contributing to the creation of robust norms for each activity. This approach ensures the highest degree of reliability in the data collected. Researchers and lab assistants are granted comprehensive access to data generated by all activities, empowering them to make well-informed decisions and draw insightful conclusions based on the wealth of information at their disposal.

3.1.3 Project Purpose

Our endeavor centers on enhancing a versatile platform to ensure maximum accessibility and utility for users, administrators, and researchers. This comprehensive expansion encompasses various key aspects:

Our web-based application is designed to seamlessly function across a wide spectrum of contemporary web browsers, including but not limited to Chrome, Firefox, and Edge. This commitment to compatibility ensures that users can engage with the platform regardless of their browser preference.

The platform prioritizes a user-centric experience, ensuring that participants find task completion and questionnaire responses straightforward and intuitive. This focus on user-friendliness enhances engagement and data quality.

Administrators play a pivotal role in overseeing user management within the platform. They are responsible for overseeing access, permissions, and user-related functions, ensuring a smooth user experience.

Recognizing the diverse linguistic backgrounds of our participants, our platform offers multilingual support. Currently, users can engage with the platform in English, Italian, and Spanish, reflecting our commitment to inclusivity.

In addition to platform enhancements, another fundamental objective of our work involves the management and analysis of data provided by participants. We employ statistical techniques, including factor analysis, to derive valuable insights from the data at our disposal.

One pivotal outcome of this data analysis is the creation of a Long-COVID Severity Index. This index is meticulously constructed using the data gathered, allowing us to gauge the severity of long-lasting COVID-19 symptoms comprehensively.

3.2 Observations

it is pertinent to highlight that following my integration into the team, the Happy Again project had already undergone global development and had undergone partial testing. An initial Alpha version was deployed and utilized for data collection and feedback gathering. Psychologists from the University of Essex, along with a limited group of authorized users, participated in this preliminary phase.

This early deployment and feedback collection phase were essential in refining the project and ensuring that it meets its objectives effectively. It allowed for critical input from professionals in the field and real-world user testing to shape the platform's functionality and usability.

The insights and feedback obtained during this phase have played a significant role in shaping the project's direction and enhancing its capabilities.

3.2.1 Improvements and Innovation

My role in this dynamic process encompassed the enhancement of pre-existing components, bug rectification, bolstering system security, and the seamless integration of novel features. It is paramount to acknowledge that each update was invariably accompanied by invaluable feedback from both psychologists and users, catalysing the continual enhancement and optimization of the application.

It is essential to underscore that this developmental process adhered to a cyclical paradigm, wherein fresh feedback was continually solicited and integrated while preexisting concerns were meticulously categorized based on their priority levels: High, Medium, and Low.

The subsequent tables furnish a comprehensive overview of the primary requisites and serve as a testament to my active contributions, as substantiated by the GitHub commits.

Task	To fix or to implement
General	- Prevent participants from accessing and completing a task more than once through its URL. - Send reminders to the participants that successfully registered but didn't complete the tasks. - Allow a registration only with an OTP valid code. - The information sheet must provide the informations about otp codes and the voucher for people of other countries.
Registration	- Add in the form the input for the otp code
Word Categorization	- The system must save the time of reaction
LCSI	- Compute long covid severity index for data analysis

Table 1. High priority requests categorized by task

Task	To fix or to implement
Admin Area	-Add Statistics download for the word categorization task with IC,EC,IW,EW,NG information, information rate -Add users informations to download: language, unique subject code, voucher/no voucher, valid/invalid
Users	-Add no voucher users
Registration	-Added new otp code: 'HappyAgainTrial'
Charlie	-Add Charlie task in the download area with the info about the covid, fatigue, quality and WC statisctics for all users -Transform each answer to a scale value to successively perform the factor Analysis -Add LCSI and MT_C

Factor Analysis	-Implement the factor analysis by normalizing the matrix of the data and do the dot product with the resultant matrix score coefficients of spss
MDS	-Implemented the Multi Dimensional Scaling matrix

Table 2. Medium priority requests categorized by task

Task	To fix or to implement
Admin area	- Downloads of all the tasks for all users - Add users info - Add correct responses to download of “Word Categorization Task” - Add word occurrences to download of “Word Categorization Task” - Update columns of the “Word Categorization Task” download with expected ang given responses and the name of the task: WC (Word Categorization), MT (Memory Task) - Update word recognition download with given and expected response

Table 3. Low priority requests categorized by task

3.3 Functional Requirements

When we delve into the process of delineating requisites for a web application project, it becomes evident that there exist two distinct categories: Functional Requirements and Non-Functional Requirements.

Functional Requirements are a set of guidelines that specify what a software system needs to do, defining its features, capabilities, and behavior. They outline the system's actions, interactions with users, and responses to different situations, answering the question, "What should the software system achieve?" In essence, they provide a detailed description of how the software should function in response to various inputs and scenarios.

We encounter a diverse set of prerequisites born from the initial web application design and the iterative feedback process. These requirements, which form the backbone of

the application's functionality, have been assembled into a comprehensive framework together with the additional ones, as elaborated in the forthcoming section.

Identifier	Description
FR-1	The application must initiate with a welcoming window displaying study information for participants.
FR-2	The system is accountable for overseeing the registration process for all participants.
FR-3	The system is obligated to furnish participants with study information and a consent form.
FR-4	The system must enable user registration only after participants accept the consent.
FR-5	The system must transmit an email to the participant for email address confirmation and account validation.
FR-6	The system must offer the option of resending the confirmation email should it go undelivered or become untraceable for the participant.
FR-7	The system must grant access to all registered participants for signing in.
FR-8	The system is mandated to differentiate between participant-users and administrator-users.
FR-9	The system must incorporate a mechanism for password reset.
FR-10	The system must afford participants the ability to log in and log out at their discretion.
FR-11	The system is required to detect and retain metadata concerning the device(s) utilized by participants.
FR-12	The system must present the tasks and questionnaires in an intuitive and user-friendly manner.
FR-13	The system must facilitate participants' return to the home page at any point.
FR-14	The system must display the estimated time required to complete each task and questionnaire.
FR-15	The system must permit participants to complete the “Demographics” questionnaire only once and store the results.
FR-16	The system must display only the current question of the “Demographics” questionnaire.

FR-17	The system must enable scrolling between questions of the “Demographics” questionnaire using “PREV” and “NEXT” buttons, which are activated only when the current question has been answered.
FR-18	The system must allow participants to complete the “Covid” survey only once and store the results.
FR-19	The system must show solely the current question of the “Covid” survey.
FR-20	The system must facilitate scrolling between questions of the "Covid" survey using “PREV” and “NEXT” buttons, which are activated only when the current question has been answered.
FR-21	The system must block participants who declare not having had Covid-19 so they are not able to proceed.
FR-22	The system must permit participants to complete the “Personality” survey only once and store the results.
FR-23	The system is responsible for presenting a comprehensive instructional description before participants can initiate the initial part of the “Word Categorisation” task.
FR-24	The system must afford participants a practice trial for the initial segment of the “Word Categorisation” task.
FR-25	The system shall enable participants to complete the initial part of the “Word Categorization” task following the demo and save the results.
FR-26	The system is mandated to present an extensive instructional description before participants can commence the second part of the “Word Categorisation” task.
FR-27	The system is authorized to allow participants to complete the second part of the “Word Categorisation” task and accurately store the results.
FR-28	The system must display a detailed instructional description for the "Flash Beep" task and prompt participants to select an audio device before they can start.
FR-29	The system must provide participants with a practice trial for the “Flash Beep” task.
FR-30	The system must permit participants to undertake the “Flash Beep” task following the demo and save the results.
FR-31	The system must present a detailed instructional description for the “Loudness Perception” task and prompt participants to select an audio device before allowing them to start.
FR-32	The system must provide participants with a practice trial for the “Loudness Perception” task.

FR-33	The system will allow participants to undertake the “Loudness Perception” task following the demo and save the results.
FR-34	The system will display a detailed instructional description for the “Target Detection” task and prompt participants to select an audio device before allowing them to start.
FR-35	The system must provide participants with a practice trial for the “Target Detection” task .
FR-36	The system will enable participants to undertake the “Target Detection” task following the demo and save the results.
FR-37	The system must present a detailed instructional description for the “Movement Perception” task before participants can initiate.
FR-38	The system will request participants to configure the screen through a size matching exercise before allowing them to start the “Movement Perception” task.
FR-39	The system must provide participants with a practice trial for the “Movement Perception” task.
FR-40	The system shall permit participants to undertake the “Movement Perception” task following the demo and save the results.
FR-42	The system must allow participants to complete the “Quality Of Life” questionnaire only once and store the results.
FR-43	The system must display only the current question of the “Quality Of Life” questionnaire.
FR-44	The system shall facilitate scrolling between questions of the “Quality Of Life” questionnaire using “PREV” and “NEXT” buttons, which are activated only when the current question has been answered.
FR-45	The system must allow participants to complete the “Fatigue” questionnaire only once and store the results.
FR-46	The system must exhibit solely the current question of the “Fatigue” questionnaire.
FR-47	The system shall enable scrolling between questions of the “Fatigue” questionnaire using “PREV” and “NEXT” buttons, which are activated only when the current question has been answered.
FR-48	The system is mandated to clearly indicate to participants which tasks they have already completed and which ones are available.
FR-49	The system must notify researchers through an automated email mechanism as soon as a participant completes all the tasks and questionnaires.
FR-50	The system must enable admin-users to access the dedicated Admin Area.

FR-51	The system must enable admin-users to view the list of active users, the number of tasks they have completed, and the timestamp for each completed task.
FR-52	The system must enable admin-users to download participants' gathered data, both individually and collectively.
FR-53	The system must enable admin-users to search for specific participant information.
FR-54	The system is required to notify admin-users through a web app notification when new data becomes available.
FR-55	The system must send reminder emails to all the users that successfully registered but didn't complete all the tasks after one week
FR-56	The application must inform participants, prior to registration, whether they are eligible for a voucher and provide them with a registration code in case they do not meet the voucher requirements.
FR-57	The application must save the information if the user can have or not the voucher
FR-58	The application must show the captcha before the participant perform the tasks
FR-59	The application must allow a registration only with a valid otp code
FR-60	The application must guarantee a filter for the admins to navigate through different types of users
FR-61	The application must show in the admin area for each participant in the admin area if he can have or not the voucher and a check box to remind if it has been sent or not
FR-62	The application must allow the admins to extend a partecipant
FR-63	The system must show in all downloads the information about the users, if is valid, if can have the voucher and his uid
FR-64	The application must insert in the "Word Categorization Task" download additional informations: statistics and word frequency
FR-65	The application must add a download called "Charlie" with all data regard the Covid, Fatigue and Quality questionnaires and Word Categorization statistics
FR-66	The system must perform the factor analysis and show the results in the "Charlie" download
FR-67	The system must calculate the LCSI severity indexes and show them in the "Charlie" download

Table 4. Functional Requirements

3.4 Non-Functional Requirements

Non-functional requirements (NFRs) are constraints and characteristics that outline the operational behavior and performance standards a software system must adhere to, apart from its core functionality. These requirements delineate the qualitative aspects governing the system's operation and serve as benchmarks for evaluating its overall quality and reliability. Their focus is on how it should perform, rather than what it should do. These requirements describe the system's qualities, characteristics, and constraints. They are crucial for ensuring the overall quality, performance, and usability of the software.

3.4.1 Performance

The performance metrics quantify how the system should behave in terms of execution speed, responsiveness, and efficient resource utilization, often involving criteria such as response times, throughput, and scalability thresholds.

Attribute	Description
Identifier	NFR-01
Name	Throughput
Description	The system's capacity to handle incoming requests within a specific timeframe.
Metric Target	30,000 requests/minute
Priority	Medium

Table 5. Non-Functional Requirement 1

Attribute	Description
Identifier	NFR-02
Name	Front-end response time
Description	The duration required to execute a task that doesn't require interaction with the backend.
Metric Target	1 second
Priority	Medium

Table 6. Non-Functional Requirement 2

3.4.2 Reliability

Reliability pertains to a system's or component's capacity to consistently execute its designated tasks without encountering failures or mistakes during a predetermined timeframe and within established circumstances.

Attribute	Description
Identifier	NFR-03
Name	Connection Interruption Tolerance
Description	The system remains operational with on-site interactions even following a brief disruption in internet connection.
Metric Target	Availability percentage of 99.5%.
Priority	High

Table 7. Non-Functional Requirement 3

3.4.3 Security

Security requirements dictate the level of protection needed and the compliance with relevant security standards and regulations to mitigate risks and vulnerabilities effectively.

Attribute	Description
Identifier	NFR-04
Name	Secure authentication token
Description	A robust encryption method is utilized to create the authentication token for user verification.
Metric Target	None
Priority	High

Table 8. Non-Functional Requirement 4

Attribute	Description
Identifier	NFR-05
Name	Secure connection to the backend
Description	All requests to the backend must employ the HTTPS security protocol, and any HTTP requests should be automatically redirected to use HTTPS.
Metric Target	None

Priority	High

Table 9. Non-Functional Requirement 5

3.4.4 Scalability

The Scalability is the capability of a system or application to handle a growing amount of work, while maintaining performance and efficiency.

Attribute	Description
Identifier	NFR-06
Name	Auto Scaling
Description	The server must have the capability to adjust dynamically when there is an increase in client-side requests.
Metric Target	Configuration in order to support 1000 requests/minute and scale up to 30,000 requests per minute.
Priority	High

Table 10. Non-Functional Requirement 6

3.4.5 Interoperability

It specify how the system should interact and exchange data with other systems, both within and outside.

Attribute	Description
Identifier	NFR-07
Name	Backend Server API Connectivity

Description	The server should be able to perform queries on the backend server and possess the required permissions to make alterations to the existing database.
Metric Target	None
Priority	High

Table 11. Non-Functional Requirement 7

3.4.6 Resource Management

Resource management encompasses the system's ability to efficiently allocate, utilize, and monitor its resources, this includes ensuring that resources are used optimally, preventing resource bottlenecks.

Attribute	**Description**
Identifier	NFR-08
Name	Memory Limits
Description	This requirement sets the maximum allowable memory usage for the client-side operations of the web application.
Metric Target	2 GB of RAM
Priority	High

Table 12. Non-Functional Requirement 8

3.4.7 Usability

It defines how the system is “user friendly”, focusing on the user experience and the design of the interfaces.

Attribute	Description
Identifier	NFR-09
Name	Participant-friendly interface
Description	The application must guarantee that all interfaces and activities accessible to users are intuitive and easy to navigate.
Metric Target	None
Priority	High

Table 13. Non-Functional Requirement 9

Attribute	Description
Identifier	NFR-10
Name	User-friendly interface for the administrators
Description	The application must ensure that all interfaces and activities available to administrative users are user-friendly and intuitive, facilitating straightforward usage.
Metric Target	None
Priority	Medium

Table 14. Non-Functional Requirement 10

3.4.8 Avaiability

This metrics guarantee that the system remains accessible and operational as needed.

Attribute	Description
Identifier	NFR-11
Name	Server availability
Description	The server should maintain high availability, minimizing downtimes and ensuring uninterrupted service for most of the time.
Metric target	Availability percentage of 99.5%
Priority	High

Table 15. Non-Functional Requirement 11

3.4.9 Maintainability

Maintainability refers to the system's capacity for straightforward and cost-effective management, including the ability to identify and resolve problems, implement improvements, and adapt to evolving needs without causing major disruptions or incurring substantial expenses.

Attribute	Description
Identifier	NFR-12
Name	Logs
Description	The system must retain a comprehensive log of every action and operation executed, enabling the transmission of this information in case of any errors or issues.
Metric Target	None

Priority	High

Table 16. Non-Functional Requirement 12

Attribute	**Description**
Identifier	NFR-13
Name	Version Support
Description	The system must ensure continuous operation even when undergoing system upgrades or modifications.
Metric Target	None
Priority	High

Table 17. Non-Functional Requirement 13

3.4.10 Portability

Metric that expose how the application be easily moved or adapted to different environments, platforms, or systems without significant modifications.

Attribute	**Description**
Identifier	NFR-14
Name	Timestamps In International Format
Description	It is crucial to ensure that all timestamps gathered within the application are standardized and formatted according to the Coordinated Universal Time (UTC).

Metric Target	None
Priority	High

Table 18. Non-Functional Requirement 14

Attribute	**Description**
Identifier	NFR-15
Name	Multi-platform
Description	The system must exhibit platform agnosticism and be compatible with widely used web browsers like Chrome, Firefox, Microsoft Edge, and Safari.
Metric Target	None
Priority	High

Table 19. Non-Functional Requirement 15

Chapter 4

Solution Development and Design

This chapter provides an in-depth exploration of the steps taken to develop the web application, offering a comprehensive overview of the existing implementation along with the enhancements introduced. It also delves into the data analysis, which has been a focal point of my work. Within this section, we will describe the applied methodology and both the original and updated use cases that define the success scenarios.

4.1 Strategy Adopted

The software release lifecycle is a structured process that guides the journey of a software product from its conceptualization to its delivery to end-users. It encompasses a series of phases and activities aimed at ensuring the successful development, testing, and deployment of software applications. This lifecycle is essential for achieving quality, reliability, and user satisfaction.

Our primary aim was to introduce substantial refinements to the existing version of the software. This involved augmenting its security measures and introducing a suite of supportive tools tailored to the needs of psychologists. The overarching goal was to transform the product into a significantly more secure, robust, and efficient solution that would cater to a wider range of user requirements.

The strategic approach employed in this endeavor is deeply rooted in our overarching goal. In my case, this goal encompasses both the essential user requirements and the ultimate product that users must engage with. Furthermore, it extends to the proficient management of data, paving the way not only for the work of psychologists but also for the subsequent data analysis, which will be elucidated in subsequent sections of this paper.

To gain a comprehensive understanding of our methodology, it is crucial to revisit the initial stages outlined in previous work regarding the development of the application. These stages include:

1. Initiation and Planning
2. Definition
3. Develop

4. Prototype
5. Test

In this updated version, each of these foundational steps is infused with the insights and experiences garnered during our work. We embrace a top-down approach, a methodology that entails starting with a high-level perspective before delving into finer details. This approach provides a holistic view of the project, fostering effective decision-making and comprehensive problem-solving.

By adhering to this strategic and methodological framework, we aim to not only meet user needs but also enhance data management, ultimately supporting the endeavors of psychologists. Moreover, this approach aligns with the broader objective of facilitating the subsequent data analysis phase. The subsequent sections of this paper will delve deeper into these facets, providing a comprehensive account of our journey and its outcomes.

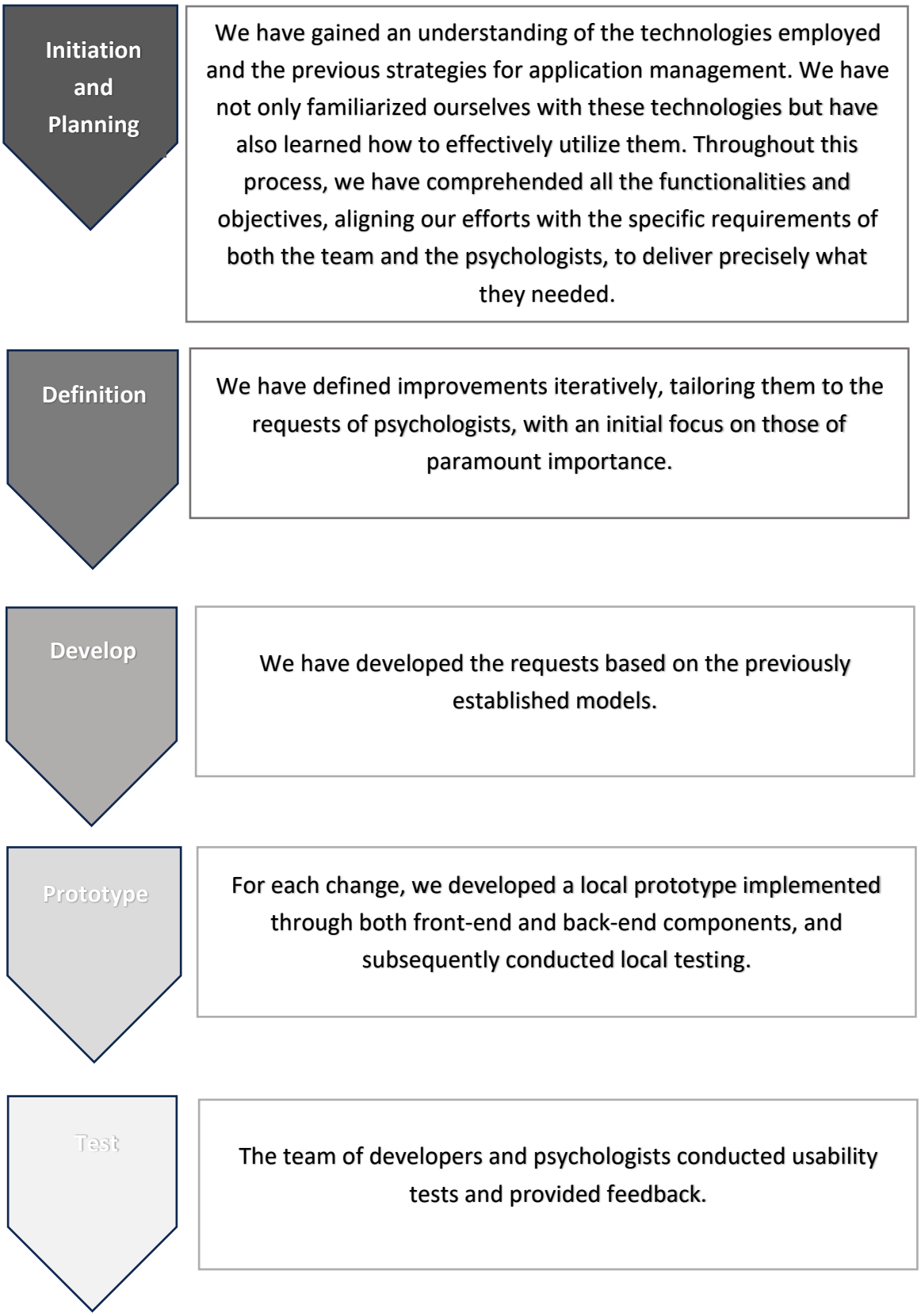


Figure 3. Schema of the Design Process

4.2 Use Cases

A use case is a written description of how users will perform tasks on the website. [10]. They constitute a systematic approach for comprehensively describing and documenting the intricate interactions and functionalities that end-users can engage with within a particular system. These interactions essentially encapsulate various scenarios and situations wherein the system comes into play to accomplish well-defined objectives. The overarching purpose of use cases is to provide a user-centric perspective that elucidates how the system will be utilized, thereby enabling the elicitation and elucidation of specific system requirements. In the following are shown a bunch of use cases that describes some of the application functionalities, not all of the use cases as the main focus of this work is the data analysis.

ID	**UC1**
Name	Register
Functional requirement	FR-1, FR-2, FR-3, FR-4, FR-5, FR-6.
Goal	The participant is able to register for the study.
Pre-condition	The participant was shown a Welcome page.
Post-condition	The system records the participant's data in a secure stand-alone database under a pseudo-nym.
Main success scenario	1. The participant clicks on the "Register" button. 2. The information sheet on the study is presented. 3. The participant reads the consent form and agrees to participate in the study. 4. The participant clicks again on the "Register" button. 5. The registration screen is shown. 6. The participant fills all the entries, name, email, password and OTP code with valid data clicks on the "Confirm" button. 7. The system stores the entered user data into a secure database. 8. The application informs the participant that an email was sent to the provided address to verify their account. 9. The participant clicks on the link and validates their account. 10. The redirected page informs the participant about their successful registration.
Includes/Extends	Validation:

	6.a.1. The participant's email has already been used and it's recorded in the database. The application informs the participant about their existing account. 8.a.1. The participant is unable to find the email sent. The application offers to click on "Resend email".

Table 20. UC1 - Register.

ID	**UC2A**
Name	Log in
Functional requirement	FR-6, FR-7, FR-8, FR-9.
Goal	The participant is able to log into the application.
Pre-condition	The participant is successfully registered.
Post-condition	The system records the active session of the participant and redirects them to the Home page.
Main success scenario	1. The participant clicks on the "Log On" button. 2. The log on screen is shown. 3. The participant fills all the entries, email and password. 4. The system authenticates the participant's entered data. 5. The participant is logged in and presented the Home page.
Includes/Extends	Password recovery: 3.a.1. The participant does not remember their password. The application shows a "Forgot password" button to click on. 3.a.2 The application presents a screen where the participant can enter their email and establish a new password in case they need to. Authentication: 4.a.1. The system is unable to find the participant's data. The application displays a "No user created with the inserted email" message. 4.a.2. The entered password does not match the one registered. The application displays a "No user created with the inserted email" message.

Table 21. UC2A – Login.

ID	**UC2B**
Name	Log Out

Functional requirement	FR-10.
Goal	The participant is able to log out from the application.
Pre-condition	The participant is logged in.
Post-condition	The system records the ending of the session, and the participant is redirected to the Log on page.
Main success scenario	1. The participant clicks on the “Log Out” button. 2. The system stores the ending session time. 3. The application shows the “Log On” screen.
Includes/Extends	None

Table 22: UC2B – Log Out.

ID	**UC3**
Name	Home
Functional requirement	FR-11, FR-12, FR-13, FR-14.
Goal	The participant is able to see the initial instructions, a full menu of tasks and questionnaires to work on.
Pre-condition	The participant is logged in.
Post-condition	None
Main success scenario	1. The application presents the first instructions of the study, including recommendations for completing tasks. 2. The application displays 10 task options in the form of buttons, which each show the estimated time it requires to complete them.
Includes/Extends	None

Table 23: UC3 - Home.

ID	**UC4**
Name	Admin
Functional requirement	FR-8,FR-50,FR-51,FR-52,FR-53.
Goal	The admin is able to see all the participant and the tasks they did and has the possibility to download the data
Pre-condition	The admin is logged in.
Post-condition	None
Main success scenario	1. The application presents the homepage. 2. The user cliks on “Admin-area” in the top bar menu. 3. The application shows all the users the tasks they completed.

	4. The user select one user. 5. The application shows the tasks of that specific user and a download button. 6. The admin clicks on the download button for the tasks he need the informations about. 7. The application start the download of the file.
Includes/Extends	None

Table 24: UC4 - Admin.

4.3 Architecture

Based on the previous work, let us briefly elucidate the architecture that has been modeled for this project. The software employs a client-server architecture, where the client initiates requests to the server, and subsequently, the server provides requested information based on the permissions assigned to the client. This architecture is structured into three layers: presentation, application, and data.

The presentation layer encompasses all elements visible to the user, including interfaces and thus the frontend. It is the layer through which user interaction primarily occurs. In contrast to the previous work, additional interfaces have been incorporated into the frontend. Notably, an admin interface has been introduced, accessible exclusively to users with specific requirements and permissions. This admin interface facilitates operations that are not available in a regular user interface.

The application layer, on the other hand, represents the business logic that interacts with the presentation layer through APIs. For technical clarification, APIs (Application Programming Interfaces) are sets of protocols and tools that enable different software applications to communicate with each other. In this context, APIs serve as intermediaries connecting the presentation layer with the application layer. Furthermore, the application layer interacts with the underlying data layer to retrieve and provide the requested results to the frontend.

The code is structured into two main folders:

1. Models: This directory houses the data models corresponding to each of the experiments and questionnaires.
2. APIs: It serves as the hub for handling and maintaining all the connections associated with the experiments and questionnaires.

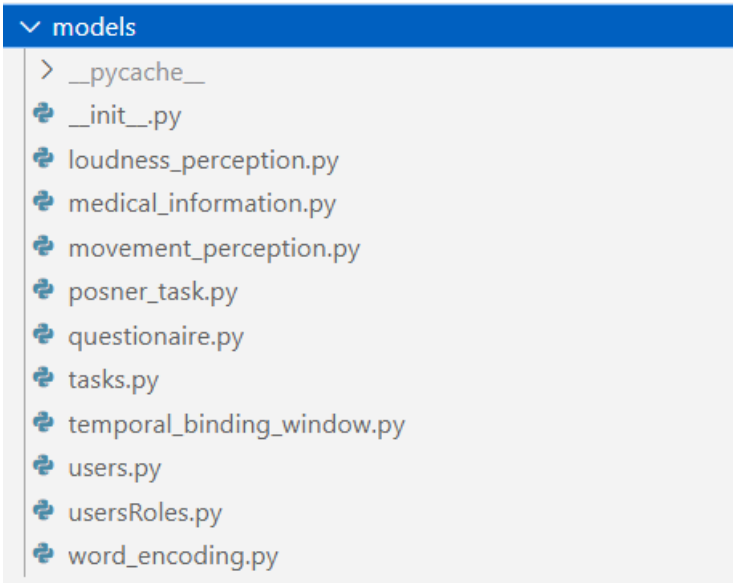


Figure 4. models folder.

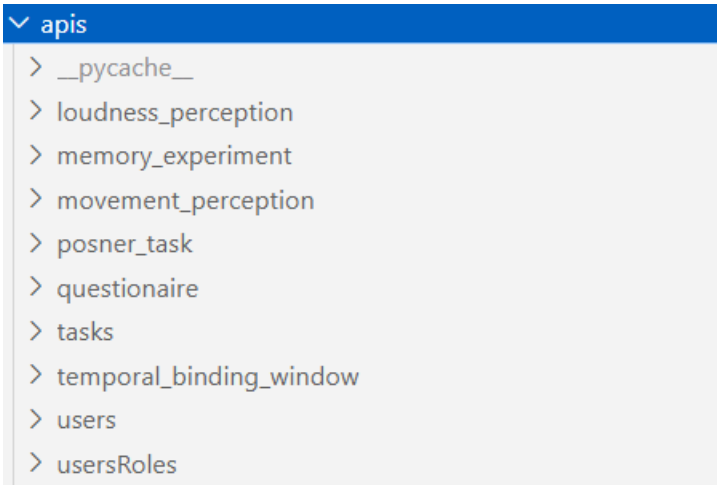


Figure 5. apis folder.

Lastly, we have the data layer, where all data is stored within a relational database. A relational database, in essence, is a type of database that organizes and stores data in structured tables with defined relationships between them. Within this database, various information is stored, including user details, codes, task creation data, user responses pertaining to different tasks, and relevant data for analysis. Notably, two primary databases are maintained:

1. Userdb: This database houses information related to users and administrators.

2. Happyagaindb: This database stores information pertaining to tasks and analytical data.

This architectural framework forms the backbone of our software solution, ensuring efficient data management, user interaction, and business logic implementation.

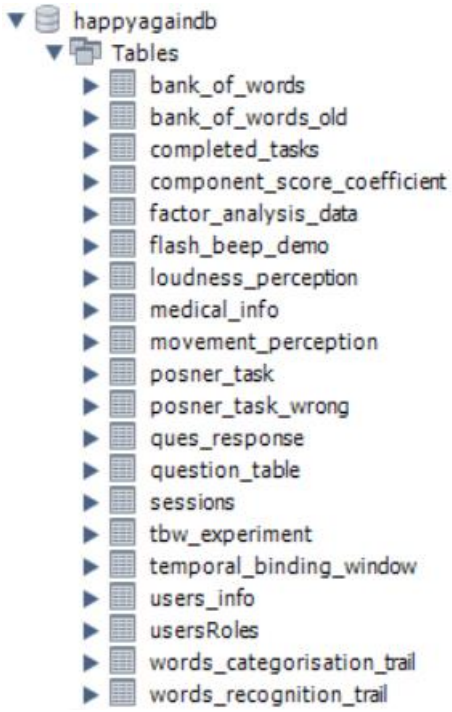


Figure 6. happyagaindb database.

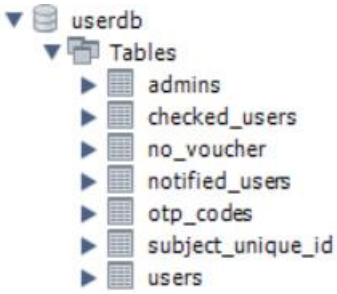


Figure 7. userdb database.

Chapter 5

Results

For the development of this project, a diverse array of programming languages, frameworks, and libraries were employed, spanning across frontend, backend, and database management, as well as for data analysis. In this chapter, I will elucidate the technologies that were utilized, followed by an in-depth exposition of the data analysis work undertaken.

5.1 Technologies

5.1.1 Front-end

In the realm of frontend development, we harnessed the Angular framework, a potent tool created and maintained by Google. It seamlessly integrates with RESTful APIs and works smoothly with various backend services. Its claim lies in its ability to expedite frontend development by simplifying the creation of components and essential services, sparing developers the need to build them from scratch, it produce dynamic content through templates enriched with variables and expressions, breaking free from the constraints of static HTML components. It's also versatile, ensuring compatibility with different platforms, web browsers, and operating systems. It excels in both unit testing and end-to-end testing. Angular is built on TypeScript, a programming language that optimizes development and is extensively used in the documentation.

One of Angular's defining features is its adherence to the Model-View-ViewModel (MVVM) pattern, comprising these vital elements:

- Model: These classes represent the data layer and aren't visible.
- View: This defines the user interface's structure and appearance.
- ViewModel: This component bridges data and notifies view status changes through logic and attributes, forming the backbone of the architecture.

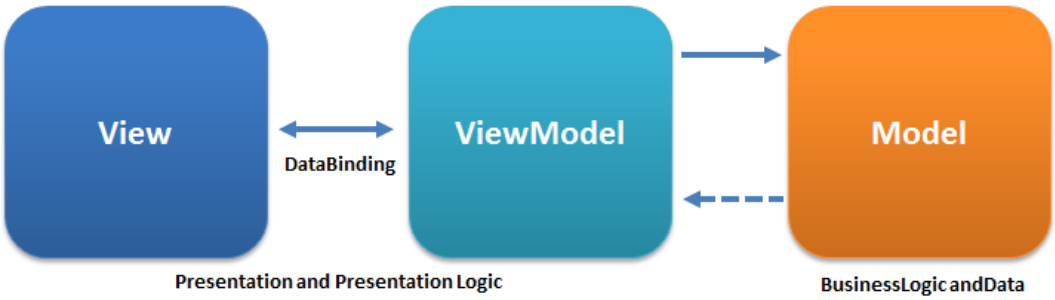


Figure 8. MVVM [11].

5.1.1 Back-end

In crafting the backend of the project, we turned to the Python Flask framework. Flask, a lightweight framework, provides a fundamental toolkit for developing backend web applications. It has the flexibility to import additional extension packages as needed. Notably, the extensions employed in this project include:

1. Flask-MySQLdb: This extension facilitates the seamless connection between Flask and MySQL databases.
2. Flask-SQLalchemy: It empowers the creation of data models and facilitates connectivity with the two essential MySQL databases.
3. Flask-Mail: This extension simplifies the setup of the Simple Mail Transfer Protocol (SMTP), enabling the delivery of registration emails to participants.
4. Flask-Cors: CORS, or Cross-Origin Resource Sharing, plays a pivotal role in configuring the server and controlling access rights to specific server resources. It serves as a gatekeeper for requests from other domains.
5. Flask-JWT-Extended: This extension provides robust features for user authentication, as well as the secure storage and retrieval of security tokens for each user.
6. The Passlib library is leveraged to support an extensive array of hash algorithms, with the application employing the pbkdf2 sha256 library class for hashing user passwords.

5.1.1 Database

The Database that was chosen for the storage of the data is MySQL. It represents a prominent relational database management system, widely acclaimed for its robustness and adaptability. It distinguishes itself as an open-source solution, available for unrestricted download and utilization, rendering it an accessible choice for both software developers and enterprises.

In its essence, MySQL is purpose-built for the structured storage and meticulous organization of data within tabular structures. This architectural foundation equips users with the capability to efficiently manage, query, and retrieve data, rendering it suitable for an extensive spectrum of applications, spanning from modest web applications to intricate corporate IT ecosystems.

5.1.2 Data Analysis

For data analysis, particularly in the context of factor analysis, which will be elaborated upon in the subsequent chapter, the software utilized is SPSS.

SPSS, or Statistical Package for the Social Sciences, is a powerful software tool widely utilized for data analysis across various research domains. It serves as a comprehensive solution for statistical analysis and data management. It provides a wide range of statistical procedures, from basic descriptive statistics to advanced multivariate analyses like factor analysis, the one used in this work. Is a versatile and robust tool for data analysis and it also offers a wide range of statistical procedures, user-friendly functionality, and robust data management capabilities.

5.2 Interfaces

In this section, we will present a series of screenshots depicting the user interfaces that have been developed with our team. The selection of interfaces to be showcased primarily revolves around those linked to the prior phases of our project. However, the central emphasis will be placed on illustrating the various updates and enhancements that have been integrated into these interfaces. Notably, particular attention will be devoted to spotlighting the newly introduced functionalities specifically for admins. These screenshots serve as a visual representation to the evolution of our user interfaces, showcasing the innovation invested in optimizing the user experience, particularly for those with administrative roles.

5.2.1 Homepage

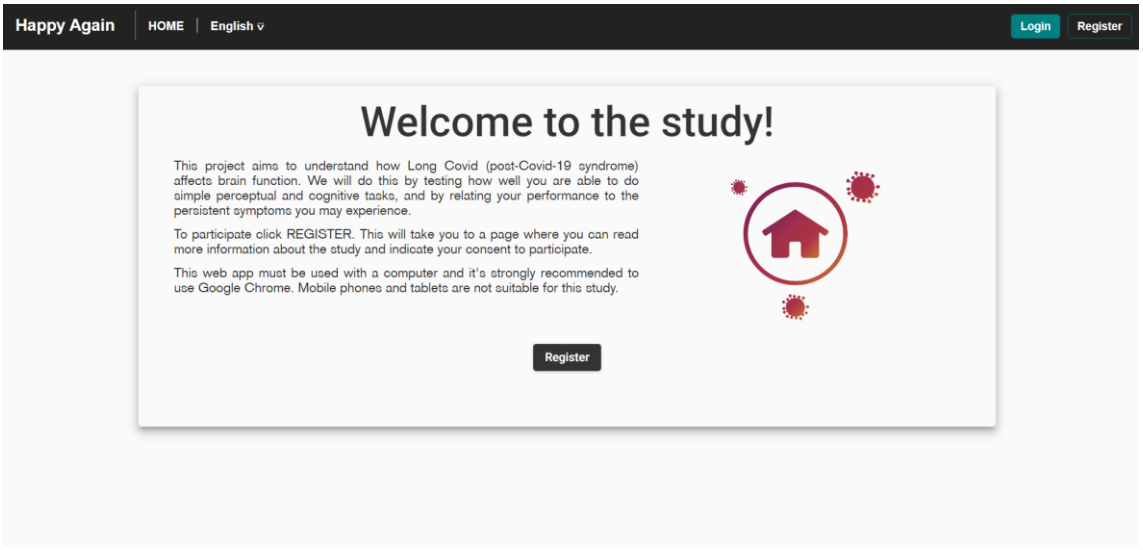


Figure 9. no logged-in homepage.

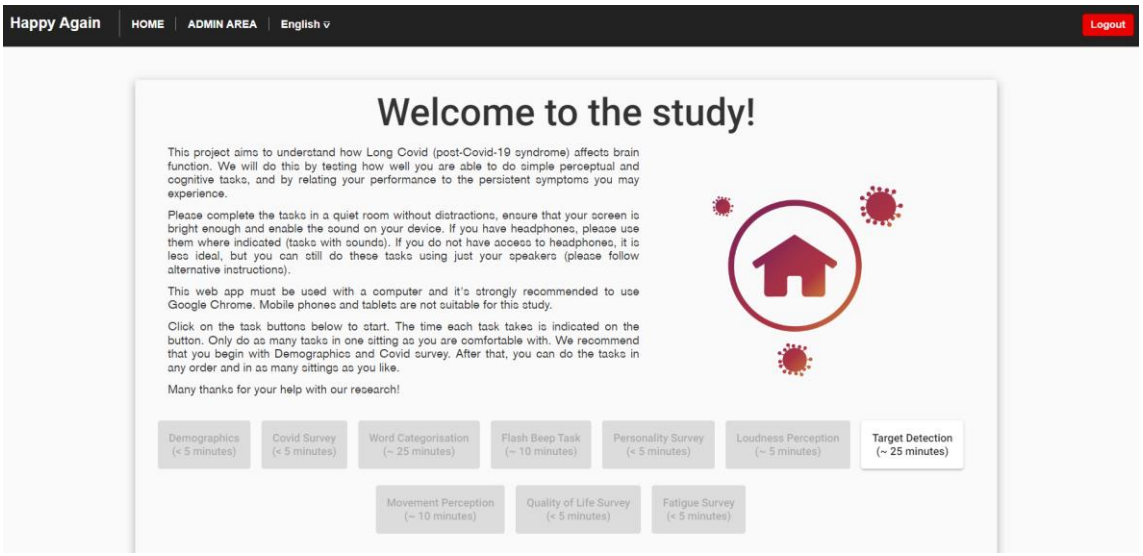


Figure 10. logged-in admin homepage.

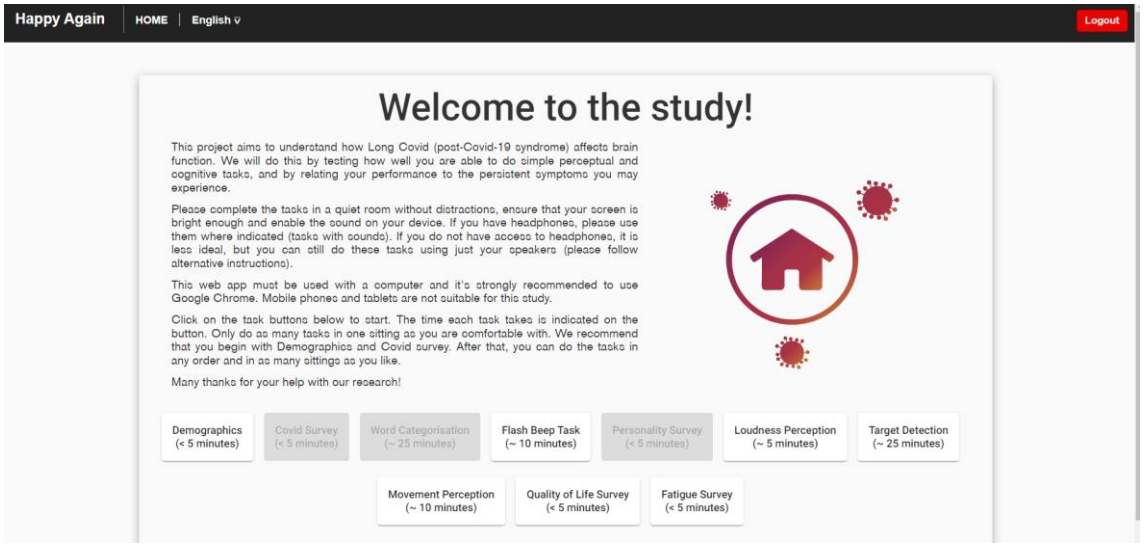
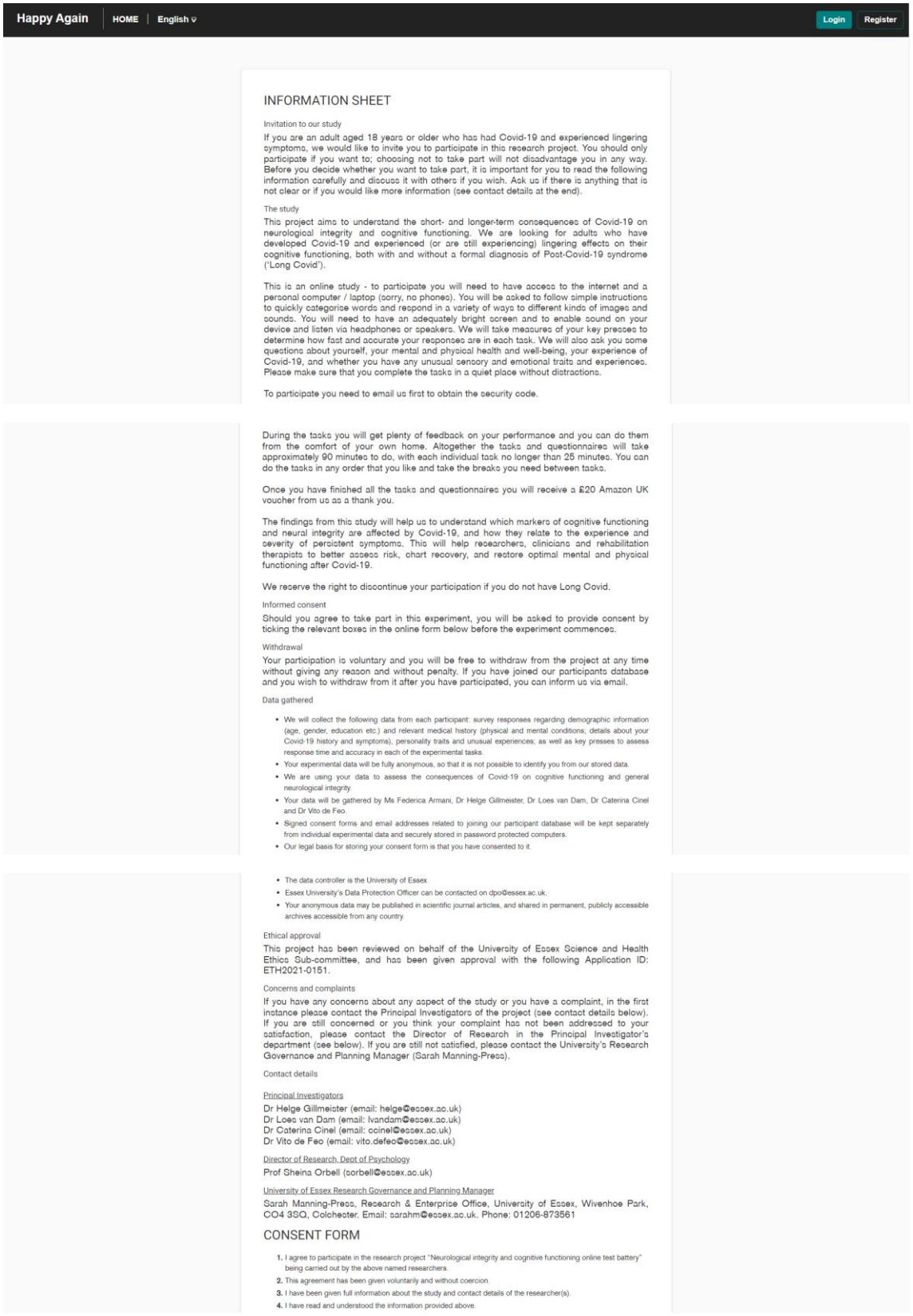


Figure 11. logged-in user homepage.

These three interfaces display the website's homepage, which has remained unchanged from the previously developed site, and respectively show the homepage for a non-logged-in user, an administrator home page (logged-in), and a regular logged-in user. The only noticeable difference is the ability to access the admin area in the top menu for the administrator.

It is also possible to notice that, the colour of the buttons for tasks changes depending on whether the task has been completed or not. If the task has been completed, it will be greyed out and no longer selectable. Conversely, if the task is incomplete, the button remains white and selectable, indicating a pending task.

5.2.2 Registration



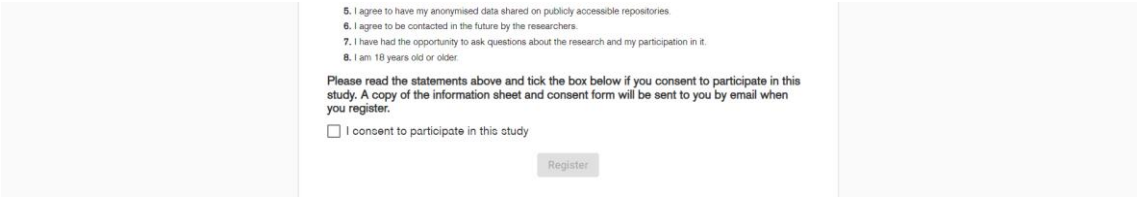


Figure 12. consent form.

The figure above shows the consent form that a user needs to sign if he wants to register for the participation of this study.

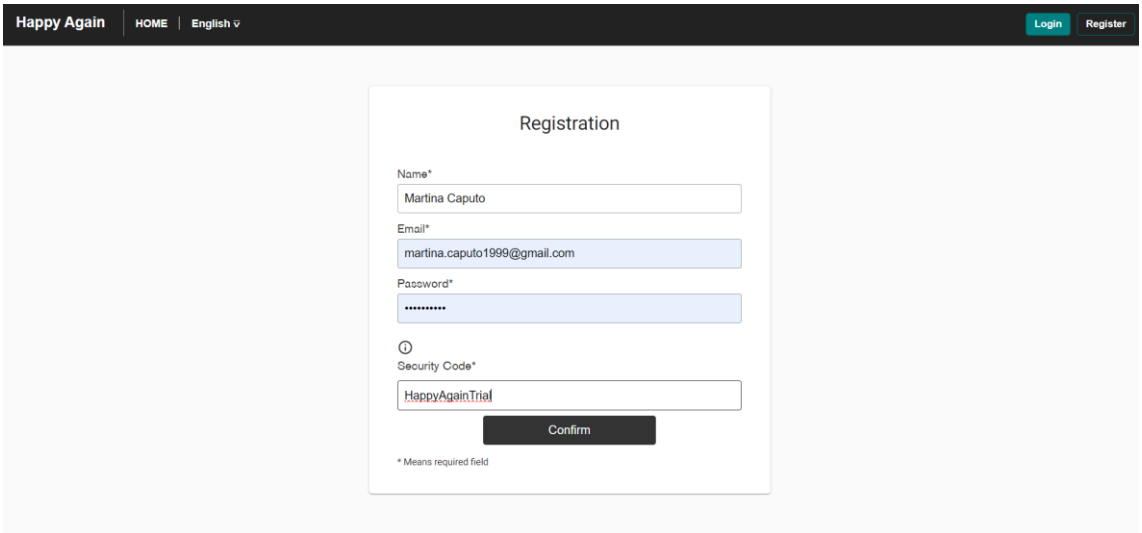


Figure 13. registration page.

The changes that have been made in the registration page regard the Security code. To prevent instances of malicious users registering and completing tasks superficially solely to receive a voucher, my team and I have implemented a system whereby users need a code provided by those who possess these secret codes, in our case, our team of psychologists, to register. This code system serves as a measure to ensure genuine engagement with the tasks and the platform. In the image there is an example of a filled form with a code that is just for trial purposes.

5.2.3 Admin Area

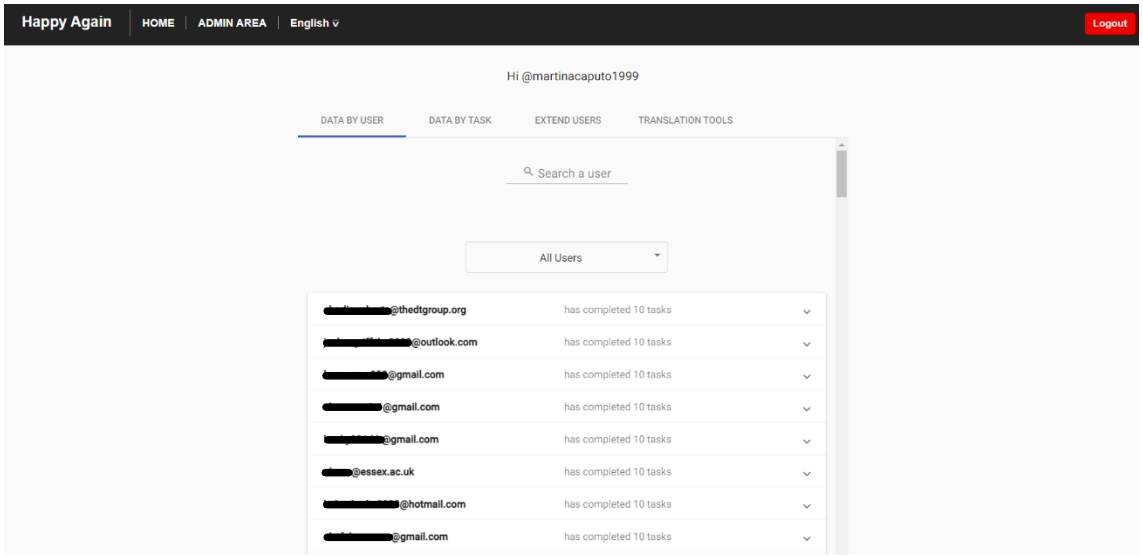


Figure 14. admin-area, data by user.

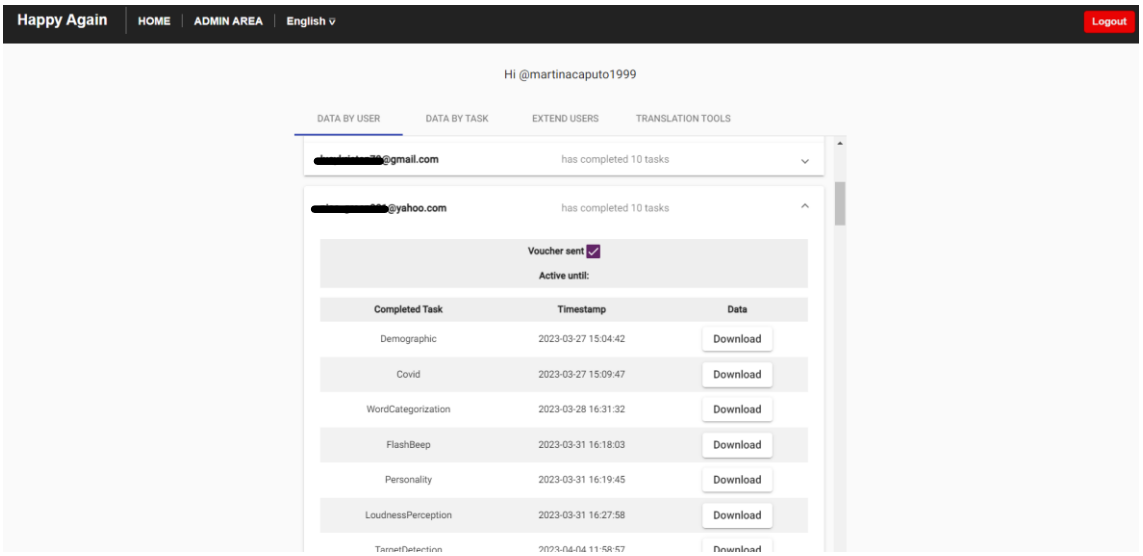


Figure 15. admin-area, data by user, voucher sent.

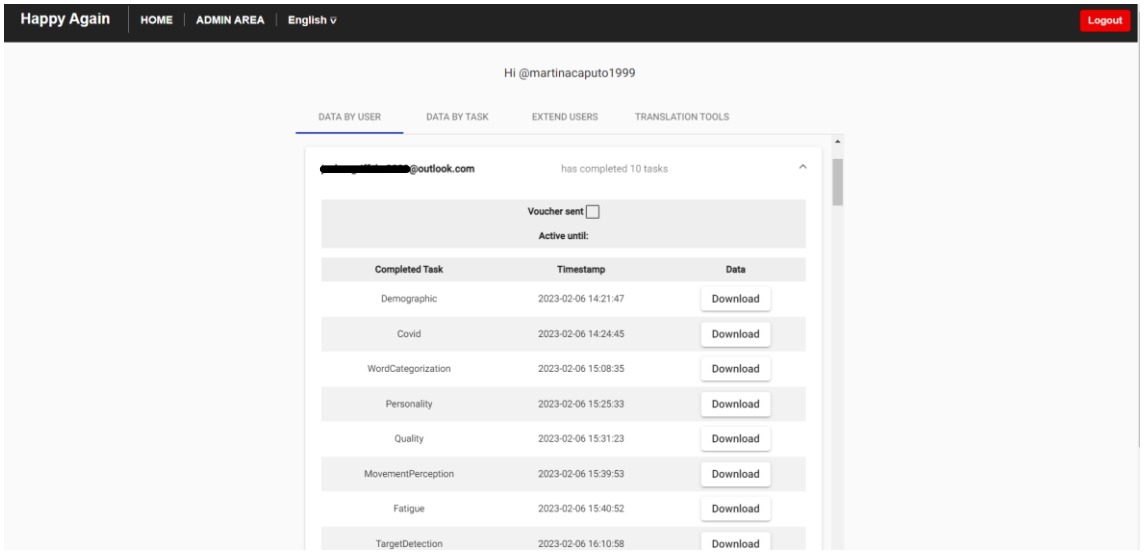


Figure 16. admin-area, data by user, voucher not sent.

Figure 14, 15, 16 shows the "Data by user" interface that is available only for the admins. In The first one there is a list of all the users and the number of tasks they completed while in the second, it is shown what happen when the admin clicks on one user, there is the possibility to see which tasks he finished, the time and also a button to download the data collected regarding that task for that user. The administrator has also the possibility to tick voucher sent to remind that this user has already obtained the voucher. In the figure 16 is shown a user that did not yet received the voucher.

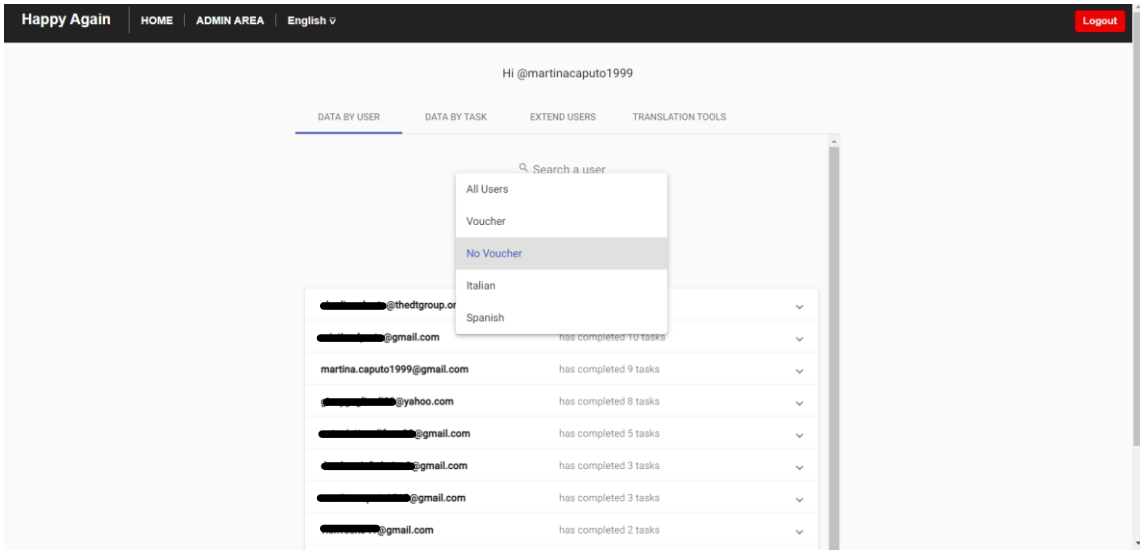


Figure 17. admin-area, data by user, filter.

Through the filter is possible to select only a set of users that accomplish a specific characteristic.

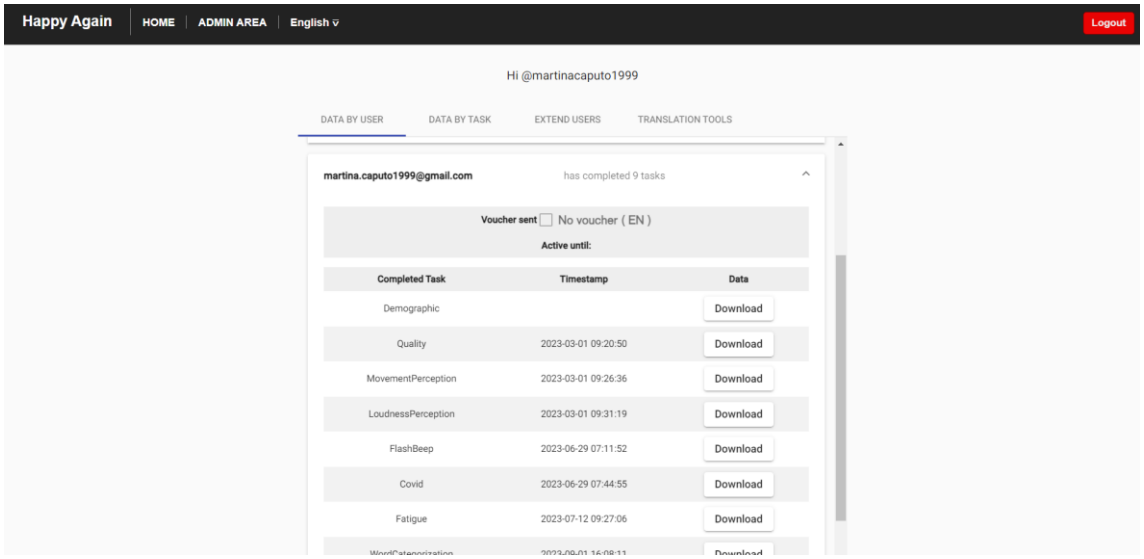


Figure 18. admin-area, data by user, no voucher.

If a user cannot receive the voucher, for example in the case of an admin, that does not participate to the study but only work on it, in the figure 18 it can be seen the sentence “no voucher”.

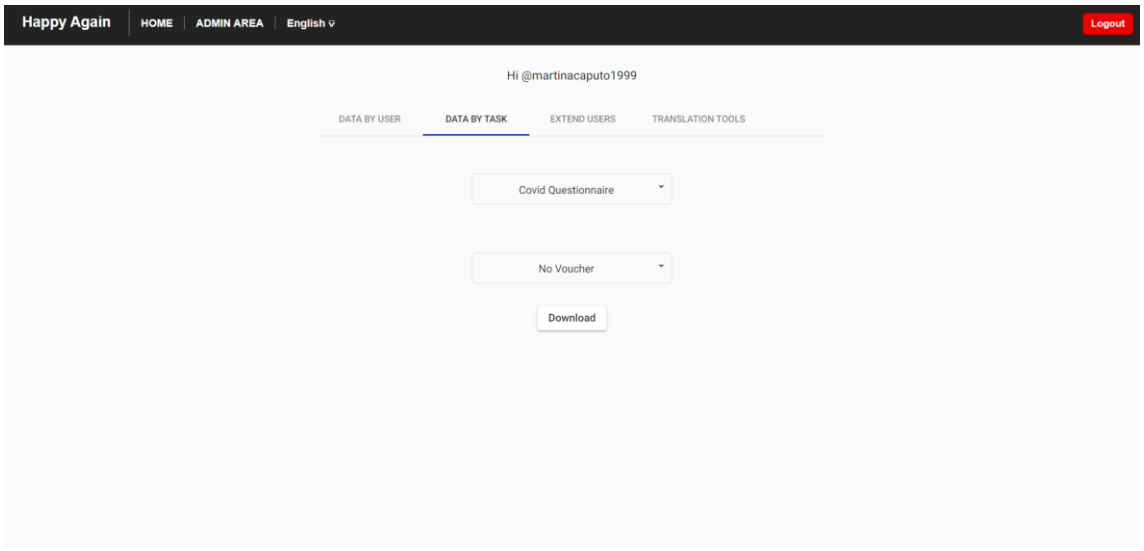


Figure 19. admin-area, data by task.

In the “data by task” page an admin has the possibility to choose one task and download the file related to that task. In this case the file will contain the responses of all the users to that specific task.

In the Figure 20 are shown all the option that are possible to select for the download.

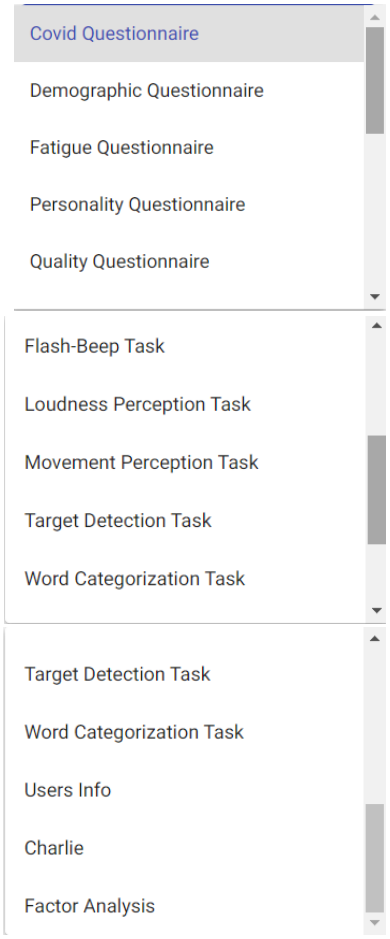


Figure 20. admin-area, data by task, task to download.

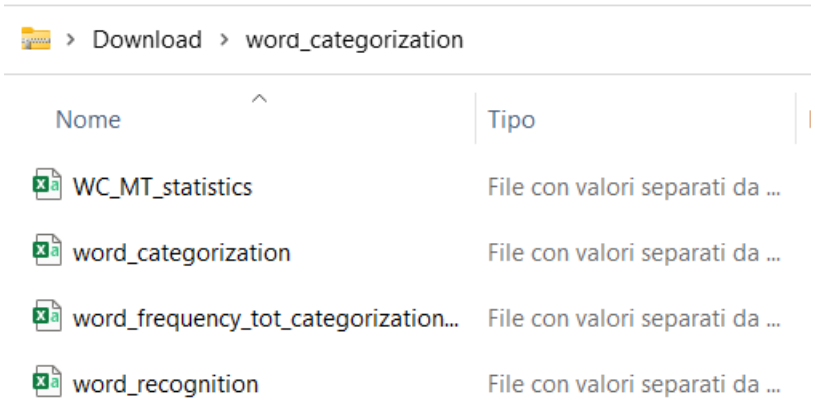
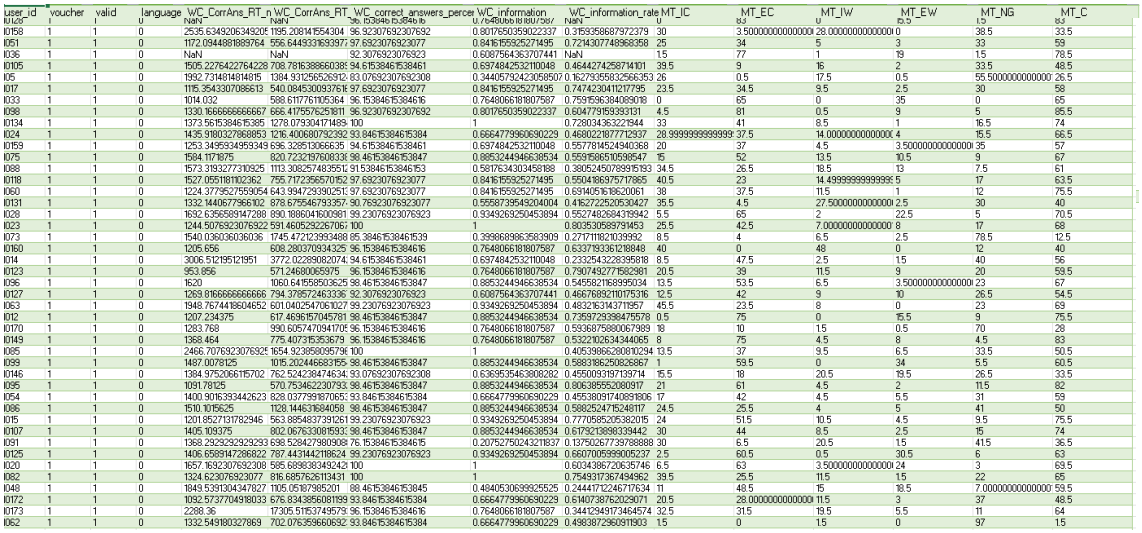


Figure 21. word_categorization.zip download.

We analyse in details the download of the word categorization task as it was one of the tasks for which I made some changes for my research work.



user_id	voucher	valid	language	WC_CorrAns_RT_n	WC_CorrAns_RT_	WC_correct_answers_percer	WC_information	WC_information_rate	MT_IC	MT_EC	MT_IW	MT_EW	MT_NG	MT_C
I0158	1	1	0	2535.634920634920	1195.208141554304	96.92307692307692	0.8017650359022337	0.3159358687972379	30	3.500000000000000	28.00000000000000	0	38.5	33.5
I051	1	1	0	1172.094488188976	556.6449331693977	97.69230769230770	0.8416155925271495	0.7214307748968358	25	34	5	3	33	59
I036	1	1	0	NaN	NaN	92.30769230769230	0.6087564363707441	NaN	1.5	77	1	19	1.5	78.5
I0105	1	1	0	1505.227642276422	708.7816388866038	94.61538461538461	0.6974842532110048	0.4644274258714101	39.5	9	16	2	33.5	48.5
I05	1	1	0	1992.731481481481	1384.931256526912	83.07692307692308	0.3440579242305850	0.1627935583266353	26	0.5	17.5	0.5	55.50000000000000	26.5
I017	1	1	0	1115.354330708661	540.0845300937616	97.69230769230770	0.8416155925271495	0.7474230411217795	23.5	34.5	9.5	2.5	30	58
I033	1	1	0	1014.032	588.6177761105364	96.15384615384616	0.7648066181807587	0.7539596384089018	0	65	0	35	0	65
I088	1	1	0	1330.166666666666	666.4175576251911	96.92307692307692	0.8017650359022337	0.6047791953991131	4.5	81	0.5	9	5	85.5
I0134	1	1	0	1373.956153846153	1278.079304171489	100	1	0.7280343632273944	33	41	8.5	1	16.5	74
I024	1	1	0	1435.918032786885	1216.400680792392	93.84615384615384	0.6664779960690229	0.4680221877712937	28.99999999999999	37.5	14.00000000000000	4	15.5	66.5
I0159	1	1	0	1253.349593495934	936.3295130666635	94.61538461538461	0.6974842532110048	0.5577814524940368	20	37	4.5	3.500000000000001	35	57
I075	1	1	0	1584.1171875	820.7232197680330	98.46153846153847	0.8853244946638534	0.5591586510598547	15	52	13.5	10.5	9	67
I088	1	1	0	1573.319327731092	1113.308257483551	91.53846153846153	0.5876634303458188	0.3805245076995193	34.5	26.5	18.5	13	7.5	61
I0118	1	1	0	1527.055118110236	755.7172295570152	97.69230769230770	0.8416155925271495	0.5504186975717985	40.5	23	14.49999999999999	5	17	63.5
I060	1	1	0	1224.377952755905	643.9947293902515	97.69230769230770	0.8416155925271495	0.6914051610620061	38	37.5	11.5	1	12	75.5
I0131	1	1	0	1332.144067796610	878.6755467933574	90.76923076923077	0.5558739549204004	0.4162722520530427	35.5	4.5	27.50000000000000	2.5	30	40
I028	1	1	0	1692.635658914728	890.1886041600981	99.23076923076923	0.9349269250453894	0.5527482684319942	5.5	65	2	22.5	5	70.5
I023	1	1	0	1244.507692307692	591.4605229267061	100	1	0.8035305897914153	25.5	42.5	7.000000000000000	8	17	68
I073	1	1	0	1540.036036036036	1745.472123893498	95.38461538461539	0.3986898863583909	0.2717118210399892	8.5	4	6.5	2.5	78.5	12.5
I0160	1	1	0	1205.656	608.2803709343250	96.15384615384616	0.7648066181807587	0.6337933616218948	40	0	48	0	12	40
I014	1	1	0	3006.512195121951	3772.022890820740	94.61538461538461	0.6974842532110048	0.2332543228395818	8.5	47.5	2.5	1.5	40	56
I0123	1	1	0	953.856	571.24680065975	96.15384615384616	0.7648066181807587	0.7907492777582961	20.5	39	11.5	9	20	59.5
I096	1	1	0	1620	1060.641558503625	98.46153846153847	0.8853244946638534	0.5455821168995034	13.5	53.5	6.5	3.500000000000001	23	67
I0127	1	1	0	1269.816666666666	794.3785724633360	92.30769230769231	0.6087564363707441	0.4667689210175316	12.5	42	9	10	26.5	54.5
I063	1	1	0	1948.767441860465	601.0402547061027	99.23076923076923	0.9349269250453894	0.4832163143711557	45.5	23.5	8	0	23	69
I012	1	1	0	1207.234375	617.4696157045781	98.46153846153847	0.8853244946638534	0.7359729398475578	0.5	75	0	15.5	9	75.5
I0170	1	1	0	1283.768	990.6057470941705	96.15384615384616	0.7648066181807587	0.5936875880067989	18	10	1.5	0.5	70	28
I0149	1	1	0	1368.464	775.4073135353679	96.15384615384616	0.7648066181807587	0.5322102634344065	8	75	4.5	8	4.5	83
I085	1	1	0	2466.707692307692	1654.923859095796	100	1	0.4053986620810294	13.5	37	9.5	6.5	33.5	50.5
I099	1	1	0	1487.0078125	1015.202446883155	98.46153846153847	0.8853244946638534	0.5883982582682867	1	59.5	0	34	5.5	60.5
I0146	1	1	0	1384.975206611570	762.5242384674634	93.07692307692308	0.6369535463808282	0.4550093197139714	15.5	18	20.5	19.5	26.5	33.5
I095	1	1	0	1091.78125	570.7534622307933	98.46153846153847	0.8853244946638534	0.8063855520809170	21	61	4.5	2	11.5	82
I054	1	1	0	1400.901639344262	828.0377991870651	93.84615384615384	0.6664779960690229	0.4553809174089180	17	42	4.5	5.5	31	59
I066	1	1	0	1510.1015625	1128.144631684058	98.46153846153847	0.8853244946638534	0.5862524715248117	24.5	25.5	4	5	41	50
I015	1	1	0	1201.852713178294	553.8954637391261	99.23076923076923	0.9349269250453894	0.7770585205382015	24	51.5	10.5	4.5	9.5	75.5
I0107	1	1	0	1405.109375	802.0676330815932	98.46153846153847	0.8853244946638534	0.6179213898339442	30	44	8.5	2.5	15	74
I091	1	1	0	1368.292929292929	698.5284279809087	76.15384615384615	0.2075275024321837	0.1375026773788888	30	6.5	20.5	1.5	41.5	36.5
I0125	1	1	0	1406.658914728682	787.4431442118624	99.23076923076923	0.9349269250453894	0.6607005999005237	2.5	60.5	0.5	30.5	6	63
I020	1	1	0	1657.169230769230	585.6896383492420	100	1	0.6034386720635746	6.5	63	3.500000000000001	24	3	69.5
I082	1	1	0	1324.623076923077	816.6857626113431	100	1	0.7549317367494962	39.5	25.5	11.5	1.5	22	65
I048	1	1	0	1849.539130434782	1105.053679852011	98.46153846153845	0.4840530699925525	0.2444712246770634	11	48.5	15	18.5	7.000000000000000	59.5
I0172	1	1	0	1092.573770491803	676.8343856081199	93.84615384615384	0.6664779960690229	0.6140738762029071	20.5	28.00000000000000	11.5	3	37	48.5
I0173	1	1	0	2288.36	1730.511537495795	96.15384615384616	0.7648066181807587	0.3441294917346457	32.5	31.5	19.5	5.5	11	64
I062	1	1	0	1332.549180327869	702.0763596606932	93.84615384615384	0.6664779960690229	0.4983872960911903	1.5	0	1.5	0	97	1.5

Figure 22. a part of the WC_MT_statistics file.

I create this statistics file that, according to the answers each user provide, computes some variables:

- user_id: represent the unique number of a user and define a specific subject.

- voucher: if a user can receive a voucher (1) or not (0).

- valid: if is a valid user and its data are useful for our research.

- language: each language has an associated number, in this case 0 represents English.

- WC_CorrAns_RT_mean: this value represents the mean of the number of correct answers that the subject gives in the word categorization task.

- WC_CorrAns_RT_SD: this value represents the standard deviation of the number of correct answers that the subject gives in the word categorization task.

- WC_correct_answers_percentage: percentage of correct answers.

- WC_information: we used Shannon Information to quantify the amount of information processed by the brain when making a binary choice. We computed the Mutual Information between the Stimulus (the word to categorise) and the Choice.

$$\mathrm{I} = sgn(ACC - 0.5) \cdot [ACC \cdot log_2(2 \cdot ACC) + (1 - ACC) \cdot log_2(2 \cdot (1 - ACC))]$$

Where:

- ACC represents the accuracy.
- *sgn*(*ACC*−0.5) is the sign function, which returns 1 if ACC > 0.5, -1 if ACC < 0.5, and 0 if ACC = 0.5.

- WC_information_rate: it measures the amount of information processed by the brain per second, considering both the accuracy and the reaction time

$$IR = \frac{I_{SYMB}(S,C)}{R_T} \text{ [bit/s]}$$

- MT_IC: MT defines the Memory Task while IC stands for Implicit Correct and it specify the percentage of when a user chooses “probably old” when that word is old or when chooses “probably new” and the word is new.

- MT_EC: EC stands for Explicit Correct and it specify the percentage of when a user chooses “I’m sure it’s old” when that word is old or when chooses “I’m sure it’s new” and the word is new.

- MT_IW: IW stands for Implicit Wrong and it specify the percentage of when a user chooses “Probably new” when that word is old or when chooses “Probably old” and the word is new.

- MT_EW: EW stands for Explicit Wrong and it specify the percentage of when a user chooses “I’m sure it’s new” when that word is old or when chooses “I’m sure it’s old” and the word is new.

- MT_NG: NG stands for Not Given, percentage of when the user chooses “I’m Not Sure”.

- MT_C: represents the sum of MT_IC+MT_EC.

uid	voucher	valid	language	country	gender	age	education	CovidQ1	CovidQ2	CovidQ3	CovidQ4	CovidQ4: Dry continuous cou	CovidQ4: Sor
10162	1	1	0	0	0	2	3	1	1	0	NaN	0	0
100	1	1	0	0	0	1	2	1	0	1	0 2 1	1	1
10154	1	1	0	1	0	2	3	1	0	1	2 9 10	0	0
1068	1	1	0	0	1	2	1	2	1	2	8 10 0 11 9 1 4 7 3 5 6	1	1
10144	1	1	0	0	1	2	3	2	1	2	13 10 12 7 8 11 0 1 2 9 3 5 6 1		1
10141	1	1	0	1	1	2	5	2	0	2	5 0 1 2 4 3	1	1
10113	1	1	0	0	1	5	1	2	1	1	5	0	0
1066	1	1	0	0	1	3	3	2	0	2	7 9 8 13	0	0
1065	1	1	0	0	1	2	2	2	1	1	13 9 2 8 6 1	0	1
1011	1	1	0	2	0	3	3	2	1	2	7 9 6 5 0 10 8 1 3 12 2	1	1
10165	1	1	0	0	1	4	5	1	1	2	10	0	0
1038	1	1	0	0	1	3	5	2	0	2	9 8 10 7	0	0
10137	1	1	0	0	1	4	5	2	0	1	3 10 9 8	0	0
1016	1	1	0	0	1	3	2	2	1	2	9 10 3 2 7 6 1 0 11 8 5 13	1	1
1039	1	1	0	0	0	4	2	2	1	3	10 5 8 9 0 7 6 1 4	1	1
10164	1	1	0	0	1	3	3	2	1	1	1 12 10 0 2 9 8 7 6 5 3	1	1
10112	1	1	0	3	1	3	3	2	0	2	4 9 11 13 12 10 7 8 5 0 2	1	0
1047	1	1	0	1	0	5	3	2	0	2	10 8 7 1 3 4 12 13	0	1
107	1	1	0	1	1	4	4	2	1	2	4 6 5 7 11 0 3 1 2 8 9	1	1
10111	1	1	0	0	1	2	5	2	0	2	7 9 10 8 2 1 5 0 3	1	1
10161	1	1	0	0	1	5	2	2	0	2	13 3 9 10 1	0	1
10120	1	1	0	0	1	4	4	2	1	2	9 10 7 8 0 13 5 2	1	0
1052	1	1	0	0	0	3	1	2	0	2	7 1 8 9 10 6 5 3 0	1	1
10169	1	1	0	0	1	3	4	2	1	2	7 9 1 11 8 0	1	1
1093	1	1	0	0	0	4	3	2	1	2	7 8 5 6 1 9 0 2 10	1	1
1044	1	1	0	0	0	2	3	2	1	2	5 0 3 6 10 1	1	1
106	1	1	0	12	1	3	4	2	1	2	2 6 10 8 9 3 13 1	0	1
1040	1	1	0	7	1	4	5	2	1	2	7 10 9 0 5 6 13 11 8 2	1	0
10155	1	1	0	1	0	3	5	2	0	2	9 8 2 5 6 1 7 10 3	0	1
1042	1	1	0	0	1	3	4	2	1	2	7 9 5 10 3 0 4	1	0
10124	1	1	0	4	0	5	0	2	0	2	7 5 9 6 8 10 12 11	0	0
1079	1	1	0	1	1	1	3	2	1	2	7 5 11 4 9 3 1 0	1	1
10109	1	1	0	0	1	4	4	2	0	2	5 6 9 0 12 8 10 7 2 4 1 11 3	1	1
10135	1	1	0	0	1	4	5	2	1	2	9	0	0
10167	1	1	0	4	1	6	2	2	0	2	8 5 0 7 6 9	1	0
10138	1	1	0	0	0	4	3	1	0	0	NaN	0	0
10156	1	1	0	0	1	3	3	2	0	2	9 10 7 6 3 8 13	0	0
10143	1	1	0	0	1	3	3	2	0	2	9 5 7	0	0
10153	1	1	0	0	1	4	1	2	1	2	0 10 9 8 3 4 12 7 6 1 2 5 11	1	1

Figure 23a. a part of the Charlie Download.

LCSI1	LCSI2	QoL_reversed	MT_C	factor1_influenza_symptom	factor2_gastrointestinal_symptor	factor3_fatigue_symptom	factor4_mixed_symptom	factor5_psychological_symp
0	46	31	56.000000000000	-0.7133241049301181	-0.053919359132527496	-2.6311154592032797	-2.4350000529150617	-0.5323620800533553
2	41	28	79.5	-0.6620193224079589	-0.3201447095071367	-2.83551044887655894	-1.9083756843863584	-0.5036570641046101
6	20	9	64	-0.5847307128738962	-0.2116732114706895	-2.741954154451303	-0.25774944634479274	-0.4741384513611453
37	109	42	65	-0.3460424131213762	1.591896265637018	-0.061066088430796 32	0.5289658889608413	-0.7112713789492683
34	99	42	59.5	1.1322293447743903	0.14803663909449233	-1.2263021244105878	0.49540519972973507	1.712958809372749
2	31	18	62.5	-0.6182247970285156	-0.5213224910247889	-2.7537457299801034	-0.6677331272363123	-0.34399623058019824
8	50	24	68.5	-0.9272409930175739	-0.5387568995472729	0.35813564031772643	-2.0059989812567927	0.04532872952574381
22	85	32	87.5	-0.927500653167462	-0.7294887087954929	1.001035865185728	0.5892066814458553	0.5785232119265068
31	67	18	76	-1.1458824443293063	0.495334896346871	1.1820459400180305	-1.2908470229062998	-1.7134282603297395
25	100	50	70.5	-0.9169517138283778	-0.8933962819538106	0.4324983588644746	0.8243518714406255	1.936227346651547
31	79	23	75	-1.3076274819011855	1.8308452303454141	-0.42126114978384194	-0.33936348101204045	-1.4328932670414198
24	101	51	67.5	-0.9919245915521291	-0.7392548761312504	0.8887499830120049	0.7619023458950721	-0.12254816767465299
28	108	47	37	0.2477557387968947	-1.0097221140298536	0.522964674880259	-0.7468663643866141	1.256763626676253
38	116	53	79.5	1.0961484530730732	-0.33966437631243684	0.3432642691367263	-0.036301853769667 53	0.9317648666266719
34	116	52	46	-0.032740976685565755	-1.0237347332302715	0.2505875276554991	1.2521563125703508	0.8594335716813597
14	109	67	65	-1.033169177307942	-0.65721295926550 09	0.5410100955224474	-0.4502862440651594	-0.19041380642393924
33	83	25	66.5	-1.168790028911132	0.704351762312334	-1.2327669409864657	1.0152255809054795	-0.5420905564067191
39	129	64	59.5	-0.07902748360112483	0.05687466428715188	0.31779159495611964	-0.10399288453643829	-0.19904072751420804
37	102	34	32	1.01156495948155	1.1565234340353356	0.39244826614655137	0.6165278578359056	-1.2586813394996987
37	106	41	68.5	0.9893023931458986	0.9974214826555015	0.17826741900112408	0.33728981141635517	0.619672772617859
30	94	40	57	1.609556741464904	-1.2315908992979725	-0.9044770824157177	-0.3734538802394504	0.7784420425175436
25	90	37	66.5	-0.8648055434895725	-0.8886476883005255	1.068475723862275	0.725690068853709	0.10398933334493254
26	63	23	65	-0.942010374523281	-0.8333323486566959	0.09526995051025852	0.3834399740879558	0.6002854053469967
35	98	40	69.5	-0.26355999432381083	1.6410214071651699	0.21460834276321508	0.259202000463968	-0.5088839442071278
32	114	51	60	1.3302905852362146	-1.4587754990281843	0.6209787364932339	0.35692950941587676	-1.621608465539894
12	82	48	73	1.548950632765341	-1.0568505203875338	-3.0954852716627	-1.6358518735601533	0.6592138583546121
33	89	33	61.5	1.190816663408937	1.0506608567645048	0.4206695054868074	-0.5706252470012647	-1.3111575763943213
11	55	17	62.5	-1.006303356547813	-0.8314452534382091	0.9785705860692001	0.16288831072585827	-0.690572161871624
6	85	63	85.5	-0.7202087782444623	-0.6776813190710661	-2.9331334043187955	1.0412000399643755	-0.3993209616784854
20	62	19	63.5	1.5532077245867697	-1.0676399314506742	-0.7461271371580072	1.0061400738141368	-0.8055276861021828
29	119	59	61	-1.4610540903231184	1.7684977575838008	0.8590911124440039	0.0403151494425739	1.2211066426268737
13	65	34	72.5	1.484902376132286	0.2272472873336707	-2.8969149915874737	0.3114825046645924	-0.6203562115298933
39	105	39	67	0.9244012826027008	1.098039162671352	0.3302931211192168	0.5777376112684318	-0.0598276206601021
27	63	16	76	1.5134562220848007	-0.9056097903110754	-1.5974502996055588	-0.7291663225338607	-0.9067258492093074
24	70	21	62.5	-1.0040633939699881	-0.7659595107727655	1.0821239509842895	0.23910077836085528	0.20411108247454707
14	107	66	62	-1.1031667223073565	-0.3728283140748588	0.7021934779069651	-3.0022246831607333	1.3046896728804234
24	73	28	23.5	-0.9217806353721287	-0.7792058678939273	-0.5281179849772824	0.3872929892652521	0.1362684091832347
22	110	56	80	-0.8777647482371524	-0.7206843413200854	1.1880695163363795	0.07117098692058654	-1.1363768035405766
39	152	83	55	0.8000420716552934	1.0019113014122967	-0.24641264386494613	-0.004181806705708 11	1.0644376727622729

Figure 23b. a part of the Charlie Download.

The "Charlie" Download file is named after a psychologist, vital to our team, and has been created for data analysis purposes. It contains information regarding user responses to all questionnaires items, including the total scores for the Quality of Life and Fatigue questionnaires. Additionally, it encompasses data also found in the WC_MT_statistics file, along with other specifics illustrated in Figure 23b, which we define as follows:

To qualify as an LC (Long COVID) patient:

Participants are required to answer YES to the question regarding having had COVID.

Provided this condition is met, there are two LC severity indices calculated as follows:

- LCSI1 (Long COVID Severity Index 1): Sum of the number of weeks to recover (Covid Question 6) + the count of lasting symptoms (Covid Question 11) + the number of limitations (Covid Question 15).

- LCSI2: Sum of the LCSI1 score + fatigue score + reversed Quality of Life score.

- Reversed Quality of Life score: Calculated as 112(maximum score of the Quality of Life questionnaire) - Quality of Life total score.

While MT_C has been previously explained, the five factors will be elaborated upon in the subsequent chapter.

Chapter 6

Data Analysis

6.1 Dimensionality Reduction and Factor Analysis of Patient Data

In the practical execution of the study, subsequent to the acquisition of patient data, the statistical software SPSS was employed to undertake a procedure known as dimensionality reduction, utilizing Principal Component Analysis (PCA) as the specific technique. The initial phase entailed the comprehensive compilation of patient data, encompassing their responses to inquiries within COVID-related questionnaires, as well as those concerning fatigue and quality of life.

The data underwent a manipulation process wherein they were transformed into standardized scales, spanning from 0, signifying an entirely adverse condition, to MAX, representing the utmost positive state. Analogously, an equivalent transformation was applied to the binary responses, wherein 'Yes' was encoded as 1 and 'No' as 0.

Primarily, the identification of valid subjects transpired by designating a validity parameter (valid=1), thereby excluding individuals that did not meet the stipulated criteria. The subsequent selection process was confined to respondents who provided an affirmative response to the query "Have you contracted COVID?" as documented in the COVID questionnaire.

Central to our endeavour is the determination of a severity index denoted as LC. This investigation encompasses both individuals who contracted COVID without subsequently developing long COVID, as well as those who experienced protracted symptoms. It is conjectured that individuals who remain unaffected by long COVID will exhibit a lower severity index in comparison to their long COVID-afflicted counterparts.

Accordingly, the analysis exclusively involves authentic patients, who have experienced COVID at a minimum. Each data entry corresponds to a distinct patient. It is imperative for the attributes under scrutiny to exhibit cardinal scaling properties, interspersed with specific categories of degeneration. Within the realm of statistics, the cardinal scale is characterized by the presence of a measurable unit.

6.1.1 Scale

It is pertinent to elaborate on the cardinal scale's nuances by delineating various subtypes of scales:

- Nominal or categorical scales: These scales lack inherent ordinal relationships between categories, as exemplified by preferences such as favourite colour, gender identity, or cultural background. These categories are not of concern within the scope of our analysis.
- Ordinal scales: While exhibiting an order among values, these scales do not adhere to a quantifiable distance metric. For instance, educational levels present an order but lack a consistent interval metric, unlike attributes like height expressed in centimetres.
- Cardinal scales: This category possesses both an order and a consistent distance metric, akin to attributes such as height. We exclusively employ this cardinal scale for our analytical purposes.

All attributes, save for the initial row designating variable names, must conform to the cardinal scaling criterion. In the SPSS software, the cardinal scale is referred to as 'scale.' This study introduces certain exceptions, termed 'degenerations,' encompassing:

- Count scales: Representing counts, such as the total number of symptoms reported by a patient.
- Likert-type scales: Ranging from 'not at all' (0) to 'very much' (MAX).
- Dichotomous presence-absence scales: These entail binary values, with 0 signifying absence and 1 signifying presence.

6.2 Factor Analysis

Having executed requisite transformations using the Python programming language, a structured table facilitating subsequent analysis was formulated. The subsequent step entailed the importation of this table into the SPSS environment, followed by the deployment of factor analysis. Column selection was guided by predefined suitability criteria, and an iterative process involving various rotation methods was undertaken, culminating in the selection of Quatrimax rotation. The salient distinction associated with Quatrimax rotation lies in its capacity to better distribute values across the analyzed factors, thereby facilitating clearer interpretations.

6.2.1 Matrices

The resulting matrices from the conducted Factor Analysis encompass:

- **Correlational Matrix**: This matrix encapsulates inter-factor correlations, pivotal for the reduction of dimensionality. Our goal is to reduce dimensionality by synthesizing fewer factors that capture the most important aspects. We aim to group factors that share commonalities, which can be seen through clusters of the correlation matrix. A cluster emerges when two attributes are highly correlated. Positive values indicate similar attributes, while negative values indicate dissimilar attributes. Two attributes are the more correlated the closer the value of the Pearson correlation in absolute value approaches 1, it can be seen how the diagonal has all values equal to 1 because each attribute is perfectly correlated to itself. Values close to zero represent that those two attributes do not correlate therefore they will not end up in the same cluster, We can consider as relevant the values ranging in absolute value from 0.3 onwards. The attributes leveraged for this study are: age, covidq1: Did you have covid?; covidq2: Have you had Covid-19 more than once?; covidq3: How severe were your symptoms?; all the symptoms of covidq4 (e.g. Dry continuous cough etc.); covidq4tot: total number of symptoms; covidq6: How many weeks did it take until you felt recovered?; covidq7: Have you had any Covid-19 vaccinations?; covidq8: If you have had Covid-19, have you had it since any of your vaccinations?; covid9: Have you suffered from Post-Covid-19 Syndrome ("Long Covid")?; covidq10: Are you using any devices, medication or other strategies to deal with your Long Covid symptoms?; all the symptoms of long-covid (covidq11) symptoms the subject experienced; covidq11tot: : total number of long-covid symptoms; all the symptoms of long-covid (covidq13) symptoms the subject is still experiencing; covidq13tot: : total number of actual long-covid symptoms; covidq15: How much have you been affected in your everyday life by long-lasting symptoms of Covid-19?; qol_total_score: Total score of quality of life survey; qol11: Work - job or in home; qol16: Independence, doing for yourself; fatigue_total_score: Total score of fatigue survey; fatigue8: Do you have difficulties concentrating?; fatigue11: How is your memory? .

	Age	Did you have covid?	Have you had Covid-19 more than once?	How severe were your symptoms?	Dry continuous cough -symptom	Sore throat -symptom	Runny nose and/or nasal congestion -symptom	Loss of taste and/or smell -symptom	Loss of appetite -symptom	Fever -symptom	Chills -symptom	Headache -symptom	Muscle or other body aches -symptom	Fatigue -symptom	Shortness of breath difficulty breathing -symptom	Nausea and/or vomiting -symptom	Diharrea -symptom	Other -symptom
Age	1.000	-0.027	-0.164	-0.053	-0.064	-0.181	-0.185	-0.153	-0.242	0.069	0.091	-0.013	0.158	0.060	0.005	-0.110	0.107	0.107
Did you have covid?	-0.027	1.000	0.224	0.296	0.061	0.082	0.015	0.133	0.082	0.093	0.083	0.216	0.198	0.122	0.123	0.034	0.006	0.052
Have you had Covid-19 more than once?	-0.164	0.224	1.000	0.000	0.130	0.110	0.067	0.083	0.165	0.014	0.156	0.132	0.055	0.088	0.066	0.113	-0.004	0.073
How severe were your symptoms?	-0.053	0.296	0.000	1.000	0.078	0.195	0.082	0.141	0.149	0.012	0.065	0.330	0.336	0.334	0.268	0.219	0.073	0.086
Dry continuous cough -symptom	-0.064	0.061	0.130	0.078	1.000	0.300	0.248	0.142	0.196	0.288	0.335	0.238	0.092	0.175	0.160	0.272	0.261	-0.021
Sore throat -symptom	-0.181	0.082	0.110	0.195	0.300	1.000	0.354	0.248	0.287	0.185	0.321	0.207	0.141	0.146	0.288	0.248	0.295	0.021
Runny nose and/or nasal congestion -symptom	-0.185	0.015	0.067	0.082	0.248	0.354	1.000	0.143	0.263	0.252	0.246	0.361	0.297	0.364	0.182	0.220	0.277	-0.012
Loss of taste and/or smell -symptom	-0.153	0.133	0.083	0.141	0.142	0.248	0.143	1.000	0.262	0.040	0.007	0.170	0.147	0.128	0.290	0.163	0.071	-0.087
Loss of appetite -symptom	-0.242	0.082	0.165	0.149	0.196	0.287	0.263	0.262	1.000	0.265	0.190	0.356	0.252	0.148	0.163	0.453	0.219	0.045
Fever -symptom	0.069	0.093	0.014	0.012	0.288	0.185	0.252	0.040	0.265	1.000	0.385	0.265	0.223	0.176	-0.014	0.235	0.233	-0.068
Chills -symptom	0.091	0.083	0.156	0.065	0.335	0.321	0.246	0.007	0.190	0.385	1.000	0.318	0.342	0.221	0.301	0.216	0.325	0.067
Headache -symptom	-0.013	0.216	0.132	0.330	0.238	0.207	0.361	0.170	0.356	0.265	0.318	1.000	0.523	0.550	0.287	0.313	0.310	0.087
Muscle or other body aches -symptom	0.158	0.198	0.055	0.336	0.092	0.141	0.297	0.147	0.252	0.223	0.342	0.523	1.000	0.527	0.353	0.259	0.180	0.127
Fatigue -symptom	0.060	0.122	0.088	0.334	0.175	0.146	0.364	0.128	0.148	0.176	0.221	0.550	0.527	1.000	0.308	0.273	0.197	0.109
Shortness of breath difficulty breathing -symptom	0.005	0.123	0.066	0.268	0.160	0.288	0.182	0.290	0.163	-0.014	0.301	0.287	0.353	0.308	1.000	0.176	0.285	0.121
Nausea and/or vomiting -symptom	-0.110	0.034	0.113	0.219	0.272	0.248	0.220	0.163	0.453	0.235	0.216	0.313	0.259	0.273	0.176	1.000	0.408	0.177
Diharrea -symptom	0.107	0.006	-0.004	0.073	0.261	0.295	0.277	0.071	0.219	0.233	0.325	0.310	0.180	0.197	0.285	0.408	1.000	0.154
Other -symptom	0.107	0.052	0.073	0.086	-0.021	0.021	-0.012	-0.087	0.045	-0.068	0.087	0.087	0.127	0.109	0.121	0.177	0.154	1.000
Total number of symptoms the subject experienced	-0.058	0.172	0.171	0.308	0.514	0.560	0.570	0.380	0.566	0.478	0.590	0.658	0.579	0.550	0.526	0.600	0.573	0.234
How many weeks did it take until you felt recovered?	0.087	0.122	-0.051	0.254	-0.062	0.026	0.088	0.136	0.046	-0.026	0.070	0.268	0.267	0.314	0.253	0.301	0.168	0.171

Table 25: a part of Correlational Matrix

- **Total Variance Explained Matrix**: The matrix denoting the "total variance explained" serves to quantify the extent to which the variability inherent in the dataset is expounded by the distinct components. It encapsulates the percentage of data variability that can be succinctly explicated through a specific quantity of components. While acknowledging the constraints of a relatively limited dataset, the values therein, albeit modest, remain tenable in light of the dataset's scope. Given our possession of 83 variables, it is conventionally advised that the number of subjects should approximate tenfold the number of variables. As such, convergence toward a stable outcome is anticipated upon the accumulation of approximately 830 subjects. Presently, our contentment derives from the discernment of salient clusters that aptly delineate the underlying factors. The total number of subjects in this analysis is 135.

Total Variance Explained

Component	Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	11.420	13.759	13.759
2	8.730	10.518	24.277
3	8.023	9.666	33.943
4	3.449	4.156	38.099
5	2.884	3.475	41.574
6	2.661	3.207	44.780
7	2.651	3.194	47.975
8	2.553	3.075	51.050
9	2.515	3.030	54.081
10	2.484	2.993	57.073
11	2.142	2.581	59.654
12	2.102	2.532	62.187
13	2.056	2.477	64.663
14	1.924	2.319	66.982
15	1.869	2.252	69.234
16	1.841	2.218	71.452
17	1.834	2.210	73.661
18	1.589	1.915	75.576
19	1.536	1.851	77.427
20	1.480	1.783	79.210
21	1.461	1.760	80.970

Extraction

Table 26: Total variance explained

- **Rotated Component Matrix**: Within the "rotated component matrix", the employment of a quatrimax rotation method is deliberated, owing to its propensity for yielding well-demarcated clusters aligning with the five discerned factors. Each factor retains its independence from the others. The primary factor, LC1, is identified as the "influenza symptoms factor", encompassing maladies such as headache, cough, heightened temperature, and the like. Conversely, LC2 pertains to gastrointestinal symptoms, encapsulating phenomena like diminished appetite and abdominal discomfort. The purview of LC3 encompasses "fatigue symptoms", which encapsulate difficulties with concentration and pervasive lethargy. LC4 that represent a mixture of symptoms and the severity. Lastly, LC5 encapsulates "psychological symptoms", embracing psychological conditions such as depression and anxiety. Notably, these five factors remain orthogonal, thereby signifying their mutual independence. The values contained herein span from 1 to -1, with

values of lesser magnitude than 0.5 being omitted for purposes of simplification. Specifically, a value of 1 signifies a robust correlation between the factor and responses to specific inquiries, while a value of 0 denotes the absence of correlation, and a value of -1 denotes a pronounced, albeit inversely aligned, correlation. It is pertinent to emphasize that, with regard to these findings, the program's capacity to discern the distinct grouping into the aforementioned five labels was achieved devoid of any explicit guidance on our part, underscoring the intrinsic significance of the factor analysis procedure.

	1	2	3	4	5
Cough -actual	,941				
Headaches -actual	,941				
Sore throat -actual	,941				
Changes to sense of smell or taste -actual	,941				
High temperature -actual	,941				
Sore throat -past	,900				
Changes to sense of smell or taste -past	,900				
Headaches -past	,900				
High temperature -past	,900				
Cough -past	,900				
Total number of actual symptoms the subject experienced	,620				
Total number of long-lasting symptom the subject experienced	,580	,510			
Loss of taste and/or smell -symptom					
Diarrhoea -past		,870			
Feeling sick -past		,870			
Loss of appetite -past		,870			
Stomach aches -past		,870			
Loss of appetite -actual		,865			
Diarrhoea -actual		,865			
Feelingsick -actual		,865			
Stomach aches -actual		,865			
Nausea and/or vomiting -symptom		,546			
Diharreaa -symptom					
Problems with memory -actual			,821		
Earache -actual			,821		
Problems with memory -past			,816		
Problems with concentration -actual			,796		
Extreme tiredness fatigue -actual			,771		
Problems with concentration -past			,765		
Extreme tiredness fatigue -past			,723		
Have you suffered from Post-Covid-19 Syndrome ("Long Covid")?			,712		
How many weeks did it take until you felt recovered?					
Headache -symptom				,767	
Fatigue -symptom				,720	
Total number of symptoms the subject experienced				,615	
Muscle or other body aches -symptom				,608	
How severe were your symptoms?				,561	
Anxiety -actual					,759
Depression -past					,732
Anxiety -past					,721
Depression -actual					,689

Table 27: a part of Rotated Component Matrix

- **Component Score Coefficients Matrix**: In the realm of this matrix, the initial five rows are pivotal for the computation of the five distinct components. This matrix plays an important role in computing values corresponding to each of the components. By means of an illustrative example: to ascertain an individual subject's valuation for the LC1 component (pertaining to influenza symptoms), reference is made to the values within the matrix. LC1 is ascertained through the summation of products, each emanating from the first row, wherein these values are multiplied by the corresponding actual response values attributed to the given attributes. This computation yields LC1 = 0.003 * (response value for attribute 1) - 0.017 * (response value for attribute 2) + 0.023* (response value for attribute 3) + ... Notably, these values undergo normalization, constrained within the spectrum spanning from 1 to -1. Ultimately, these normalized values delineate the foundational constituents of the five discerned factors.

Component Score Coefficient Matrix

	Component															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Age	0.003	-0.017	0.023	0.004	0.057	0.053	0.047	0.023	-0.087	-0.030	-0.025	0.035	0.058	-0.066	-0.065	0.039
Did you have covid?	0.011	-0.042	0.042	0.052	0.077	-0.039	-0.018	-0.035	-0.015	-0.061	-0.100	-0.024	0.067	0.337	0.022	0.117
Have you had Covid-19 more than once?	0.004	0.002	-0.003	-0.061	-0.047	-0.004	0.044	0.069	-0.012	0.104	0.041	0.039	-0.062	0.311	0.047	0.010
How severe were your symptoms?	-0.009	-0.039	-0.014	0.220	-0.039	-0.067	-0.081	-0.041	0.137	-0.021	0.071	-0.075	0.152	0.036	-0.093	-0.040
Dry continuous cough -symptom	0.003	-0.023	-0.008	-0.028	0.079	0.025	0.300	-0.067	-0.099	-0.060	-0.123	0.023	-0.027	-0.013	0.166	-0.145
Sore throat -symptom	0.020	-0.025	-0.041	-0.017	-0.070	-0.046	0.145	0.043	0.156	0.106	0.042	0.008	0.071	0.003	0.129	0.039
Runny nose and/or nasal congestion -symptom	-0.006	0.002	-0.001	0.068	0.016	0.006	0.031	-0.096	-0.060	0.013	-0.041	0.089	-0.075	-0.026	0.160	-0.027
Loss of taste and/or smell -symptom	0.035	-0.021	-0.048	0.114	0.113	-0.115	-0.057	0.062	0.122	-0.041	0.023	0.009	-0.014	0.022	0.008	0.154
Loss of appetite -symptom	-0.008	0.020	-0.038	0.151	-0.088	0.105	-0.085	0.028	-0.056	0.011	0.097	-0.031	0.001	-0.020	-0.024	0.236
Fever -symptom	-0.001	-0.011	0.077	-0.033	-0.071	-0.014	0.246	0.004	-0.119	0.041	0.070	-0.109	0.023	-0.067	-0.141	0.143
Chills -symptom	0.000	-0.011	-0.016	-0.116	-0.032	-0.020	0.353	0.052	0.103	0.031	-0.001	0.042	0.031	0.117	-0.087	-0.020
Headache -symptom	-0.009	-0.017	-0.041	0.297	0.015	0.134	-0.066	0.021	-0.059	0.010	0.029	0.011	-0.080	-0.021	0.011	-0.083
Muscle or other body aches -symptom	-0.027	-0.008	0.024	0.191	0.015	-0.025	-0.023	-0.034	-0.006	0.004	-0.036	0.048	0.020	-0.009	-0.014	0.067
Fatigue -symptom	0.013	-0.001	-0.002	0.277	0.009	-0.017	-0.083	-0.008	-0.090	-0.015	-0.047	0.055	-0.063	-0.066	0.035	-0.102
Shortness of breath difficulty breathing -symptom	0.003	-0.012	-0.060	0.068	0.020	-0.046	0.073	0.039	0.344	0.014	-0.021	-0.040	-0.028	-0.002	-0.067	-0.058
Nausea and/or vomiting -symptom	-0.021	0.067	-0.022	0.072	-0.031	-0.043	-0.005	0.047	-0.010	-0.046	0.040	-0.154	0.126	0.043	-0.026	0.129
Diharreaa -symptom	-0.026	0.064	-0.017	-0.040	0.091	0.050	0.182	-0.025	0.027	-0.066	-0.065	-0.051	-0.046	-0.021	-0.083	-0.070
Other -symptom	0.001	-0.016	-0.013	0.008	0.035	-0.021	-0.050	-0.020	0.013	-0.040	0.022	0.020	0.018	-0.007	0.035	0.001
Total number of symptoms the subject experienced	-0.003	0.000	-0.029	0.123	0.013	-0.005	0.143	0.007	0.042	-0.005	0.001	-0.014	-0.003	-0.006	0.014	0.042
How many weeks did it take until you felt recovered?	0.008	0.032	0.053	0.138	-0.033	-0.093	-0.142	-0.022	0.030	-0.091	0.014	-0.085	-0.052	0.006	-0.050	-0.026
Have you had any Covid-19 vaccinations?	0.009	0.001	-0.004	0.086	-0.082	0.057	-0.064	0.080	0.004	0.033	0.077	-0.079	-0.067	-0.005	0.057	-0.359
If you have had Covid-19, have you had it since any of your vaccinations?	-0.024	0.019	-0.013	-0.034	0.044	0.024	0.001	-0.010	0.011	-0.063	0.070	-0.002	-0.003	0.439	-0.099	-0.070
Have you suffered from Post-Covid-19 Syndrome ("Long Covid")?	-0.010	-0.004	0.120	-0.010	-0.006	-0.112	-0.053	0.037	-0.016	-0.036	-0.029	0.024	0.061	0.122	0.023	0.079
Are you using any devices, medication or other strategies to deal with your Long Covid symptoms?	0.014	-0.025	0.011	0.063	-0.107	-0.014	-0.001	0.023	-0.033	0.034	0.064	-0.004	-0.050	-0.107	-0.051	0.056
Extreme tiredness fatigue -past	-0.013	-0.002	0.119	-0.045	0.000	-0.040	0.010	0.017	-0.035	-0.020	-0.111	0.037	-0.005	0.114	0.026	-0.054
Shortness o fbreath -past	-0.015	-0.007	0.031	-0.086	0.023	-0.073	0.045	0.005	0.337	-0.028	-0.097	0.029	0.005	0.018	-0.024	-0.048
Chest pain or fightness -past	-0.023	0.013	0.000	-0.026	0.003	0.028	0.013	-0.011	0.066	0.032	-0.080	0.089	-0.018	-0.024	0.078	-0.016
Problems with memory -past	-0.015	-0.009	0.184	-0.047	-0.063	-0.029	0.042	-0.011	0.028	-0.055	0.122	-0.060	-0.077	-0.070	-0.145	0.021
Problems with concentration -past	-0.006	-0.025	0.161	0.004	0.019	-0.015	0.034	-0.014	-0.106	-0.044	-0.193	-0.004	0.048	0.000	0.020	-0.021
Difficulties sleeping insomnia -past	-0.011	-0.007	0.018	0.013	0.014	-0.033	-0.010	0.010	-0.048	-0.091	-0.015	-0.077	0.026	-0.042	0.443	-0.011

Table 28: A part of Component Score Coefficients Matrix

6.2.2 Factors

In accordance with the predefined factors in SPSS, we have implemented the corresponding Python code within our application. After acquiring the data matrix, encompassing the responses of each user, we initiated a normalization procedure. This entailed subtracting each cell's value from the mean of its respective column and dividing it by the standard deviation of that column. Subsequent to this normalization process, we employed the matrix of component score coefficients to perform a matrix multiplication operation, resulting in the derivation of 21 distinct factors. From this set of factors, we specifically selected the initial five, which are directly relevant to this study. These selected factors have seamlessly integrated as supplementary columns in the downloadable datasets for the Covid Questionnaire, Fatigue, Quality, and Charlie. Upon downloading these files, users will readily observe the presence of these new columns, representing the extracted factors.

6.3 MDS

Multidimensional Scaling (MDS) is a statistical method used for data analysis and visualization. Its main purpose is to represent complex data in a simpler, lower-dimensional space while maintaining the relationships between data points. MDS is valuable for creating visualizations that reveal data patterns. It comes in two types: classical MDS and metric MDS, each with specific applications. MDS finds use in various fields, aiding in tasks like clustering and similarity modeling. In essence, MDS simplifies data for insightful visualization and analysis.

The procedure undertaken involved the utilization of the normalized user data matrix for factor analysis. Instead of opting for the traditional correlation matrix, the approach involved the computation of a dissimilarity matrix. This particular dissimilarity matrix was generated by analyzing the responses to questionnaires, encompassing 83 columns, utilizing Python.

One noteworthy aspect of this dissimilarity matrix is that it quantifies the dissimilarity or distinctness between every pair of columns within the dataset. To achieve this, the distance between each pair of attributes, or questionnaire responses, was meticulously calculated. The resulting dissimilarity matrix contains values that represent the dissimilarity between these pairs of attributes.

It's important to highlight the diagonal of zeros within this matrix. This diagonal signifies that each column exhibits perfect self-similarity, which aligns with the inherent nature of a dissimilarity metric.

age	covidq1	covidq2	covidq3	covidq4_dry_continuous_cough	covidq4_sore_throat	covidq4_runny_nose_nasal_congestion
0	16.887545349836458	18.566440896781568	17.349008094075252	17.651020524969997	18.672963631867226	18.849771867405387
16.887545349836458	0	15.130210432715007	13.93989305049341	16.406117504768552	16.171285094804087	16.741657850906222
18.566440896781568	15.130210432715007	0	17.203996759964543	16.36062048800901	16.328150795552332	16.745050918750113
17.349008094075252	13.93989305049341	17.203996759964543	0	16.435701383851157	15.37581050329907	16.46976265797933
17.651020524969997	16.406117504768552	16.36062048800901	16.435701383851157	0	14.532367352848546	15.04159359980268
18.672963631867226	16.171285094804087	16.328150795552332	15.37581050329907	14.532367352848546	0	13.867622663959827
18.849771867405387	16.741657850906222	16.745050918750113	16.46976265797933	15.04159359980268	13.867622663959827	0
18.54431869348773	15.822837431740288	16.740299000752167	15.969834796947401	16.075407347826808	15.010670759593623	15.853457288336402
19.17040836071171	16.279190515869487	15.974077218337	15.909387815032034	15.520890708070787	14.489522032707345	14.791259390737597
16.56259243551739	16.026186633089765	17.290645540733408	17.061084243610697	14.810725026407336	15.655080055770823	15.07589181263802
16.47692927476259	16.15183520301749	15.99587182597142	16.6167903358883	14.193441482101509	14.192284015013788	15.175919113785543
17.25018782129841	14.737032627508688	16.13719588847299	13.908513590607031	15.045055839894209	15.329129325289701	13.811630572398194
15.595340080140332	14.778801858934747	16.64638664133736	13.787987396219144	16.27491603226684	15.838528341720274	14.401461593520189
16.513961313382424	15.438943096764158	16.485069450003607	13.729980716211628	15.676361866472357	15.876994632242354	13.733718199689662
17.179524354841263	15.819572740019463	16.8812624759615	14.67322695738765	15.792859755305575	14.466442331034008	15.624854343609321
18.15246219311172	16.73681815734343	16.565758961496567	15.28650570061735	14.815969242074884	14.903070141518015	15.194587705422443
16.418195490461517	16.901387090028425	17.57176670961202	16.604060416317726	14.880094359134658	14.486472475184907	14.747498529217863
16.33680940491929	16.526896501894758	16.68070031897577	16.432838336626936	17.544782571740363	17.065276329776413	17.45343013267446
17.673186785385628	15.283403486121784	15.898421169557249	14.33393467690263	12.090056762053765	11.407612676630352	11.347357305274382
16.33090434303952	15.642309567230035	17.585334314661925	14.644797697393107	17.61027251404059	16.84566901090654	16.392211604195513
17.15019526527144	16.559996113949083	16.7433641745964	16.93761454940265	17.5090083044555	17.803107798888053	17.472527958233236
17.682616523580432	12.98113566900406	13.540172940275909	16.060745759002334	17.015769308210352	17.400882865474152	16.670732372167635
15.490052513324274	14.024080757129544	16.194712055238764	15.24555079467502	17.610345030638026	16.741232330728877	17.93126253139481
15.84579165402158	16.763827800692813	18.004655443959603	15.577096125582461	17.220051015854317	17.37561174898464	15.770616241225783
15.441654911395604	14.39771003572327	15.981966220426996	15.399720985732205	17.13553575297181	16.22629098454769	15.888550395427105

Table 29: A part of the dissimilarity matrix

Subsequent to obtaining the dissimilarity matrix, it was imported into IBM SPSS, where the ALSCAL (Alternative Least Squares Scaling) algorithm was employed. ALSCAL is a multidimensional scaling (MDS) technique used to uncover underlying patterns and structures in data by transforming high-dimensional dissimilarity information into a lower-dimensional representation.

```
ALSCAL
  VARIABLES= Age to how_is_your_memory
  /SHAPE=SYMMETRIC
  /LEVEL=RATIO
  /CONDITION=MATRIX
  /MODEL=EUCLID
  /CRITERIA=CONVERGE(.000000001) STRESSMIN(.000000005) ITER(2000) CUTOFF(0) DIMENS(1)
  /PLOT=ALL
 /PRINT=DATA HEADER
 /OUTFILE='C:\Users\marti\OneDrive\Desktop\Tesi Martina Definitiva\outputMDS_spss1.sav'.
```

Figure 24: ALSCAL algorithm

The study was performed according to different kind of LEVEL: RATIO, INTERVAL, ORDINAL, and NOMINAL. This categorization reflects the varying degrees of measurement precision and scale characteristics associated with each attribute.

The ALSCAL algorithm was executed separately for each attribute level, encompassing a range of dimensions from 5 down to 1. This dimensionality reduction process aimed to focus on finding significant LC factors.

The algorithm, configured to interpret dissimilarity data in Euclidean space, was equipped with specific convergence criteria, stress minimization thresholds, and iteration limits. These parameters were carefully fine-tuned to ensure the accuracy of the transformation process.

Upon executing the ALSCAL algorithm, a series of Stimulus Coordinates tables were generated. These tables provided insights into the spatial relationships and configurations of the data points in the lower-dimensional space. By scrutinizing these tables, LC factors that held statistical significance were identified, akin to the approach previously employed with the Rotated Component Matrix.

This comprehensive procedure, involving the application of ALSCAL across various attribute levels and dimensionalities, facilitated the exploration of intricate patterns and the extraction of valuable insights from the dataset. It served as an important step in the data analysis pipeline.

6.3.1 Test with 5 dimensions

Stimulus Number	Stimulus Name	1	2	3	4	5
1	Age	.6950	-2.5388	.4884	.9832	-.2215
2	Have_Cov	-.3362	.7212	-.7525	2.0811	.4435
3	Had_Covi	.8464	1.1591	-.7002	2.0203	.3854
4	how_seve	-.9649	.3594	-1.8314	.8554	.5156
5	dry_cont	.3663	.7922	-2.2495	.1733	-.0336
6	sore_thr	.1954	1.4506	-1.6071	-.2114	.3404
7	runny_no	.0364	.3237	-1.8701	-.9492	-.9346
8	loss_tas	1.4490	1.4114	-.2252	1.2117	.8488
9	loss_app	1.2940	.9283	-1.5859	-.8404	-.2130
10	fever_s	.3772	.4039	-1.4355	.9274	-1.8543
11	chills_s	.0768	-.1304	-2.2039	-.1668	-.9032
12	headache	-.6999	.6308	-1.5084	.6064	-1.1585
13	body_ach	-1.2047	-.2560	-1.4469	.0261	-1.0096
14	fatigue_	-.9527	.4158	-1.2045	.5921	-1.3227
15	shortnes	-.9376	.3993	-1.6695	.1430	.8352
16	nausea_a	.6293	.9724	-.6750	-1.0691	-1.4842
17	diarrhea	.2981	.2815	-.8597	-1.1775	-1.7314
18	other_s	.5526	-1.8960	-.4788	-.9802	-1.1015
19	total_s	-.2553	.8580	-1.3817	-.6709	-.7906
20	weeks_un	-1.7590	.1838	-.4381	.8869	-.1866
21	Have_vac	1.0483	-.2988	.1196	2.6347	-.2324
22	Had_co_1	.9160	.3793	-.8122	2.2041	.1518
23	Had_Long	-1.7089	-.5242	.4444	.8752	-.1960
24	use_devi	-.3971	-1.8746	-.5944	.1716	-1.1970
25	extreme_	-1.7253	-.4534	.3159	.5656	-.4526
26	shortn_1	-.9998	-.4415	-.7608	-.0015	1.7396
27	chest_pa	-.4752	-.2814	-.7102	-1.0942	1.5519
28	memory_o	-1.6459	-.2274	.4333	.8471	-.2159
29	concentr	-1.6890	-.0959	.2001	.5601	-.7173
30	insomnia	-1.3308	-1.5319	.1678	-.1737	-.5409
31	heart_pa	-.8889	-.5090	.0112	-1.2677	1.0158
32	dizzines	-.7668	1.0985	.8392	-.4263	-1.1728
33	pins_and	-.5831	-.2842	-.1932	-.4932	1.8672
34	joint_pa	-1.2132	-.4605	-.0333	-.3954	1.3036
35	depressi	-.6684	-.2603	1.5755	1.4619	-.6390
36	anxiety_	-.4414	.0100	1.7888	.0538	-1.1285
37	tinnitus	.0149	-1.9247	.2004	-.6759	.7606
38	earache_	.4837	-.2021	-1.3185	-.1885	1.8310
39	feeling_	.2672	1.2164	.3906	-1.2522	-.8797
40	diarrh_1	.2671	1.2164	.3905	-1.2522	-.8796
41	stomach_	.2670	1.2165	.3904	-1.2522	-.8796
42	loss_a_1	.2669	1.2165	.3904	-1.2522	-.8796
43	high_tem	.2104	1.4990	.8960	-.0298	.8510
44	cough_ol	.2103	1.4990	.8960	-.0298	.8510
45	headac_1	.2102	1.4990	.8960	-.0298	.8510
46	sore_t_1	.2102	1.4991	.8959	-.0298	.8510
47	changes_	.2101	1.4991	.8959	-.0298	.8510
48	rashes_o	.8902	-.4927	.5068	-1.8792	-.3577
49	other_ol	1.0489	-1.4936	-1.4746	-.8057	-.0193
50	total_ol	-.6280	.8034	.7973	-.8174	.3388
51	extrem_1	-1.5744	-.5268	.7052	.7977	-.3866
52	shortn_2	-.6374	-.5181	-.1934	-.0430	2.0370
53	chest__1	-.0237	-.7076	.0283	-1.0555	1.7265
54	memory_a	-1.5507	-.3852	.6809	.8567	-.2677
55	concen_1	-1.6792	-.5754	.3996	.6038	-.5654
56	insomn_1	-1.0803	-1.7549	.0382	-.3613	.3500
57	heart__1	.3042	-1.1191	.2065	-1.3868	1.2119
58	dizzin_1	-.3814	.5406	1.5618	-.4199	-1.0445
59	pins_a_1	-.2909	-.2416	.1442	-.1485	1.9911
60	joint__1	-.9016	-.5630	.1792	-.1890	1.6345
61	depres_1	-.3924	-.7192	1.8474	1.2910	.0684
62	anxiet_1	-.1553	-.8254	1.9310	.2134	-.4887
63	tinnit_1	.2896	-1.9795	.5729	-.5946	.4581
64	earach_1	-1.5220	-.3785	.7050	.8893	-.2724
65	feelin_1	.3616	.9352	.5543	-1.4482	-.7947
66	diarrh_2	.3615	.9353	.5542	-1.4483	-.7947
67	stomac_1	.3614	.9353	.5541	-1.4483	-.7947
68	loss_a_2	.3613	.9354	.5540	-1.4483	-.7947
69	high_t_1	.6232	1.0506	1.1907	.0132	1.1075
70	cough_ac	.6231	1.0506	1.1907	.0132	1.1075
71	headac_2	.6231	1.0507	1.1907	.0132	1.1075
72	sore_t_2	.6230	1.0507	1.1906	.0132	1.1076
73	change_1	.6230	1.0507	1.1906	.0132	1.1076
74	rashes_a	1.0224	-.6772	.7487	-1.6590	.1431
75	other_ac	1.3639	-1.7198	-1.0275	-.6696	.2961
76	total_ac	-.4501	.4584	1.0976	-.7872	.6598
77	everyday	-.7891	-1.3843	.9421	-.1727	-.9654
78	qol_tota	2.5171	-.9478	-1.1835	1.1013	.1306
79	Work_job	2.6510	-.8086	-.9668	1.0605	-.0155
80	indipend	2.4893	-.9626	-1.0402	1.3190	-.0700
81	fatigu_1	1.6221	-1.0601	.2222	1.5643	-1.3089
82	difficul	1.5673	-.9231	.0513	1.5904	-1.4181
83	how_is_y	1.9747	-.9811	.2702	1.4875	-1.113

Table 30: Stimulus Coordinates, /LEVEL=RATIO, 5 dimensions

Stimulus Number	Stimulus Name	1	2	3	4	5
1	Age	.6950	-2.5388	.4884	.9832	-.2215
2	Have_Cov	-.3362	.7212	-.7525	2.0811	.4435
3	Had_Covi	.8464	1.1591	-.7002	2.0203	.3854
4	how_seve	-.9649	.3594	-1.8314	.8554	.5156
5	dry_cont	.3663	.7922	-2.2495	.1733	-.0336
6	sore_thr	.1954	1.4506	-1.6071	-.2114	.3404
7	runny_no	.0364	.3237	-1.8701	-.9492	-.9346
8	loss_tas	1.4490	1.4114	-.2252	1.2117	.8488
9	loss_app	1.2940	.9283	-1.5859	-.8404	-.2130
10	fever_s	.3772	.4039	-1.4355	.9274	-1.8543
11	chills_s	.0768	-.1304	-2.2039	-.1668	-.9032
12	headache	-.6999	.6308	-1.5084	.6064	-1.1585
13	body_ach	-1.2047	-.2560	-1.4469	.0261	-1.0096
14	fatigue_	-.9527	.4158	-1.2045	.5921	-1.3227
15	shortnes	-.9376	.3993	-1.6695	.1430	.8352
16	nausea_a	.6293	.9724	-.6750	-1.0691	-1.4842
17	diarrhea	.2981	.2815	-.8597	-1.1775	-1.7314
18	other_s	.5526	-1.8960	-.4788	-.9802	-1.1015
19	total_s	-.2553	.8580	-1.3817	-.6709	-.7906
20	weeks_un	-1.7590	.1838	-.4381	.8869	-.1866
21	Have_vac	1.0483	-.2988	.1196	2.6347	-.2324
22	Had_co_1	.9160	.3793	-.8122	2.2041	.1518
23	Had_Long	-1.7089	-.5242	.4444	.8752	-.1960
24	use_devi	-.3971	-1.8746	-.5944	.1716	-1.1970
25	extreme_	-1.7253	-.4534	.3159	.5656	-.4526
26	shortn_1	-.9998	-.4415	-.7608	-.0015	1.7396
27	chest_pa	-.4752	-.2814	-.7102	-1.0942	1.5519
28	memory_o	-1.6459	-.2274	.4333	.8471	-.2159
29	concentr	-1.6890	-.0959	.2001	.5601	-.7173
30	insomnia	-1.3308	-1.5319	.1678	-.1737	-.5409
31	heart_pa	-.8889	-.5090	.0112	-1.2677	1.0158
32	dizzines	-.7668	1.0985	.8392	-.4263	-1.1728
33	pins_and	-.5831	-.2842	-.1932	-.4932	1.8672
34	joint_pa	-1.2132	-.4605	-.0333	-.3954	1.3036
35	depressi	-.6684	-.2603	1.5755	1.4619	-.6390
36	anxiety_	-.4414	.0100	1.7888	.0538	-1.1285
37	tinnitus	.0149	-1.9247	.2004	-.6759	.7606
38	earache_	.4837	-.2021	-1.3185	-.1885	1.8310
39	feeling_	.2672	1.2164	.3906	-1.2522	-.8797
40	diarrh_1	.2671	1.2164	.3905	-1.2522	-.8796
41	stomach_	.2670	1.2165	.3904	-1.2522	-.8796
42	loss_a_1	.2669	1.2165	.3904	-1.2522	-.8796
43	high_tem	.2104	1.4990	.8960	-.0298	.8510
44	cough_ol	.2103	1.4990	.8960	-.0298	.8510
45	headac_1	.2102	1.4990	.8960	-.0298	.8510
46	sore_t_1	.2102	1.4991	.8959	-.0298	.8510
47	changes_	.2101	1.4991	.8959	-.0298	.8510
48	rashes_o	.8902	-.4927	.5068	-1.8792	-.3577
49	other_ol	1.0489	-1.4936	-1.4746	-.8057	-.0193
50	total_ol	-.6280	.8034	.7973	-.8174	.3388
51	extrem_1	-1.5744	-.5268	.7052	.7977	-.3866
52	shortn_2	-.6374	-.5181	-.1934	-.0430	2.0370
53	chest__1	-.0237	-.7076	.0283	-1.0555	1.7265
54	memory_a	-1.5507	-.3852	.6809	.8567	-.2677
55	concen_1	-1.6792	-.5754	.3996	.6038	-.5654
56	insomn_1	-1.0803	-1.7549	.0382	-.3613	.3500
57	heart__1	.3042	-1.1191	.2065	-1.3868	1.2119
58	dizzin_1	-.3814	.5406	1.5618	-.4199	-1.0445
59	pins_a_1	-.2909	-.2416	.1442	-.1485	1.9911
60	joint__1	-.9016	-.5630	.1792	-.1890	1.6345
61	depres_1	-.3924	-.7192	1.8474	1.2910	.0684
62	anxiet_1	-.1553	-.8254	1.9310	.2134	-.4887
63	tinnit_1	.2896	-1.9795	.5729	-.5946	.4581
64	earach_1	-1.5220	-.3785	.7050	.8893	-.2724
65	feelin_1	.3616	.9352	.5543	-1.4482	-.7947
66	diarrh_2	.3615	.9353	.5542	-1.4483	-.7947
67	stomac_1	.3614	.9353	.5541	-1.4483	-.7947
68	loss_a_2	.3613	.9354	.5540	-1.4483	-.7947
69	high_t_1	.6232	1.0506	1.1907	.0132	1.1075
70	cough_ac	.6231	1.0506	1.1907	.0132	1.1075
71	headac_2	.6231	1.0507	1.1907	.0132	1.1075
72	sore_t_2	.6230	1.0507	1.1906	.0132	1.1076
73	change_1	.6230	1.0507	1.1906	.0132	1.1076
74	rashes_a	1.0224	-.6772	.7487	-1.6590	.1431
75	other_ac	1.3639	-1.7198	-1.0275	-.6696	.2961
76	total_ac	-.4501	.4584	1.0976	-.7872	.6598
77	everyday	-.7891	-1.3843	.9421	-.1727	-.9654
78	qol_tota	2.5171	-.9478	-1.1835	1.1013	.1306
79	Work_job	2.6510	-.8086	-.9668	1.0605	-.0155
80	indipend	2.4893	-.9626	-1.0402	1.3190	-.0700
81	fatigu_1	1.6221	-1.0601	.2222	1.5643	-1.3089
82	difficul	1.5673	-.9231	.0513	1.5904	-1.4181
83	how_is_y	1.9747	-.9811	.2702	1.4875	-1.113

Table 31: Stimulus Coordinates, /LEVEL=INTERVAL, 5 dimensions

Stimulus Number	Stimulus Name	1	2	3	4	5
1	Age	-2.4976	1.8819	.4076	.4196	1.0690
2	Have_Cov	-.7775	.0039	1.3080	-.5582	-1.6395
3	Had_Covi	-.5416	-1.1444	1.2590	-1.0101	-2.0441
4	how_seve	-1.0288	.0951	-.2353	-1.8257	-1.0360
5	dry_cont	-.3610	-2.3315	.6868	-.6953	.1144
6	sore_thr	.5279	-1.7993	.1309	-.6723	-.1528
7	runny_no	-.1808	-2.0882	-.6916	-.1432	.6340
8	loss_tas	1.2018	-1.0730	2.0213	.3043	.2088
9	loss_app	.3630	-2.0687	.5772	-.9039	.8259
10	fever_s	-1.6520	-2.1571	.0522	1.3844	.1962
11	chills_s	-1.6809	-1.6155	-.5739	-.6765	.5653
12	headache	-1.1581	-1.2618	-.3496	.5797	-.8928
13	body_ach	-1.2932	-.4699	-1.2865	.0884	.2943
14	fatigue_	-1.2229	-.9237	-.5981	.6083	-.7452
15	shortnes	-.2447	-.3826	-.5475	-1.4474	-.5935
16	nausea_a	.1738	-1.9900	-.4810	.1347	.1968
17	diarrhea	-.4258	-1.5984	-.9833	.4812	.8335
18	other_s	-1.5405	.6120	-1.1943	-1.4721	.3461
19	total_s	-.0101	-1.1966	-.7549	-.1706	.1125
20	weeks_un	-.5559	.6571	-.6048	-.8819	-1.2250
21	Have_vac	-1.8550	.7367	2.1356	.2199	-2.1328
22	Had_co_1	-1.1358	-.2931	1.2779	-1.5126	-1.5544
23	Had_Long	-.3914	1.4383	-.4998	.4733	-.5432
24	use_devi	-1.7467	.7881	-.3966	.4914	1.0617
25	extreme_	-.4726	.9155	-.7504	.3686	-.5949
26	shortn_1	.4997	1.4484	.0645	-1.1210	.7664
27	chest_pa	1.1173	.5466	-.4939	-.8153	.7641
28	memory_o	-.3090	.7762	-.5528	.7182	-.6221
29	concentr	-.3664	.3000	-.8560	.8169	-.4662
30	insomnia	-.6439	.9916	-.8189	1.0294	.0860
31	heart_pa	.6930	.7491	-.9414	-.0716	.4290
32	dizzines	1.0118	-.2654	-.6908	.8692	-.5191
33	pins_and	1.1047	1.0291	.1343	.0085	.4491
34	joint_pa	.3016	.8921	-.7827	-.3750	-.3235
35	depressi	.2768	1.0509	.3187	1.9814	-.6387
36	anxiety_	.8579	.6104	-.3658	1.4186	.5419
37	tinnitus	-.2380	1.3232	-.8144	-.7494	-.3175
38	earache_	.2910	.1076	.1005	-2.1221	-.4871
39	feeling_	1.0283	-.9402	-.6691	.4079	.0532
40	diarrh_1	1.0283	-.9402	-.6691	.4079	.0531
41	stomach_	1.0283	-.9402	-.6691	.4079	.0531
42	loss_a_1	1.0283	-.9402	-.6691	.4079	.0531
43	high_tem	1.3374	-.1022	.0311	-.1473	-.7910
44	cough_ol	1.3374	-.1022	.0311	-.1473	-.7911
45	headac_1	1.3374	-.1022	.0311	-.1473	-.7911
46	sore_t_1	1.3374	-.1022	.0311	-.1473	-.7911
47	changes_	1.3374	-.1022	.0311	-.1473	-.7911
48	rashes_o	.8663	-.0413	-.9592	-.2643	1.4441
49	other_ol	-1.4219	-.3317	-.1930	-1.5582	1.6167
50	total_ol	.8277	.1636	-.7443	-.0865	-.1340
51	extrem_1	-.3988	1.2025	-.5110	.5923	-.7024
52	shortn_2	.9872	1.6008	.5779	-.6699	.3889
53	chest__1	1.2409	1.0671	-.2031	-.5229	.8261
54	memory_a	-.3164	.9089	-.5914	.8552	-.5588
55	concen_1	-.5457	.9076	-.8505	.6430	-.4157
56	insomn_1	-.5547	1.3750	-.9849	-.0282	-.3175
57	heart__1	1.2335	.4990	.3638	.4228	1.4283
58	dizzin_1	1.2556	.3369	-.3263	.9862	.0108
59	pins_a_1	1.1455	.9706	.2644	-.0195	.4532
60	joint__1	.5057	1.2339	-.5432	-.6791	-.2029
61	depres_1	.3719	1.9350	.6385	1.4289	-.5323
62	anxiet_1	.5610	1.2212	-.1878	1.1853	.7691
63	tinnit_1	-.5010	1.4282	-.9346	-.6536	.1090
64	earach_1	-.3207	.9080	-.5937	.8514	-.5628
65	feelin_1	1.1378	-.8894	-.6938	.1942	-.0369
66	diarrh_2	1.1378	-.8894	-.6938	.1942	-.0369
67	stomac_1	1.1378	-.8894	-.6938	.1942	-.0370
68	loss_a_2	1.1378	-.8894	-.6938	.1942	-.0370
69	high_t_1	1.5461	.3219	.5303	-.0650	-.5093
70	cough_ac	1.5461	.3219	.5303	-.0650	-.5093
71	headac_2	1.5461	.3219	.5302	-.0650	-.5093
72	sore_t_2	1.5461	.3219	.5302	-.0650	-.5093
73	change_1	1.5461	.3219	.5302	-.0650	-.5093
74	rashes_a	1.2098	.1677	-.6429	-.3997	1.3557
75	other_ac	-1.1292	-.0208	.3835	-1.6762	1.9804
76	total_ac	.9581	.4404	-.6949	-.0953	-.1304
77	everyday	-.4763	1.2446	-.8955	.6721	-.2651
78	qol_tota	-2.4196	-1.1646	3.2137	-1.1225	1.8480
79	Work_job	-1.9686	-1.3217	3.5229	-1.1775	1.4782
80	indipend	-2.5826	-1.2109	3.4094	-.8340	1.4315
81	fatigu_1	-2.7685	-.2763	1.8285	1.5347	.5828
82	difficul	-2.8517	-.7794	1.5282	1.5653	.2590
83	how_is_y	-2.0800	-.5303	2.5401	1.7312	1.3109

Table 32: Stimulus Coordinates, /LEVEL=ORDINAL, 5 dimensions

Stimulus Number	Stimulus Name	1	2	3	4	5
1	Age	-1.7818	1.3427	.6822	-.4187	-.4901
2	Have_Cov	-.9228	.2073	.7875	.8468	.6146
3	Had_Covi	-.9306	-.6501	.3997	.7700	-.1537
4	how_seve	-.8638	.2071	.1244	.2127	1.4937
5	dry_cont	-1.0752	-.9742	-.1381	.3298	1.2495
6	sore_thr	-.2268	-1.0464	-.0607	.3983	1.1723
7	runny_no	-.7787	-.7437	-.7606	-.0078	1.4818
8	loss_tas	-.3665	-1.0782	.7045	.3136	.7534
9	loss_app	-.7008	-1.8324	-.6663	-.1475	1.0731
10	fever_s	-1.6338	-.5718	-.3738	1.3588	.8334
11	chills_s	-1.5227	-.5876	-.6805	.4476	1.2459
12	headache	-1.0962	-.1720	-.7739	1.3514	1.5015
13	body_ach	-1.0563	.6170	-1.1282	.5860	1.4905
14	fatigue_	-.9020	.1265	-.6057	1.2878	1.1395
15	shortnes	-.4106	.0399	-.1502	-.1364	1.3396
16	nausea_a	-.2295	-1.4233	-1.5344	.3937	.3217
17	diarrhea	-.5453	-.7819	-1.6091	.1526	.3484
18	other_s	-.8163	.3674	-.1844	-.2120	-.0949
19	total_s	-.3874	-.9507	-1.4076	.9060	2.1265
20	weeks_un	-.1540	.8228	-.1691	.3605	.1169
21	Have_vac	-1.5140	.2052	1.0926	.7999	-.9486
22	Had_co_1	-1.2545	-.2863	.1939	.0188	-.2255
23	Had_Long	.0191	1.9674	-.1312	.3238	-.5162
24	use_devi	-1.1439	.8536	-.0260	.0684	.2413
25	extreme_	.0543	1.9310	-.4817	.4856	-.4102
26	shortn_1	.0680	.9020	.2309	-1.3111	.2897
27	chest_pa	.4589	.3009	-.2456	-1.6202	.3815
28	memory_o	.1340	1.8155	-.1718	.6734	-.2676
29	concentr	.0358	1.6976	-.5778	1.0468	.0661
30	insomnia	-.2447	1.4344	-.2299	-.1371	-.1938
31	heart_pa	.7968	.6706	-.1472	-1.1365	.2071
32	dizzines	.7858	.1846	-.8240	.3942	-.5286
33	pins_and	.5107	.5318	.1597	-1.1116	.1123
34	joint_pa	.5523	.9562	.0015	-.7677	-.0871
35	depressi	.0531	1.2998	.2133	.4472	-.3388
36	anxiety_	.5893	.7851	-.2702	.0973	-.4838
37	tinnitus	-.0045	.8093	.3662	-.6025	.4478
38	earache_	-.2476	-.2675	.2833	-.5352	.4384
39	feeling_	1.1431	-1.3399	-1.8547	.1005	-1.0708
40	diarrh_1	1.1431	-1.3399	-1.8547	.1005	-1.0708
41	stomach_	1.1431	-1.3399	-1.8547	.1005	-1.0708
42	loss_a_1	1.1431	-1.3399	-1.8547	.1005	-1.0708
43	high_tem	1.9771	-.9403	1.3229	.8183	.0115
44	cough_ol	1.9771	-.9403	1.3229	.8183	.0115
45	headac_1	1.9771	-.9403	1.3229	.8183	.0115
46	sore_t_1	1.9771	-.9403	1.3229	.8183	.0115
47	changes_	1.9771	-.9403	1.3229	.8183	.0115
48	rashes_o	.4270	-.3283	-.2849	-.7762	-.0448
49	other_ol	-1.3981	-.2617	-.2392	-1.1139	.2954
50	total_ol	2.0733	.2149	-.4695	-.0214	-.0976
51	extrem_1	.1575	2.1258	-.1463	.6974	-.5668
52	shortn_2	.3270	.8300	.5310	-1.6129	.1466
53	chest__1	.5822	.4467	.2396	-1.7938	.3311
54	memory_a	.1645	1.8817	-.1116	.6429	-.3734
55	concen_1	.0074	2.1103	-.3650	.7643	.0944
56	insomn_1	-.1349	1.2791	.0658	-.3994	.1130
57	heart__1	.2663	.2324	.1143	-1.3420	.1166
58	dizzin_1	.7524	.3630	-.4273	-.0426	-.5589
59	pins_a_1	.5544	.5716	.6246	-1.0008	.5777
60	joint__1	.6323	1.0928	.4252	-1.0438	.3672
61	depres_1	.1756	1.5617	.5672	.0835	-.5581
62	anxiet_1	.3559	1.1362	.0476	-.0607	-.5020
63	tinnit_1	-.1812	.8897	.2756	-.7992	.1974
64	earach_1	.1645	1.8817	-.1116	.6429	-.3734
65	feelin_1	1.1571	-1.2348	-1.7490	-.4598	-.8708
66	diarrh_2	1.1571	-1.2348	-1.7490	-.4598	-.8708
67	stomac_1	1.1571	-1.2348	-1.7490	-.4598	-.8708
68	loss_a_2	1.1571	-1.2348	-1.7490	-.4598	-.8708
69	high_t_1	1.8417	-.9163	1.9926	.3575	.0598
70	cough_ac	1.8417	-.9163	1.9926	.3575	.0598
71	headac_2	1.8417	-.9163	1.9926	.3575	.0598
72	sore_t_2	1.8417	-.9163	1.9926	.3575	.0598
73	change_1	1.8417	-.9163	1.9926	.3575	.0598
74	rashes_a	.4398	-.2363	-.0827	-.9337	.3788
75	other_ac	-1.5228	-.2981	.0005	-1.6023	.3128
76	total_ac	2.1384	.4303	.1174	-.5621	.0296
77	everyday	-.0888	1.2283	-.3075	-.1016	-.2701
78	qol_tota	-3.3425	-1.8671	1.5310	-1.2240	-.6120
79	Work_job	-3.0337	-1.9629	1.3756	-1.0948	-.8561
80	indipend	-3.3854	-1.6582	1.3576	-.9199	-.8665
81	fatigu_1	-2.6050	-.1213	.3054	1.1730	-2.1923
82	difficul	-2.6378	-.2191	.2379	1.3734	-1.8918
83	how_is_y	-2.4308	-.4507	.5849	.6986	-1.5346

Table 33: Stimulus Coordinates, /LEVEL=NOMINAL, 5 dimensions

For the ratio and interval attribute levels, the results appeared highly similar, if not identical, making it challenging to discern clear-cut divisions.

Conversely, the ordinal attribute level displayed more pronounced distinctions right from the initial stages of analysis. This was evident in the spatial separation of data points, suggesting a more structured and clustered arrangement within the reduced-dimensional representation.

In the case of the nominal attribute level, it became even more apparent that distinct divisions and groupings could be discerned.

The individuated dimensions are:

1: covid and severity

2: influenza symptoms

3: gastrointestinal

4: psychological

5: fatigue

6.3.2 Test with 4 dimensions

Stimulus Number	Stimulus Name	1	2	3	4
1	Age	1.9388	.0986	-.9074	-1.4201
2	Have_Cov	.9381	-.0990	-1.7181	.9811
3	Had_Covi	.1249	-1.7773	-1.6028	-.7314
4	how_seve	.9580	.2761	-.1685	1.8457
5	dry_cont	.4328	-1.3612	.4603	1.6084
6	sore_thr	-.6062	-1.0959	.4144	1.5229
7	runny_no	.3484	-.8918	1.3813	1.2319
8	loss_tas	-.7764	-1.7031	-1.3990	.0919
9	loss_app	-.4240	-1.6604	.3582	1.2877
10	fever_s	1.2269	-1.4868	1.3526	.1680
11	chills_s	1.1283	-.9081	.9243	1.3057
12	headache	.9747	-.4592	1.3828	.9543
13	body_ach	1.1561	.3549	1.1327	1.0126
14	fatigue_	1.0371	-.1476	1.5295	.6061
15	shortnes	.3532	.4105	-.1074	1.8451
16	nausea_a	-.5122	-1.1730	1.5159	.4664
17	diarrhea	.0603	-.8170	1.7907	.5347
18	other_s	1.2710	-.6167	1.2048	-1.2663
19	total_s	-.0669	-.5839	1.2216	1.1215
20	weeks_un	.8249	1.2959	.4845	.8510
21	Have_vac	1.5043	-1.3967	-.7889	-1.4356
22	Had_co_1	1.1572	-1.3537	-1.4352	.4658
23	Had_Long	.8654	1.6100	.1375	-.1139
24	use_devi	1.8843	.3627	.7658	-.2514
25	extreme_	.7844	1.4756	.5063	-.1159
26	shortn_1	.1901	1.1553	-.9957	1.2383
27	chest_pa	-.4865	.8453	-.7935	1.3801
28	memory_o	.7026	1.5114	.3340	-.2453
29	concentr	.6860	1.2989	.8920	-.0580
30	insomnia	1.0562	1.2852	.6526	-.6241
31	heart_pa	-.5523	1.3645	-.3068	.7638
32	dizzines	-.8576	.4594	1.4851	-.1929
33	pins_and	-.4702	1.0700	-1.1072	.8650
34	joint_pa	-.1392	1.4542	-.6394	.5445
35	depressi	.5361	.7555	.2797	-1.8886
36	anxiety_	-.3643	.6243	.9325	-1.5251
37	tinnitus	.6803	.5759	-.8030	-1.5538
38	earache_	.0325	-.2668	-1.5959	1.3075
39	feeling_	-1.3125	-.4066	1.1345	.1508
40	diarrh_1	-1.3125	-.4066	1.1346	.1509
41	stomach_	-1.3125	-.4065	1.1346	.1510
42	loss_a_1	-1.3125	-.4064	1.1347	.1511
43	high_tem	-1.6789	-.0513	-.4207	-.1589
44	cough_ol	-1.6789	-.0513	-.4207	-.1588
45	headac_1	-1.6789	-.0512	-.4206	-.1587
46	sore_t_1	-1.6789	-.0512	-.4206	-.1587
47	changes_	-1.6789	-.0511	-.4206	-.1586
48	rashes_o	-1.0417	-.7288	.9547	-1.1482
49	other_ol	1.2488	-.8055	-.5378	1.4816
50	total_ol	-1.1942	.7035	.2567	.0130
51	extrem 1	.7335	1.4814	.3513	-.5727
52	shortn_2	-.1205	1.1608	-1.3375	.8563
53	chest__1	-.6085	.8759	-1.3743	.7277
54	memory_a	.6480	1.4891	.2700	-.5294
55	concen_1	.8290	1.4262	.5716	-.3281
56	insomn_1	1.0040	1.5190	-.2083	-.3479
57	heart__1	-.4750	.8287	-1.3629	.9465
58	dizzin_1	-.9283	.5930	1.1018	-.8522
59	pins_a_1	-.5188	.8949	-1.4008	.5003
60	joint__1	-.1862	1.3280	-1.0775	.3289
61	depres_1	.3097	.8862	-.5892	-1.8371
62	anxiet_1	-.0458	.7313	.0293	-1.7834
63	tinnit_1	.5919	.4561	-.9372	-1.5365
64	earach_1	.6351	1.4662	.2271	-.6022
65	feelin_1	-1.3460	-.3649	1.0893	.0065
66	diarrh_2	-1.3460	-.3648	1.0894	.0066
67	stomac_1	-1.3460	-.3648	1.0895	.0067
68	loss_a_2	-1.3460	-.3647	1.0895	.0069
69	high_t_1	-1.4917	-.1118	-.8424	-.5721
70	cough_ac	-1.4918	-.1117	-.8424	-.5721
71	headac_2	-1.4918	-.1117	-.8424	-.5720
72	sore_t_2	-1.4918	-.1116	-.8424	-.5720
73	change_1	-1.4918	-.1116	-.8424	-.5719
74	rashes_a	-1.1463	-.6510	-.0103	-1.3850
75	other_ac	1.1893	-.8804	-1.0913	1.2229
76	total_ac	-1.1864	.7916	-.1336	-.2524
77	everyday	.8780	1.1804	.8040	-.7452
78	qol_tota	1.2935	-2.1618	-1.2206	.1691
79	Work_job	1.1506	-2.2756	-1.1180	.0297
80	indipend	1.4027	-2.1557	-1.1502	-.0460
81	fatigu_1	1.5156	-1.4782	-.1086	-1.3481
82	difficul	1.5431	-1.5402	.0230	-1.2110
83	how_is_y	1.3694	-1.7216	-.2828	-1.3047

Table 34: Stimulus Coordinates, /LEVEL=RATIO, 4 dimensions

Stimulus Number	Stimulus Name	1	2	3	4
1	Age	1.9388	.0986	-.9074	-1.4201
2	Have_Cov	.9381	-.0990	-1.7181	.9811
3	Had_Covi	.1249	-1.7773	-1.6028	-.7314
4	how_seve	.9580	.2761	-.1685	1.8457
5	dry_cont	.4328	-1.3612	.4603	1.6084
6	sore_thr	-.6062	-1.0959	.4144	1.5229
7	runny_no	.3484	-.8918	1.3813	1.2319
8	loss_tas	-.7764	-1.7031	-1.3990	.0919
9	loss_app	-.4240	-1.6604	.3582	1.2877
10	fever_s	1.2269	-1.4868	1.3526	.1680
11	chills_s	1.1283	-.9081	.9243	1.3057
12	headache	.9747	-.4592	1.3828	.9543
13	body_ach	1.1561	.3549	1.1327	1.0126
14	fatigue_	1.0371	-.1476	1.5295	.6061
15	shortnes	.3532	.4105	-.1074	1.8451
16	nausea_a	-.5122	-1.1730	1.5159	.4664
17	diarrhea	.0603	-.8170	1.7907	.5347
18	other_s	1.2710	-.6167	1.2048	-1.2663
19	total_s	-.0669	-.5839	1.2216	1.1215
20	weeks_un	.8249	1.2959	.4845	.8510
21	Have_vac	1.5043	-1.3967	-.7889	-1.4356
22	Had_co_1	1.1572	-1.3537	-1.4352	.4658
23	Had_Long	.8654	1.6100	.1375	-.1139
24	use_devi	1.8843	.3627	.7658	-.2514
25	extreme_	.7844	1.4756	.5063	-.1159
26	shortn_1	.1901	1.1553	-.9957	1.2383
27	chest_pa	-.4865	.8453	-.7935	1.3801
28	memory_o	.7026	1.5114	.3340	-.2453
29	concentr	.6860	1.2989	.8920	-.0580
30	insomnia	1.0562	1.2852	.6526	-.6241
31	heart_pa	-.5523	1.3645	-.3068	.7638
32	dizzines	-.8576	.4594	1.4851	-.1929
33	pins_and	-.4702	1.0700	-1.1072	.8650
34	joint_pa	-.1392	1.4542	-.6394	.5445
35	depressi	.5361	.7555	.2797	-1.8886
36	anxiety_	-.3643	.6243	.9325	-1.5251
37	tinnitus	.6803	.5759	-.8030	-1.5538
38	earache_	.0325	-.2668	-1.5959	1.3075
39	feeling_	-1.3125	-.4066	1.1345	.1508
40	diarrh_1	-1.3125	-.4066	1.1346	.1509
41	stomach_	-1.3125	-.4065	1.1346	.1510
42	loss_a_1	-1.3125	-.4064	1.1347	.1511
43	high_tem	-1.6789	-.0513	-.4207	-.1589
44	cough_ol	-1.6789	-.0513	-.4207	-.1588
45	headac_1	-1.6789	-.0512	-.4206	-.1587
46	sore_t_1	-1.6789	-.0512	-.4206	-.1587
47	changes_	-1.6789	-.0511	-.4206	-.1586
48	rashes_o	-1.0417	-.7288	.9547	-1.1482
49	other_ol	1.2488	-.8055	-.5378	1.4816
50	total_ol	-1.1942	.7035	.2567	.0130
51	extrem 1	.7335	1.4814	.3513	-.5727
52	shortn_2	-.1205	1.1608	-1.3375	.8563
53	chest__1	-.6085	.8759	-1.3743	.7277
54	memory_a	.6480	1.4891	.2700	-.5294
55	concen_1	.8290	1.4262	.5716	-.3281
56	insomn_1	1.0040	1.5190	-.2083	-.3479
57	heart__1	-.4750	.8287	-1.3629	.9465
58	dizzin_1	-.9283	.5930	1.1018	-.8522
59	pins_a_1	-.5188	.8949	-1.4008	.5003
60	joint__1	-.1862	1.3280	-1.0775	.3289
61	depres_1	.3097	.8862	-.5892	-1.8371
62	anxiet_1	-.0458	.7313	.0293	-1.7834
63	tinnit_1	.5919	.4561	-.9372	-1.5365
64	earach_1	.6351	1.4662	.2271	-.6022
65	feelin_1	-1.3460	-.3649	1.0893	.0065
66	diarrh_2	-1.3460	-.3648	1.0894	.0066
67	stomac_1	-1.3460	-.3648	1.0895	.0067
68	loss_a_2	-1.3460	-.3647	1.0895	.0069
69	high_t_1	-1.4917	-.1118	-.8424	-.5721
70	cough_ac	-1.4918	-.1117	-.8424	-.5721
71	headac_2	-1.4918	-.1117	-.8424	-.5720
72	sore_t_2	-1.4918	-.1116	-.8424	-.5720
73	change_1	-1.4918	-.1116	-.8424	-.5719
74	rashes_a	-1.1463	-.6510	-.0103	-1.3850
75	other_ac	1.1893	-.8804	-1.0913	1.2229
76	total_ac	-1.1864	.7916	-.1336	-.2524
77	everyday	.8780	1.1804	.8040	-.7452
78	qol_tota	1.2935	-2.1618	-1.2206	.1691
79	Work_job	1.1506	-2.2756	-1.1180	.0297
80	indipend	1.4027	-2.1557	-1.1502	-.0460
81	fatigu_1	1.5156	-1.4782	-.1086	-1.3481
82	difficul	1.5431	-1.5402	.0230	-1.2110
83	how_is_y	1.3694	-1.7216	-.2828	-1.3047

Table 35: Stimulus Coordinates, /LEVEL=INTERVAL, 4 dimensions

Stimulus Number	Stimulus Name	1	2	3	4
1	Age	2.2313	-1.9166	-.2151	-.6281
2	Have_Cov	.6167	.1188	-1.9224	.4476
3	Had_Covi	.3627	1.3069	-2.0701	.8020
4	how_seve	.2523	-.5562	-1.0946	-1.6529
5	dry_cont	.6086	2.1266	-.0629	-.5603
6	sore_thr	-.3805	1.7210	.0713	-.3181
7	runny_no	.2185	1.6847	1.0652	-.4866
8	loss_tas	-.2909	1.7887	-1.1997	.6500
9	loss_app	.0135	2.0903	-.0500	-.8046
10	fever_s	1.8959	1.5150	1.1569	.4993
11	chills_s	1.3319	1.1321	.8380	-1.2185
12	headache	1.0996	.8585	.7325	.7823
13	body_ach	.8903	-.0871	1.2698	-.5606
14	fatigue_	1.1242	.4567	.9515	.6287
15	shortnes	-.2779	.2739	.0680	-1.3840
16	nausea_a	-.0007	1.6313	.8133	.0189
17	diarrhea	.5154	1.0892	1.4698	-.2104
18	other_s	.9327	-1.1723	.5783	-1.5923
19	total_s	-.0821	.8686	.8123	-.2801
20	weeks_un	.2195	-1.0580	-.0318	.7354
21	Have_vac	1.8987	-.6042	-2.1760	1.4227
22	Had_co_1	.8024	.4098	-2.3237	-.1040
23	Had_Long	.0053	-1.4649	.0262	.4683
24	use_devi	1.5463	-.9844	.6140	-.5665
25	extreme_	.0579	-1.1635	.3269	.4388
26	shortn_1	-.6297	-1.0057	-.7048	-1.1435
27	chest_pa	-1.2451	-.2827	.1187	-.7779
28	memory_o	.0499	-.9421	.3435	.6908
29	concentr	.0912	-.6192	.7723	.6473
30	insomnia	.4506	-1.2206	.7603	.3404
31	heart_pa	-.8682	-.6773	.5475	-.3051
32	dizzines	-.9417	.1502	.6640	.8224
33	pins_and	-.9749	-.6788	-.5294	-.1595
34	joint_pa	-.7228	-.8859	.1041	-.1339
35	depressi	.0138	-1.0363	.1595	1.8302
36	anxiety_	-.5573	-.5227	.9691	.9940
37	tinnitus	-.3638	-1.4082	.2359	-.4445
38	earache_	-.8059	.0457	-1.2591	-1.1952
39	feeling_	-.8498	.7521	.7586	.4450
40	diarrh_1	-.8498	.7521	.7586	.4450
41	stomach_	-.8498	.7521	.7586	.4450
42	loss_a_1	-.8498	.7521	.7586	.4450
43	high_tem	-1.2380	.2638	-.3188	.4705
44	cough_ol	-1.2380	.2638	-.3188	.4705
45	headac_1	-1.2380	.2638	-.3188	.4705
46	sore_t_1	-1.2380	.2638	-.3188	.4705
47	changes_	-1.2380	.2638	-.3188	.4705
48	rashes_o	-.8505	.0521	1.0826	-.9425
49	other_ol	1.1250	.2511	.1783	-2.0754
50	total_ol	-.9805	-.2313	.4665	.0718
51	extrem_1	.0624	-1.2927	.1550	.6790
52	shortn_2	-.9182	-1.0125	-1.0778	-.5839
53	chest__1	-1.3174	-.6966	-.0975	-.6983
54	memory_a	.0511	-1.0386	.4236	.7186
55	concen_1	.1594	-1.1492	.6061	.4708
56	insomn_1	-.0022	-1.5170	.4425	-.0889
57	heart__1	-1.0400	-.0853	.0419	-1.2171
58	dizzin_1	-1.0329	-.1822	.3752	.8792
59	pins_a_1	-1.0252	-.6017	-.5037	-.0949
60	joint__1	-.8814	-1.0277	-.1771	-.3744
61	depres_1	-.1837	-1.6868	-.3964	1.5134
62	anxiet_1	-.2760	-1.1980	.6802	.8632
63	tinnit_1	-.0184	-1.5242	.2882	-.5431
64	earach_1	.0498	-1.0395	.4199	.7148
65	feelin_1	-1.0116	.7358	.6709	.2631
66	diarrh_2	-1.0116	.7358	.6709	.2631
67	stomac_1	-1.0116	.7358	.6709	.2631
68	loss_a_2	-1.0116	.7358	.6710	.2631
69	high_t_1	-1.2509	.1081	-.6423	.5389
70	cough_ac	-1.2509	.1081	-.6423	.5389
71	headac_2	-1.2509	.1081	-.6423	.5389
72	sore_t_2	-1.2509	.1081	-.6423	.5389
73	change_1	-1.2509	.1081	-.6423	.5389
74	rashes_a	-1.2057	.0007	.7167	-.9788
75	other_ac	1.0136	.1412	-.1829	-2.3077
76	total_ac	-1.0956	-.4107	.3629	.0739
77	everyday	.0823	-1.3933	.5803	.3999
78	qol_tota	3.1761	1.6751	-1.8988	-1.8964
79	Work_job	2.7818	2.1213	-2.2160	-1.4427
80	indipend	3.4021	1.7222	-1.9649	-1.3713
81	fatigu_1	3.2144	.1114	-.4354	.8221
82	difficul	3.1723	.5082	-.1570	.8741
83	how_is_y	3.3402	.7124	-.4549	.9632

Table 36: Stimulus Coordinates, /LEVEL=ORDINAL, 4 dimensions

Stimulus Number	Stimulus Name	1	2	3	4
1	Age	1.6993	-1.2805	-.6506	-.3993
2	Have_Cov	.8801	-.1977	-.7510	.8076
3	Had_Covi	.8875	.6200	-.3812	.7344
4	how_seve	.8238	-.1975	-.1186	.2029
5	dry_cont	1.0254	.9291	.1318	.3146
6	sore_thr	.2163	.9979	.0579	.3799
7	runny_no	.7426	.7092	.7254	-.0074
8	loss_tas	.3496	1.0283	-.6719	.2991
9	loss_app	.6684	1.7476	.6354	-.1406
10	fever_s	1.5581	.5454	.3565	1.2959
11	chills_s	1.4522	.5603	.6490	.4270
12	headache	1.0455	.1640	.7381	1.2889
13	body_ach	1.0074	-.5885	1.0759	.5589
14	fatigue_	.8602	-.1206	.5777	1.2282
15	shortnes	.3916	-.0381	.1433	-.1301
16	nausea_a	.2189	1.3574	1.4633	.3755
17	diarrhea	.5201	.7457	1.5346	.1455
18	other_s	.7785	-.3504	.1758	-.2022
19	total_s	.3695	.9067	1.3424	.8641
20	weeks_un	.1469	-.7847	.1612	.3438
21	Have_vac	1.4439	-.1957	-1.0420	.7629
22	Had_co_1	1.1964	.2731	-.1850	.0179
23	Had_Long	-.0182	-1.8763	.1251	.3088
24	use_devi	1.0909	-.8141	.0248	.0652
25	extreme_	-.0518	-1.8416	.4594	.4631
26	shortn_1	-.0649	-.8603	-.2202	-1.2503
27	chest_pa	-.4376	-.2870	.2343	-1.5452
28	memory_o	-.1278	-1.7314	.1639	.6422
29	concentr	-.0342	-1.6190	.5510	.9984
30	insomnia	.2334	-1.3680	.2193	-.1308
31	heart_pa	-.7600	-.6396	.1403	-1.0838
32	dizzines	-.7494	-.1761	.7859	.3759
33	pins_and	-.4871	-.5072	-.1524	-1.0601
34	joint_pa	-.5267	-.9120	-.0015	-.7321
35	depressi	-.0506	-1.2396	-.2034	.4265
36	anxiety_	-.5620	-.7487	.2577	.0928
37	tinnitus	.0043	-.7718	-.3492	-.5745
38	earache_	.2361	.2551	-.2702	-.5104
39	feeling_	-1.0902	1.2779	1.7688	.0958
40	diarrh_1	-1.0902	1.2779	1.7688	.0958
41	stomach_	-1.0902	1.2779	1.7688	.0958
42	loss_a_1	-1.0902	1.2779	1.7688	.0958
43	high_tem	-1.8855	.8968	-1.2616	.7804
44	cough_ol	-1.8855	.8968	-1.2616	.7804
45	headac_1	-1.8855	.8968	-1.2616	.7804
46	sore_t_1	-1.8855	.8968	-1.2616	.7804
47	changes_	-1.8855	.8968	-1.2616	.7804
48	rashes_o	-.4073	.3131	.2717	-.7403
49	other_ol	1.3334	.2496	.2282	-1.0623
50	total_ol	-1.9773	-.2050	.4478	-.0204
51	extrem_1	-.1503	-2.0274	.1396	.6651
52	shortn_2	-.3119	-.7915	-.5064	-1.5382
53	chest__1	-.5553	-.4260	-.2285	-1.7108
54	memory_a	-.1569	-1.7946	.1064	.6131
55	concen_1	-.0070	-2.0126	.3481	.7290
56	insomn_1	.1286	-1.2199	-.0628	-.3810
57	heart__1	-.2539	-.2217	-.1091	-1.2799
58	dizzin_1	-.7176	-.3462	.4075	-.0406
59	pins_a_1	-.5287	-.5451	-.5957	-.9545
60	joint__1	-.6030	-1.0422	-.4056	-.9954
61	depres_1	-.1675	-1.4894	-.5410	.0796
62	anxiet_1	-.3394	-1.0836	-.0454	-.0579
63	tinnit_1	.1728	-.8485	-.2628	-.7622
64	earach_1	-.1569	-1.7946	.1064	.6131
65	feelin_1	-1.1035	1.1776	1.6680	-.4385
66	diarrh_2	-1.1035	1.1776	1.6680	-.4385
67	stomac_1	-1.1035	1.1776	1.6680	-.4385
68	loss_a_2	-1.1035	1.1776	1.6680	-.4385
69	high_t_1	-1.7564	.8739	-1.9003	.3410
70	cough_ac	-1.7564	.8739	-1.9003	.3410
71	headac_2	-1.7564	.8739	-1.9003	.3410
72	sore_t_2	-1.7564	.8739	-1.9003	.3410
73	change_1	-1.7564	.8739	-1.9003	.3410
74	rashes_a	-.4194	.2253	.0788	-.8905
75	other_ac	1.4523	.2843	-.0863	-1.5281
76	total_ac	-2.0394	-.4104	-.1120	-.5360
77	everyday	.0847	-1.1714	.2933	-.0969
78	qol_tota	3.1878	1.7806	-1.4601	-1.1673
79	Work_job	2.8932	1.8720	-1.3119	-1.0441
80	indipend	3.2286	1.5814	-1.2947	-.8773
81	fatigu_1	2.4844	.1157	-.2913	1.1187
82	difficul	2.5157	.2090	-.2268	1.3097
83	how_is_y	2.3183	.4298	-.5578	.6662

Table 37: Stimulus Coordinates, /LEVEL=NOMINAL, 4 dimensions

In this case the dimensions individuated are:

1: covid and recover

2: influenza

3: gastrointestinal

4: fatigue/memory

6.3.3 Test with 3 dimensions

Stimulus Number	Stimulus Name	1	2	3
1	Age	1.9027	-.8442	.7312
2	Have_Cov	.5742	.3800	1.8727
3	Had_Covi	.1888	1.4388	1.5487
4	how_seve	.5580	.5274	1.8368
5	dry_cont	.3005	1.9034	-.4791
6	sore_thr	-.7239	1.6521	-.3328
7	runny_no	.3152	1.2245	-1.3922
8	loss_tas	-.7379	1.5233	1.0989
9	loss_app	-.3702	1.8617	-.4096
10	fever_s	1.2582	1.1512	-1.1760
11	chills_s	1.0839	1.3115	-.9393
12	headache	1.0149	.7522	-1.2759
13	body_ach	1.2223	.0445	-1.2421
14	fatigue_	1.0634	.3145	-1.3566
15	shortnes	-.1644	1.1808	1.3336
16	nausea_a	-.3532	1.1267	-1.3549
17	diarrhea	.1432	.8665	-1.5814
18	other_s	1.5843	-.2849	-1.0125
19	total_s	-.0838	1.0532	-1.1815
20	weeks_un	.9062	-1.0304	-.8897
21	Have_vac	1.8180	.4691	1.1970
22	Had_co_1	1.1438	1.1764	1.2117
23	Had_long	.7599	-1.4414	-.0759
24	use_devi	1.7084	-.4413	-.5171
25	extreme_	.7173	-1.3287	-.3707
26	shortn_1	-.0723	-.4657	1.6992
27	chest_pa	-1.0073	.0286	1.3124
28	memory_o	.6097	-1.3769	-.2042
29	concentr	.6396	-1.1469	-.7737
30	insomnia	.9185	-1.3169	-.4394
31	heart_pa	-.8327	-1.1936	.0732
32	dizzines	-.7704	-.4034	-1.2904
33	pins_and	-.7782	-.7653	1.1562
34	joint_pa	-.2591	-1.3624	.4547
35	depressi	.7029	-1.6364	.1583
36	anxiety_	-.2990	-1.2443	-.9779
37	tinnitus	.7160	-1.1765	.9285
38	earache_	-.0377	.7874	1.6461
39	feeling_	-1.0614	.3846	-1.0595
40	diarrh_1	-1.0614	.3846	-1.0595
41	stomach_	-1.0614	.3846	-1.0595
42	loss_a_1	-1.0614	.3845	-1.0596
43	high_tem	-1.4830	.0534	.1410
44	cough_ol	-1.4830	.0533	.1409
45	headac_1	-1.4830	.0533	.1409
46	sore_t_1	-1.4830	.0533	.1409
47	changes_	-1.4831	.0533	.1408
48	rashes_o	-.9263	.2828	-1.3074
49	other_ol	1.2195	1.4143	.1804
50	total_ol	-1.0765	-.5108	-.3128
51	extrem_1	.5866	-1.4106	-.2561
52	shortn_2	-.4834	-.6530	1.4963
53	chest__1	-.9356	-.4025	1.2599
54	memory_a	.4957	-1.3940	-.2291
55	concen_1	.6683	-1.3076	-.4695
56	insomn_1	.7769	-1.4085	.0527
57	heart__1	-.8988	-.5107	1.2555
58	dizzin_1	-.8425	-.7176	-1.0394
59	pins_a_1	-.8039	-.5662	1.1849
60	joint__1	-.4190	-1.0943	.9196
61	depres_1	.3900	-1.6264	.7018
62	anxiet_1	.0862	-1.5792	-.2469
63	tinnit_1	.7424	-1.1300	.9074
64	earach_1	.4753	-1.3909	-.2061
65	feelin_1	-1.0827	.2484	-1.0283
66	diarrh_2	-1.0827	.2484	-1.0283
67	stomac_1	-1.0827	.2484	-1.0283
68	loss_a_2	-1.0827	.2484	-1.0284
69	high_t_1	-1.4243	-.0311	.5035
70	cough_ac	-1.4243	-.0311	.5035
71	headac_2	-1.4243	-.0311	.5035
72	sore_t_2	-1.4243	-.0312	.5034
73	change_1	-1.4244	-.0312	.5034
74	rashes_a	-1.2165	.3172	-.9350
75	other_ac	.9780	1.2807	.9352
76	total_ac	-1.0636	-.6630	-.0408
77	everyday	.6558	-1.2940	-.5558
78	qol_tota	1.2087	1.8319	.9940
79	Work_job	1.1322	1.8947	.9119
80	indipend	1.3599	1.7597	.9494
81	fatigu_1	1.9386	.8394	-.0056
82	difficul	1.8832	.9259	-.1504
83	how_is_y	1.8224	1.1551	.1491

Table 38: Stimulus Coordinates, /LEVEL=RATIO, 3 dimensions

Stimulus Number	Stimulus Name	1	2	3
1	Age	1.9027	-.8442	.7312
2	Have_Cov	.5742	.3800	1.8727
3	Had_Covi	.1888	1.4388	1.5487
4	how_seve	.5580	.5274	1.8368
5	dry_cont	.3005	1.9034	-.4791
6	sore_thr	-.7239	1.6521	-.3328
7	runny_no	.3152	1.2245	-1.3922
8	loss_tas	-.7379	1.5233	1.0989
9	loss_app	-.3702	1.8617	-.4096
10	fever_s	1.2582	1.1512	-1.1760
11	chills_s	1.0839	1.3115	-.9393
12	headache	1.0149	.7522	-1.2759
13	body_ach	1.2223	.0445	-1.2421
14	fatigue_	1.0634	.3145	-1.3566
15	shortnes	-.1644	1.1808	1.3336
16	nausea_a	-.3532	1.1267	-1.3549
17	diarrhea	.1432	.8665	-1.5814
18	other_s	1.5843	-.2849	-1.0125
19	total_s	-.0838	1.0532	-1.1815
20	weeks_un	.9062	-1.0304	-.8897
21	Have_vac	1.8180	.4691	1.1970
22	Had_co_1	1.1438	1.1764	1.2117
23	Had_Long	.7599	-1.4414	-.0759
24	use_devi	1.7084	-.4413	-.5171
25	extreme_	.7173	-1.3287	-.3707
26	shortn_1	-.0723	-.4657	1.6992
27	chest_pa	-1.0073	.0286	1.3124
28	memory_o	.6097	-1.3769	-.2042
29	concentr	.6396	-1.1469	-.7737
30	insomnia	.9185	-1.3169	-.4394
31	heart_pa	-.8327	-1.1936	.0732
32	dizzines	-.7704	-.4034	-1.2904
33	pins_and	-.7782	-.7653	1.1562
34	joint_pa	-.2591	-1.3624	.4547
35	depressi	.7029	-1.6364	.1583
36	anxiety_	-.2990	-1.2443	-.9779
37	tinnitus	.7160	-1.1765	.9285
38	earache_	-.0377	.7874	1.6461
39	feeling_	-1.0614	.3846	-1.0595
40	diarrh_1	-1.0614	.3846	-1.0595
41	stomach_	-1.0614	.3846	-1.0595
42	loss_a_1	-1.0614	.3845	-1.0596
43	high_tem	-1.4830	.0534	.1410
44	cough_ol	-1.4830	.0533	.1409
45	headac_1	-1.4830	.0533	.1409
46	sore_t_1	-1.4830	.0533	.1409
47	changes_	-1.4831	.0533	.1408
48	rashes_o	-.9263	.2828	-1.3074
49	other_ol	1.2195	1.4143	.1804
50	total_ol	-1.0765	-.5108	-.3128
51	extrem_1	.5866	-1.4106	-.2561
52	shortn_2	-.4834	-.6530	1.4963
53	chest__1	-.9356	-.4025	1.2599
54	memory_a	.4957	-1.3940	-.2291
55	concen_1	.6683	-1.3076	-.4695
56	insomn_1	.7769	-1.4085	.0527
57	heart__1	-.8988	-.5107	1.2555
58	dizzin_1	-.8425	-.7176	-1.0394
59	pins_a_1	-.8039	-.5662	1.1849
60	joint__1	-.4190	-1.0943	.9196
61	depres_1	.3900	-1.6264	.7018
62	anxiet_1	.0862	-1.5792	-.2469
63	tinnit_1	.7424	-1.1300	.9074
64	earach_1	.4753	-1.3909	-.2061
65	feelin_1	-1.0827	.2484	-1.0283
66	diarrh_2	-1.0827	.2484	-1.0283
67	stomac_1	-1.0827	.2484	-1.0283
68	loss_a_2	-1.0827	.2484	-1.0284
69	high_t_1	-1.4243	-.0311	.5035
70	cough_ac	-1.4243	-.0311	.5035
71	headac_2	-1.4243	-.0311	.5035
72	sore_t_2	-1.4243	-.0312	.5034
73	change_1	-1.4244	-.0312	.5034
74	rashes_a	-1.2165	.3172	-.9350
75	other_ac	.9780	1.2807	.9352
76	total_ac	-1.0636	-.6630	-.0408
77	everyday	.6558	-1.2940	-.5558
78	qol_tota	1.2087	1.8319	.9940
79	Work_job	1.1322	1.8947	.9119
80	indipend	1.3599	1.7597	.9494
81	fatigu_1	1.9386	.8394	-.0056
82	difficul	1.8832	.9259	-.1504
83	how_is_y	1.8224	1.1551	.1491

Table 39: Stimulus Coordinates, /LEVEL=INTERVAL, 3 dimensions

Stimulus Number	Stimulus Name	1	2	3
1	Age	2.5355	.3545	-.8241
2	Have_Cov	.2776	1.6520	-.6339
3	Had_Covi	-.3978	2.2051	-.1366
4	how_seve	-.1003	1.5750	-.8272
5	dry_cont	-.2968	1.0864	1.6481
6	sore_thr	-.9341	.5143	1.1096
7	runny_no	-.5196	.1377	1.7030
8	loss_tas	-1.0795	1.5248	.5084
9	loss_app	-.7434	.8515	1.6293
10	fever_s	1.1702	.0677	2.0633
11	chills_s	.5802	.4738	1.8316
12	headache	.8509	-.2459	1.1379
13	body_ach	.8441	-.5959	.8472
14	fatigue_	.9940	-.3994	.8091
15	shortnes	-.6382	.9306	-.1923
16	nausea_a	-.4257	-.1472	1.5098
17	diarrhea	.1587	-.5388	1.5341
18	other_s	1.6734	-.8577	.2713
19	total_s	-.3295	-.2752	.8927
20	weeks_un	.5685	-.4499	-.7628
21	Have_vac	1.8378	1.7498	-1.4600
22	Had_co_1	.3252	2.1042	-.4522
23	Had_Long	.5099	-.6165	-1.0377
24	use_devi	1.6867	-.1139	-.0157
25	extreme_	.4423	-.6818	-.7013
26	shortn_1	-.4858	.6011	-1.2073
27	chest_pa	-1.0685	-.4038	-.3233
28	memory_o	.3671	-.6693	-.6638
29	concentr	.3715	-.8153	-.3235
30	insomnia	.8066	-.8553	-.5497
31	heart_pa	-.4489	-.8534	-.4374
32	dizzines	-.6295	-.9832	-.0009
33	pins_and	-.6068	-.1793	-.8237
34	joint_pa	-.3145	-.6306	-.6586
35	depressi	.6283	-.7798	-1.4637
36	anxiety_	-.1227	-1.2816	-.2622
37	tinnitus	.1370	-.7690	-.9603
38	earache_	-1.0082	1.1076	-.5671
39	feeling_	-.8001	-.7500	.5138
40	diarrh_1	-.8001	-.7500	.5138
41	stomach_	-.8001	-.7500	.5138
42	loss_a_1	-.8001	-.7500	.5138
43	high_tem	-1.0796	-.1403	-.3794
44	cough_ol	-1.0796	-.1404	-.3794
45	headac_1	-1.0797	-.1404	-.3794
46	sore_t_1	-1.0797	-.1404	-.3794
47	changes_	-1.0797	-.1404	-.3794
48	rashes_o	-.6120	-1.0480	.5495
49	other_ol	.8131	.4347	1.7192
50	total_ol	-.6590	-.6985	-.2064
51	extrem_1	.5149	-.6518	-.9328
52	shortn_2	-.6262	.4480	-1.3349
53	chest__1	-1.0394	-.4478	-.7264
54	memory_a	.4126	-.7709	-.6997
55	concen_1	.5333	-.7969	-.6457
56	insomn_1	.4409	-.7799	-.9700
57	heart__1	-1.2934	.1410	-.0395
58	dizzin_1	-.6113	-.9413	-.3310
59	pins_a_1	-.6239	-.1521	-.8272
60	joint__1	-.4874	-.4199	-.9607
61	depres_1	.4756	-.5334	-1.8771
62	anxiet_1	.3374	-1.0470	-.8232
63	tinnit_1	.5593	-.8280	-.9030
64	earach_1	.4110	-.7665	-.7015
65	feelin_1	-.9436	-.6710	.4433
66	diarrh_2	-.9436	-.6710	.4433
67	stomac_1	-.9436	-.6710	.4433
68	loss_a_2	-.9436	-.6710	.4433
69	high_t_1	-1.0764	-.0452	-.5791
70	cough_ac	-1.0765	-.0452	-.5791
71	headac_2	-1.0765	-.0452	-.5791
72	sore_t_2	-1.0765	-.0452	-.5791
73	change_1	-1.0765	-.0452	-.5791
74	rashes_a	-1.0739	-.8464	.3550
75	other_ac	.6215	.8598	1.7371
76	total_ac	-.7470	-.6791	-.4213
77	everyday	.5511	-.8886	-.7972
78	qol_tota	1.7423	3.3935	1.6929
79	Work_job	1.3087	3.4289	1.7731
80	indipend	1.9335	3.3701	1.6292
81	fatigu_1	2.7808	.9594	.5427
82	difficul	2.6753	.8738	.9419
83	how_is_y	2.8016	1.2053	1.0110

Table 40: Stimulus Coordinates, /LEVEL=ORDINAL, 3 dimensions

Stimulus Number	Stimulus Name	1	2	3
1	Age	1.5846	-1.1941	.6067
2	Have_Cov	.8207	-.1844	.7004
3	Had_Covi	.8276	.5782	.3554
4	how_seve	.7683	-.1842	.1106
5	dry_cont	.9562	.8664	-.1229
6	sore_thr	.2017	.9306	-.0540
7	runny_no	.6925	.6614	-.6764
8	loss_tas	.3260	.9589	.6266
9	loss_app	.6233	1.6297	-.5925
10	fever_s	1.4530	.5086	-.3324
11	chills_s	1.3542	.5225	-.6052
12	headache	.9749	.1529	-.6883
13	body_ach	.9394	-.5488	-1.0033
14	fatigue_	.8022	-.1125	-.5387
15	shortnes	.3652	-.0355	-.1336
16	nausea_a	.2041	1.2658	-1.3646
17	diarrhea	.4850	.6954	-1.4310
18	other_s	.7260	-.3268	-.1640
19	total_s	.3445	.8455	-1.2519
20	weeks_un	.1370	-.7317	-.1504
21	Have_vac	1.3465	-.1825	.9717
22	Had_co_1	1.1157	.2546	.1725
23	Had_Long	-.0170	-1.7497	-.1167
24	use_devi	1.0173	-.7592	-.0231
25	extreme_	-.0483	-1.7174	-.4284
26	shortn_1	-.0605	-.8022	.2053
27	chest_pa	-.4081	-.2676	-.2185
28	memory_o	-.1192	-1.6146	-.1528
29	concentr	-.0319	-1.5098	-.5139
30	insomnia	.2176	-1.2757	-.2045
31	heart_pa	-.7087	-.5964	-.1309
32	dizzines	-.6988	-.1642	-.7329
33	pins_and	-.4542	-.4730	.1421
34	joint_pa	-.4912	-.8504	.0014
35	depressi	-.0472	-1.1560	.1897
36	anxiety_	-.5241	-.6982	-.2403
37	tinnitus	.0040	-.7197	.3256
38	earache_	.2202	.2379	.2519
39	feeling_	-1.0166	1.1917	-1.6495
40	diarrh_1	-1.0166	1.1917	-1.6495
41	stomach_	-1.0166	1.1917	-1.6495
42	loss_a_1	-1.0166	1.1917	-1.6495
43	high_tem	-1.7583	.8363	1.1765
44	cough_ol	-1.7583	.8363	1.1765
45	headac_1	-1.7583	.8363	1.1765
46	sore_t_1	-1.7583	.8363	1.1765
47	changes_	-1.7583	.8363	1.1765
48	rashes_o	-.3798	.2919	-.2533
49	other_ol	1.2434	.2327	-.2128
50	total_ol	-1.8439	-.1911	-.4175
51	extrem_1	-.1401	-1.8906	-.1301
52	shortn_2	-.2908	-.7381	.4723
53	chest__1	-.5178	-.3973	.2131
54	memory_a	-.1463	-1.6735	-.0992
55	concen_1	-.0065	-1.8768	-.3246
56	insomn_1	.1200	-1.1376	.0585
57	heart__1	-.2368	-.2067	.1017
58	dizzin_1	-.6692	-.3228	-.3800
59	pins_a_1	-.4031	-.5083	.5555
60	joint__1	-.5623	-.9719	.3782
61	depres_1	-.1562	-1.3889	.5045
62	anxiet_1	-.3165	-1.0105	.0423
63	tinnit_1	.1611	-.7913	.2451
64	earach_1	-.1463	-1.6735	-.0992
65	feelin_1	-1.0291	1.0982	-1.5554
66	diarrh_2	-1.0291	1.0982	-1.5554
67	stomac_1	-1.0291	1.0982	-1.5554
68	loss_a_2	-1.0291	1.0982	-1.5554
69	high_t_1	-1.6379	.8149	1.7721
70	cough_ac	-1.6379	.8149	1.7721
71	headac_2	-1.6379	.8149	1.7721
72	sore_t_2	-1.6379	.8149	1.7721
73	change_1	-1.6379	.8149	1.7721
74	rashes_a	-.3911	.2101	-.0735
75	other_ac	1.3543	.2651	.0805
76	total_ac	-1.9018	-.3827	.1045
77	everyday	.0790	-1.0924	-.2735
78	qol_tota	2.9727	1.6605	1.3616
79	Work_job	2.6980	1.7457	1.2234
80	indipend	3.0108	1.4747	1.2074
81	fatigu_1	2.3168	.1079	.2716
82	difficul	2.3460	.1949	.2115
83	how_is_y	2.1618	.4008	.5201

Table 41: Stimulus Coordinates, /LEVEL=NOMINAL, 3 dimensions

The factors individuated are slightly different for the different kind of levels:

For ratio e interval we have:

1: psychological

2: influenza

3: gastrointestinal

Ordinal:

1: influenza

2:psychological

3: gastrointestinal

Nominal:

1: covid and recovery

2: influenza

3: gastrointestinal

6.3.4 Test with 2 dimensions

Stimulus Number	Stimulus Name	1	2
1	Age	-1.5960	.9980
2	Have_Cov	-1.5162	.5899
3	Had_Covi	-.5313	-1.6286
4	how_seve	-1.6013	.1254
5	dry_cont	-.2171	-1.6644
6	sore_thr	.5941	-1.4390
7	runny_no	-.0055	-1.5976
8	loss_tas	.5496	-1.5488
9	loss_app	.3184	-1.6120
10	fever_s	-1.0889	-1.3584
11	chills_s	-.8913	-1.3699
12	headache	-.9781	-1.1366
13	body_ach	-1.4126	-.3148
14	fatigue_	-1.2540	-.7280
15	shortnes	.1723	-1.4173
16	nausea_a	.5706	-1.4134
17	diarrhea	.3156	-1.4907
18	other_s	-1.5919	.1051
19	total_s	.1981	-1.3218
20	weeks_un	-1.0619	.8655
21	Have_vac	-1.8326	-.0664
22	Had_co_1	-1.4924	-.7097
23	Had_Long	-.6662	1.2062
24	use_devi	-1.4997	.3205
25	extreme_	-.6415	1.1326
26	shortn_1	-.3682	1.3386
27	chest_pa	1.2892	.1264
28	memory_o	-.5107	1.1590
29	concentr	-.6591	1.0628
30	insomnia	-.7787	1.1466
31	heart_pa	.6964	1.0001
32	dizzines	1.2330	.1475
33	pins_and	.7944	.9968
34	joint_pa	.1942	1.1936
35	depressi	-.5190	1.3939
36	anxiety_	.5561	1.1981
37	tinnitus	-.7091	1.1507
38	earache_	.2135	-1.4009
39	feeling_	1.1327	-.5561
40	diarrh_1	1.1327	-.5561
41	stomach_	1.1327	-.5561
42	loss_a_1	1.1327	-.5562
43	high_tem	1.2089	.0386
44	cough_ol	1.2089	.0386
45	headac_1	1.2089	.0386
46	sore_t_1	1.2089	.0386
47	changes_	1.2089	.0386
48	rashes_o	1.2226	-.4883
49	other_ol	-1.0687	-1.0966
50	total_ol	.9418	.3705
51	extrem_1	-.4541	1.1801
52	shortn_2	.3251	1.2947
53	chest__1	1.0297	.7372
54	memory_a	-.3450	1.1601
55	concen_1	-.5440	1.1147
56	insomn_1	-.5679	1.1720
57	heart__1	1.0130	.7988
58	dizzin_1	1.0428	.6245
59	pins_a_1	.8320	.8674
60	joint__1	.3079	1.1475
61	depres_1	-.2632	1.4617
62	anxiet_1	.2010	1.2844
63	tinnit_1	-.7090	1.0829
64	earach_1	-.3154	1.1516
65	feelin_1	1.1412	-.3716
66	diarrh_2	1.1412	-.3716
67	stomac_1	1.1413	-.3716
68	loss_a_2	1.1413	-.3716
69	high_t_1	1.1873	.1896
70	cough_ac	1.1873	.1896
71	headac_2	1.1873	.1896
72	sore_t_2	1.1873	.1896
73	change_1	1.1874	.1896
74	rashes_a	1.2220	-.2694
75	other_ac	-1.0650	-1.0429
76	total_ac	.8779	.5362
77	everyday	-.4345	1.1449
78	qol_tota	-1.3125	-1.4694
79	Work_job	-1.2390	-1.5099
80	indipend	-1.4114	-1.3904
81	fatigu_1	-1.5854	-.6687
82	difficul	-1.5243	-.7806
83	how_is_y	-1.5257	-.8824

Table 42: Stimulus Coordinates, /LEVEL=RATIO, 2 dimensions

Stimulus Number	Stimulus Name	1	2
1	Age	-1.5960	.9980
2	Have_Cov	-1.5162	.5899
3	Had_Covi	-.5313	-1.6286
4	how_seve	-1.6013	.1254
5	dry_cont	-.2171	-1.6644
6	sore_thr	.5941	-1.4390
7	runny_no	-.0055	-1.5976
8	loss_tas	.5496	-1.5488
9	loss_app	.3184	-1.6120
10	fever_s	-1.0889	-1.3584
11	chills_s	-.8913	-1.3699
12	headache	-.9781	-1.1366
13	body_ach	-1.4126	-.3148
14	fatigue_	-1.2540	-.7280
15	shortnes	.1723	-1.4173
16	nausea_a	.5706	-1.4134
17	diarrhea	.3156	-1.4907
18	other_s	-1.5919	.1051
19	total_s	.1981	-1.3218
20	weeks_un	-1.0619	.8655
21	Have_vac	-1.8326	-.0664
22	Had_co_1	-1.4924	-.7097
23	Had_Long	-.6662	1.2062
24	use_devi	-1.4997	.3205
25	extreme_	-.6415	1.1326
26	shortn_1	-.3682	1.3386
27	chest_pa	1.2892	.1264
28	memory_o	-.5107	1.1590
29	concentr	-.6591	1.0628
30	insomnia	-.7787	1.1466
31	heart_pa	.6964	1.0001
32	dizzines	1.2330	.1475
33	pins_and	.7944	.9968
34	joint_pa	.1942	1.1936
35	depressi	-.5190	1.3939
36	anxiety_	.5561	1.1981
37	tinnitus	-.7091	1.1507
38	earache_	.2135	-1.4009
39	feeling_	1.1327	-.5561
40	diarrh_1	1.1327	-.5561
41	stomach_	1.1327	-.5561
42	loss_a_1	1.1327	-.5562
43	high_tem	1.2089	.0386
44	cough_ol	1.2089	.0386
45	headac_1	1.2089	.0386
46	sore_t_1	1.2089	.0386
47	changes_	1.2089	.0386
48	rashes_o	1.2226	-.4883
49	other_ol	-1.0687	-1.0966
50	total_ol	.9418	.3705
51	extrem_1	-.4541	1.1801
52	shortn_2	.3251	1.2947
53	chest__1	1.0297	.7372
54	memory_a	-.3450	1.1601
55	concen_1	-.5440	1.1147
56	insomn_1	-.5679	1.1720
57	heart__1	1.0130	.7988
58	dizzin_1	1.0428	.6245
59	pins_a_1	.8320	.8674
60	joint__1	.3079	1.1475
61	depres_1	-.2632	1.4617
62	anxiet_1	.2010	1.2844
63	tinnit_1	-.7090	1.0829
64	earach_1	-.3154	1.1516
65	feelin_1	1.1412	-.3716
66	diarrh_2	1.1412	-.3716
67	stomac_1	1.1413	-.3716
68	loss_a_2	1.1413	-.3716
69	high_t_1	1.1873	.1896
70	cough_ac	1.1873	.1896
71	headac_2	1.1873	.1896
72	sore_t_2	1.1873	.1896
73	change_1	1.1874	.1896
74	rashes_a	1.2220	-.2694
75	other_ac	-1.0650	-1.0429
76	total_ac	.8779	.5362
77	everyday	-.4345	1.1449
78	qol_tota	-1.3125	-1.4694
79	Work_job	-1.2390	-1.5099
80	indipend	-1.4114	-1.3904
81	fatigu_1	-1.5854	-.6687
82	difficul	-1.5243	-.7806
83	how_is_y	-1.5257	-.8824

Table 43: Stimulus Coordinates, /LEVEL=INTERVAL, 2 dimensions

Stimulus Number	Stimulus Name	1	2
1	Age	-2.0094	1.1534
2	Have_Cov	-1.2157	-.1199
3	Had_Covi	-.4285	-1.6794
4	how_seve	-.0508	-1.1510
5	dry_cont	-.2991	-1.5645
6	sore_thr	.3690	-1.1323
7	runny_no	.3111	-1.3654
8	loss_tas	.2484	-1.4801
9	loss_app	.0712	-1.6429
10	fever_s	-1.2082	-1.4715
11	chills_s	-.8052	-1.3262
12	headache	-.8277	-.3448
13	body_ach	-.6740	.1698
14	fatigue_	-.8661	.0831
15	shortnes	.2538	-.6154
16	nausea_a	.2898	-1.1212
17	diarrhea	.1521	-1.0764
18	other_s	-1.0637	1.0182
19	total_s	.3275	-.5447
20	weeks_un	-.1146	.7989
21	Have_vac	-2.2961	.9889
22	Had_co_1	-1.3783	-.8601
23	Had_Long	-.0166	1.0764
24	use_devi	-1.1888	.5156
25	extreme_	.0239	.8819
26	shortn_1	.1774	.8140
27	chest_pa	.9647	.1925
28	memory_o	.1097	.7969
29	concentr	.1005	.7248
30	insomnia	-.2224	.9963
31	heart_pa	.7032	.5426
32	dizzines	.8478	.3705
33	pins_and	.5667	.4137
34	joint_pa	.5849	.5992
35	depressi	.0484	1.4670
36	anxiety_	.6834	.8082
37	tinnitus	.4506	.8371
38	earache_	.6864	-.8434
39	feeling_	.9085	-.0978
40	diarrh_1	.9085	-.0978
41	stomach_	.9085	-.0978
42	loss_a_1	.9085	-.0978
43	high_tem	.8961	.0886
44	cough_ol	.8961	.0886
45	headac_1	.8961	.0886
46	sore_t_1	.8962	.0886
47	changes_	.8962	.0886
48	rashes_o	.9235	.0896
49	other_ol	-.9439	-1.1477
50	total_ol	.8360	.2997
51	extrem_1	-.0117	1.0123
52	shortn_2	.4078	.8906
53	chest__1	1.0602	.4065
54	memory_a	.1147	.8848
55	concen_1	.0360	.9222
56	insomn_1	.1566	1.0472
57	heart__1	.8854	-.5033
58	dizzin_1	.8027	.5475
59	pins_a_1	.5991	.4753
60	joint__1	.6929	.6385
61	depres_1	.1353	1.6720
62	anxiet_1	.2768	1.0978
63	tinnit_1	.1583	1.0198
64	earach_1	.1150	.8830
65	feelin_1	.9260	-.1704
66	diarrh_2	.9260	-.1704
67	stomac_1	.9260	-.1704
68	loss_a_2	.9260	-.1704
69	high_t_1	.8742	.1160
70	cough_ac	.8742	.1160
71	headac_2	.8742	.1160
72	sore_t_2	.8742	.1161
73	change_1	.8742	.1161
74	rashes_a	1.1291	-.0214
75	other_ac	-.8696	-1.3422
76	total_ac	.9320	.3809
77	everyday	.0684	1.0832
78	qol_tota	-3.0659	-2.3225
79	Work_job	-2.7913	-2.4697
80	indipend	-3.1943	-2.1992
81	fatigu_1	-2.5889	.1570
82	difficul	-2.5577	-.1138
83	how_is_y	-2.8016	-.2485

Table 44: Stimulus Coordinates, /LEVEL=ORDINAL, 2 dimensions

Stimulus Number	Stimulus Name	1	2
1	Age	-1.4952	1.1267
2	Have_Cov	-.7744	.1740
3	Had_Covi	-.7809	-.5455
4	how_seve	-.7249	.1738
5	dry_cont	-.9022	-.8175
6	sore_thr	-.1903	-.8781
7	runny_no	-.6534	-.6240
8	loss_tas	-.3076	-.9048
9	loss_app	-.5881	-1.5376
10	fever_s	-1.3710	-.4798
11	chills_s	-1.2778	-.4930
12	headache	-.9199	-.1443
13	body_ach	-.8864	.5178
14	fatigue_	-.7569	.1061
15	shortnes	-.3445	.0335
16	nausea_a	-.1926	-1.1943
17	diarrhea	-.4576	-.6561
18	other_s	-.6850	.3083
19	total_s	-.3251	-.7978
20	weeks_un	-.1293	.6904
21	Have_vac	-1.2704	.1722
22	Had_co_1	-1.0527	-.2403
23	Had_Long	.0160	1.6509
24	use_devi	-.9599	.7163
25	extreme_	.0456	1.6204
26	shortn_1	.0571	.7569
27	chest_pa	.3851	.2525
28	memory_o	.1124	1.5234
29	concentr	.0301	1.4245
30	insomnia	-.2053	1.2036
31	heart_pa	.6687	.5627
32	dizzines	.6594	.1549
33	pins_and	.4286	.4463
34	joint_pa	.4635	.8024
35	depressi	.0445	1.0907
36	anxiety_	.4945	.6588
37	tinnitus	-.0038	.6791
38	earache_	-.2078	-.2245
39	feeling_	.9592	-1.1244
40	diarrh_1	.9592	-1.1244
41	stomach_	.9592	-1.1244
42	loss_a_1	.9592	-1.1244
43	high_tem	1.6590	-.7891
44	cough_ol	1.6590	-.7891
45	headac_1	1.6590	-.7891
46	sore_t_1	1.6590	-.7891
47	changes_	1.6590	-.7891
48	rashes_o	.3583	-.2754
49	other_ol	-1.1732	-.2196
50	total_ol	1.7398	.1803
51	extrem_1	.1322	1.7839
52	shortn_2	.2744	.6965
53	chest__1	.4886	.3749
54	memory_a	.1380	1.5790
55	concen_1	.0062	1.7708
56	insomn_1	-.1132	1.0733
57	heart__1	.2234	.1951
58	dizzin_1	.6314	.3046
59	pins_a_1	.4652	.4796
60	joint__1	.5305	.9170
61	depres_1	.1474	1.3105
62	anxiet_1	.2986	.9534
63	tinnit_1	-.1520	.7466
64	earach_1	.1380	1.5790
65	feelin_1	.9710	-1.0362
66	diarrh_2	.9710	-1.0362
67	stomac_1	.9710	-1.0362
68	loss_a_2	.9710	-1.0362
69	high_t_1	1.5454	-.7689
70	cough_ac	1.5454	-.7689
71	headac_2	1.5454	-.7689
72	sore_t_2	1.5454	-.7689
73	change_1	1.5454	-.7689
74	rashes_a	.3690	-.1983
75	other_ac	-1.2778	-.2502
76	total_ac	1.7944	.3611
77	everyday	-.0745	1.0307
78	qol_tota	-2.8048	-1.5667
79	Work_job	-2.5457	-1.6471
80	indipend	-2.8408	-1.3914
81	fatigu_1	-2.1860	-.1018
82	difficul	-2.2135	-.1839
83	how_is_y	-2.0398	-.3782

Table 45: Stimulus Coordinates, /LEVEL=NOMINAL, 2 dimensions

Also here it can be noticed differences:

Ratio e interval:

1: influenza

2: fatigue e recover

Ordinal:

1: covid and influenza

2: anxiety

And nominal:

1: covid and influenza

2: memory and anxiety

6.3.5 Test with 1 dimension

Stimulus Number	Stimulus Name	1
1	Age	1.3856
2	Have_Cov	1.2300
3	Had_Covi	1.3280
4	how_seve	1.2388
5	dry_cont	1.2825
6	sore_thr	1.1366
7	runny_no	1.2074
8	loss_tas	1.2190
9	loss_app	1.2064
10	fever_s	1.3436
11	chills_s	1.2543
12	headache	1.1542
13	body_ach	1.0917
14	fatigue_	1.1052
15	shortnes	1.0543
16	nausea_a	1.0572
17	diarrhea	1.0946
18	other_s	1.1810
19	total_s	.9407
20	weeks_un	.9253
21	Have_vac	1.3669
22	Had_co_1	1.2387
23	Had_Long	-.9112
24	use_devi	1.0892
25	extreme_	-.8080
26	shortn_1	-.9788
27	chest_pa	-.9289
28	memory_o	-.8043
29	concentr	-.7561
30	insomnia	-.8931
31	heart_pa	-.8754
32	dizzines	-.9066
33	pins_and	-.9207
34	joint_pa	-.8391
35	depressi	-1.0278
36	anxiety_	-.9637
37	tinnitus	.8547
38	earache_	1.0199
39	feeling_	-.7767
40	diarrh_1	-.7767
41	stomach_	-.7767
42	loss_a_1	-.7767
43	high_tem	-.8120
44	cough_ol	-.8120
45	headac_1	-.8120
46	sore_t_1	-.8120
47	changes_	-.8120
48	rashes_o	-.8906
49	other_ol	1.1316
50	total_ol	-.7034
51	extrem_1	-.7792
52	shortn_2	-.9371
53	chest__1	-.8839
54	memory_a	-.7461
55	concen_1	-.7135
56	insomn_1	-.8144
57	heart__1	-.9094
58	dizzin_1	-.8708
59	pins_a_1	-.8141
60	joint__1	-.7842
61	depres_1	-1.0263
62	anxiet_1	-.8943
63	tinnit_1	.8157
64	earach_1	-.7186
65	feelin_1	-.7456
66	diarrh_2	-.7456
67	stomac_1	-.7456
68	loss_a_2	-.7456
69	high_t_1	-.7995
70	cough_ac	-.7995
71	headac_2	-.7995
72	sore_t_2	-.7995
73	change_1	-.7995
74	rashes_a	-.8324
75	other_ac	1.1264
76	total_ac	-.7114
77	everyday	-.7070
78	qol_tota	1.5159
79	Work_job	1.4997
80	indipend	1.5232
81	fatigu_1	1.2784
82	difficul	1.2783
83	how_is_y	1.3217

Table 46: Stimulus Coordinates, /LEVEL=RATIO, 1 dimension

Stimulus Number	Stimulus Name	1
1	Age	-1.3856
2	Have_Cov	-1.2300
3	Had_Covi	-1.3280
4	how_seve	-1.2388
5	dry_cont	-1.2825
6	sore_thr	-1.1366
7	runny_no	-1.2074
8	loss_tas	-1.2190
9	loss_app	-1.2064
10	fever_s	-1.3436
11	chills_s	-1.2543
12	headache	-1.1542
13	body_ach	-1.0917
14	fatigue_	-1.1052
15	shortnes	-1.0543
16	nausea_a	-1.0572
17	diarrhea	-1.0946
18	other_s	-1.1810
19	total_s	-.9407
20	weeks_un	-.9253
21	Have_vac	-1.3669
22	Had_co_1	-1.2387
23	Had_Long	.9112
24	use_devi	-1.0892
25	extreme_	.8080
26	shortn_1	.9788
27	chest_pa	.9289
28	memory_o	.8043
29	concentr	.7561
30	insomnia	.8931
31	heart_pa	.8754
32	dizzines	.9066
33	pins_and	.9207
34	joint_pa	.8391
35	depressi	1.0278
36	anxiety_	.9637
37	tinnitus	-.8547
38	earache_	-1.0199
39	feeling_	.7767
40	diarrh_1	.7767
41	stomach_	.7767
42	loss_a_1	.7767
43	high_tem	.8120
44	cough_ol	.8120
45	headac_1	.8120
46	sore_t_1	.8120
47	changes_	.8120
48	rashes_o	.8906
49	other_ol	-1.1316
50	total_ol	.7034
51	extrem_1	.7792
52	shortn_2	.9371
53	chest__1	.8839
54	memory_a	.7461
55	concen_1	.7135
56	insomn_1	.8144
57	heart__1	.9094
58	dizzin_1	.8708
59	pins_a_1	.8141
60	joint__1	.7842
61	depres_1	1.0263
62	anxiet_1	.8943
63	tinnit_1	-.8157
64	earach_1	.7186
65	feelin_1	.7456
66	diarrh_2	.7456
67	stomac_1	.7456
68	loss_a_2	.7456
69	high_t_1	.7995
70	cough_ac	.7995
71	headac_2	.7995
72	sore_t_2	.7995
73	change_1	.7995
74	rashes_a	.8324
75	other_ac	-1.1264
76	total_ac	.7114
77	everyday	.7070
78	qol_tota	-1.5159
79	Work_job	-1.4997
80	indipend	-1.5232
81	fatigu_1	-1.2784
82	difficul	-1.2783
83	how_is_y	-1.3217

Table 47: Stimulus Coordinates, /LEVEL=INTERVAL, 1 dimension

Stimulus Number	Stimulus Name	1
1	Age	1.4369
2	Have_Cov	.7735
3	Had_Covi	1.0222
4	how_seve	.5321
5	dry_cont	.9189
6	sore_thr	.3604
7	runny_no	.4623
8	loss_tas	.7345
9	loss_app	.8647
10	fever_s	1.2928
11	chills_s	.9864
12	headache	.5099
13	body_ach	.3331
14	fatigue_	.5070
15	shortnes	.1974
16	nausea_a	.3494
17	diarrhea	.3769
18	other_s	.3133
19	total_s	-.0203
20	weeks_un	-.2492
21	Have_vac	1.6551
22	Had_co_1	1.0368
23	Had_Long	-.6310
24	use_devi	.6437
25	extreme_	-.5462
26	shortn_1	-.1714
27	chest_pa	-.6797
28	memory_o	-.5210
29	concentr	-.4985
30	insomnia	-.2699
31	heart_pa	-.7115
32	dizzines	-.7466
33	pins_and	-.4473
34	joint_pa	-.6309
35	depressi	-.9177
36	anxiety_	-.8299
37	tinnitus	-.7024
38	earache_	-.1253
39	feeling_	-.6564
40	diarrh_1	-.6564
41	stomach_	-.6564
42	loss_a_1	-.6564
43	high_tem	-.6681
44	cough_ol	-.6681
45	headac_1	-.6682
46	sore_t_1	-.6682
47	changes_	-.6682
48	rashes_o	-.6217
49	other_ol	.9380
50	total_ol	-.8637
51	extrem_1	-.5802
52	shortn_2	-.4775
53	chest__1	-.8721
54	memory_a	-.5631
55	concen_1	-.5552
56	insomn_1	-.6585
57	heart__1	-.3111
58	dizzin_1	-.7739
59	pins_a_1	-.5186
60	joint__1	-.7842
61	depres_1	-1.1073
62	anxiet_1	-.7488
63	tinnit_1	-.6554
64	earach_1	-.5621
65	feelin_1	-.6005
66	diarrh_2	-.6005
67	stomac_1	-.6006
68	loss_a_2	-.6006
69	high_t_1	-.5800
70	cough_ac	-.5800
71	headac_2	-.5801
72	sore_t_2	-.5801
73	change_1	-.5801
74	rashes_a	-.8001
75	other_ac	.9872
76	total_ac	-.9595
77	everyday	-.5910
78	qol_tota	3.3868
79	Work_job	3.2540
80	indipend	3.4366
81	fatigu_1	1.7783
82	difficul	1.7988
83	how_is_y	2.0847

Table 48: Stimulus Coordinates, /LEVEL=ORDINAL, 1 dimension

Stimulus Number	Stimulus Name	1
1	Age	1.3747
2	Have_Cov	.7120
3	Had_Covi	.7180
4	how_seve	.6665
5	dry_cont	.8295
6	sore_thr	.1750
7	runny_no	.6007
8	loss_tas	.2828
9	loss_app	.5407
10	fever_s	1.2605
11	chills_s	1.1748
12	headache	.8458
13	body_ach	.8150
14	fatigue_	.6959
15	shortnes	.3168
16	nausea_a	.1771
17	diarrhea	.4207
18	other_s	.6298
19	total_s	.2989
20	weeks_un	.1188
21	Have_vac	1.1681
22	Had_co_1	.9679
23	Had_Long	-.0147
24	use_devi	.8825
25	extreme_	-.0419
26	shortn_1	-.0525
27	chest_pa	-.3540
28	memory_o	-.1034
29	concentr	-.0277
30	insomnia	.1888
31	heart_pa	-.6148
32	dizzines	-.6062
33	pins_and	-.3940
34	joint_pa	-.4261
35	depressi	-.0410
36	anxiety_	-.4547
37	tinnitus	.0035
38	earache_	.1910
39	feeling_	-.8819
40	diarrh_1	-.8819
41	stomach_	-.8819
42	loss_a_1	-.8819
43	high_tem	-1.5254
44	cough_ol	-1.5254
45	headac_1	-1.5254
46	sore_t_1	-1.5254
47	changes_	-1.5254
48	rashes_o	-.3295
49	other_ol	1.0787
50	total_ol	-1.5996
51	extrem_1	-.1216
52	shortn_2	-.2523
53	chest__1	-.4492
54	memory_a	-.1269
55	concen_1	-.0057
56	insomn_1	.1041
57	heart__1	-.2054
58	dizzin_1	-.5805
59	pins_a_1	-.4277
60	joint__1	-.4878
61	depres_1	-.1355
62	anxiet_1	-.2746
63	tinnit_1	.1398
64	earach_1	-.1269
65	feelin_1	-.8927
66	diarrh_2	-.8927
67	stomac_1	-.8927
68	loss_a_2	-.8927
69	high_t_1	-1.4209
70	cough_ac	-1.4209
71	headac_2	-1.4209
72	sore_t_2	-1.4209
73	change_1	-1.4209
74	rashes_a	-.3393
75	other_ac	1.1748
76	total_ac	-1.6498
77	everyday	.0685
78	qol_tota	2.5788
79	Work_job	2.3405
80	indipend	2.6119
81	fatigu_1	2.0098
82	difficul	2.0351
83	how_is_y	1.8754

Table 49: Stimulus Coordinates, /LEVEL=NOMINAL, 1 dimension

Conducting a one-dimensional ALSCAL analysis through the algorithm serves to simplify complex data by summarizing it into a single dimension. This is valuable for simplifying data interpretation, highlighting primary trends, and facilitating visual representation. It aids in identifying significant differences and relationships within the data, making it a useful tool for data reduction and visualization.

Chapter 7

Conclusions

7.1 Future Steps

The current study has made significant advancements in the enhancement and refinement of the 'Happy Again' study. It has introduced novel security measures and data analysis strategies to ensure the robustness and reliability of the platform. Additionally, we have implemented efficient data management practices and improved the usability of the admin area, making it user-friendly for administrators.

As we move forward, there are several future steps and improvements that can be considered to further enhance the effectiveness and reach of this research endeavor:

One of the primary future steps should involve enhancing the scalability of the website. This would involve optimizing the platform's infrastructure to handle a larger volume of participants and data seamlessly. Accommodating a larger user base can lead to more comprehensive and statistically significant results.

In an era of increasing cyber threats, continuously improving and updating security measures is imperative. Future efforts should focus on staying ahead of potential vulnerabilities and protecting the integrity of the data collected. Collaborating with cybersecurity experts can be beneficial in this regard.

Expanding the reach of the voucher program to participants from other nations can significantly enrich the dataset and broaden the study's applicability. This step would require adapting the platform to accommodate multiple languages, currency options, and international regulations.

Increasing the number of available translations for the website can break down language barriers and encourage participation from diverse linguistic backgrounds. This inclusivity can lead to a more comprehensive dataset and broader insights into Long covid's global impact.

As the participant base grows, performing more extensive and nuanced data analysis becomes essential. Collaborating with a team of experts can help unlock deeper insights into Long covid's various aspects.

Raising public awareness about Long COVID and the research study is vital. Future steps should include developing educational materials, collaborating with healthcare

organizations, and utilizing social media and other communication channels to reach a broader audience.

7.2 Conclusions

In conclusion, this study represents a significant step forward in Long COVID research by improving and advancing a dedicated website for data collection and analysis. The introduction of enhanced security measures and data analysis strategies ensures the integrity and reliability of the collected data. However, the journey towards understanding Long COVID is ongoing, and there are numerous opportunities for further improvement and expansion.

As we look to the future, the scalability of the platform, increased security measures, and global participation will be essential in maximizing the impact of this research. Multilingual support and collaboration with experts will enable a deeper exploration of Long COVID's complexities.

In summary, this research represents a significant milestone, but it is only the beginning of a broader effort to comprehensively understand and address the challenges posed by Long COVID. By continuously improving our methods and expanding our reach, we can work to achieve better information, more effective treatments and better support for people affected by this condition around the world.

References

[1] https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020

[2] https://www.who.int/news-room/fact-sheets/detail/coronavirus-disease-(covid-19)

[3] https://www.britannica.com/science/coronavirus-virus-group

[4] https://www.ninds.nih.gov/current-research/coronavirus-and-ninds/coronavirus-and-nervous-system#:~:text=Some%20people%20with%20COVID%2D19,require%20intensive%20care%20during%20infections.

[5] https://www.cdc.gov/coronavirus/2019-ncov/long-term-effects/index.html

[6] https://www.caymanchem.com/news/research-tools-for-long-covid-syndrome

[7] https://www.bhf.org.uk/informationsupport/heart-matters-magazine/news/coronavirus-and-your-health/long-covid

[8] R. J. Addante, "A critical role of the human hippocampus in an electrophysiological measure of implicit memory," *Neuroimage*, vol. 109, pp. 515–528, Apr. 2015, doi: 10.1016/j.neuroimage.2014.12.069.

[9] R. P. Lawson, J. Aylward, S. White, and G. Rees, "A striking reduction of simple loudness adaptation in autism," *Sci Rep*, vol. 5, Nov. 2015, doi: 10.1038/srep16157.

[10] https://www.usability.gov/how-to-and-tools/methods/use-cases.html#:~:text=A%20use%20case%20is%20a,when%20that%20goal%20is%20fulfilled.

[11] https://en.wikipedia.org/wiki/Model%E2%80%93view%E2%80%93viewmodel

Acknowledgments

I want to take a moment to express my heartfelt thanks to all the people who have been there for me throughout this journey. Your presence and support mean the world to me, both in my academic pursuits and in life.

To my academic mentors, Prof.ssa Gabriella Olmo, Dr. Vito De Feo and Dr. Helge Gillmeister, I want to extend my sincere gratitude. Your guidance and dedication have been instrumental in helping me navigate this thesis journey. Your unwavering support has not only shaped my academic growth but has also left a lasting impact on my personal development.

To the team of the university of Essex especially the team of psychologists and Charlie.

To my parents, your boundless dedication to our family has been nothing short of remarkable. Your love, support, and sacrifices are beyond measure. I will forever strive to make you proud, not only in my academic pursuits but as the person I have become, thanks to your guidance. You have instilled in me values of tenacity, dedication, discipline, commitment, responsibility, and independence, which I carry with me in all life's challenges.

To Marco, my guiding star, you have been my constant source of inspiration from our earliest days. You have stood by my side unwaveringly, a steadfast presence in my life.

To my grandparents, aunts, uncles, Giulia, Roberta and my entire family, thank you for the support and love you show me every day.

Gaia, words cannot adequately express my gratitude. Our shared memories hold more meaning than mere words ever could. Since childhood, we have navigated life's ups and downs together, supporting each other like sisters through all the beautiful and challenging moments we've faced as a team. It's challenging to articulate all that I feel in this moment, but I want to try. My thesis represents a compilation of my experiences, challenges, and victories, and it wouldn't be complete without you. You are the most precious part of my story, my best friend, and my most trusted confidante. Now, as I graduate, I cannot imagine this moment without you. You have always supported my dreams and encouraged me to give my best. I dedicate the sun to you.

Frica, Giusy, and Anto, you have become my second family. Since the day we crossed paths at the university, we have been inseparable. Our friendship has grown alongside us, weathering storms and enjoying clear skies together. It has evolved over time and led us to live together in another city, creating a unique and invaluable experience. I

wouldn't have chosen anyone else to share this journey with; I would make this choice a thousand times over.

Myliu**,** You've been by my side during this final year of university, witnessing my journey and offering support during moments of anxiety. You took care of me, keeping me company during intense study sessions. You probably even learned a bit about machine learning from hearing me repeat things every morning and correcting my English pronunciation. Thank you for the snacks and the comfort during my crazy, hunched-over study sessions.

Luca**,** Luca is that special person with whom I've shared the joys and challenges of university life, gradually extending our connection to encompass all aspects of life, passions, and experiences, pain, and happiness. We've achieved milestones together and apart, always there for each other no matter what. You're the one who won't let me leave for Turin without the "final goodbye" the night before departure.

Ale**,** Words fall short when it comes to thanking you. Thank you for the daily trust you place in me. Thank you for sharing your joys and insecurities with me, unfiltered. You are an integral part of this journey, not only academically but in life as well. We've grown together, and I am proud of that.

Roberto**,** What a stroke of luck to have met you. In a world where everything was new to us, our paths crossed, and we bonded deeply. Now, there's no "one" without the other, my dear twin.

Emilio, I'm grateful for the enduring friendship that has been a constant presence in my life. Our journey together began in high school, continued through our undergraduate years, and evolved even when our paths diverged.

Giovanni, Raimondo and Daniele, The three musketeers, brought together in one of the most improbable ways, it was destiny. We've supported each other throughout our university journey, sharing countless beautiful experiences and growing together along the way.

Matte and Gabri, Thank you for turned these last few months upside down. The most important ones, filled with intense work on my thesis project. You provided a much-needed escape after stressful and intense days, and I am immensely grateful. With you, the gym takes on a different flavour.

In closing, I extend my deepest appreciation to each of you, especially Mario, Mazzi, Ale, Francesco, Andrea, Fulvia, Vincenzo, Giorgio. Your presence and support have been the cornerstone of my academic and personal growth.

As I step into the next chapter of my life, I carry your encouragement and love with me, knowing that your influence will continue to shape my journey in profound ways.