CHAPTER 3
METHODOLOGY

3.1 Research Design

This study was conducted to examine the effects of various fragrances on the brainwave activity of calmness and the performance of working memory, which employed a mixed-experimental design. Participants were randomly assigned to four different groups, with one group receiving a placebo, and each was exposed to a unique fragrance in a regulated laboratory setting. EEG recordings and working memory assessments were conducted prior to and after the fragrance exposure to analyse the differences between the groups. The combination of neurophysiological data (EEG), behavioural results, and chemical analyses of scents allowed for a comprehensive exploration of how olfactory stimuli might influence cognitive and emotional functions.

3.2 Study Area

The experimental process was carried out at the Imaging and Neuroscience laboratory, located in the Faculty of Science and Technology at Universiti Sains Islam Malaysia (USIM), in Nilai, Negeri Sembilan. This location was chosen for its capacity to provide a tightly regulated environment, which minimized outside disturbances and preserved the validity and reliability of EEG and other physiological measures.

3.3 Study Population

The target sample comprised healthy male Malaysian university students aged between 18 and 25 years, encompassing both undergraduate and postgraduate individuals. Recruitment efforts involved distributing physical flyers around the USIM campus and extending digital outreach through student-accessed channels like email and WhatsApp (see Appendix I). This age group was selected because of their easy accessibility, the development of their cognitive skills, and their correspondence with the study's goals. At 18 years old, advanced cognitive abilities, including working memory, are typically established and tend to be stable (Breit *et al*., 2024; Murty *et al*., 2016), rendering this group ideal for memory-based activities like the CogniFit assessment. Limiting the sample to this particular age group also reduced variability associated with cognitive and emotional regulation differences due to age (Livingstone *et al*., 2020). Moreover, university students usually exhibit more consistent cognitive traits, which aid in minimizing possible confounding variables in the data (Shi *et al*., 2020). By clearly defining these criteria, the study results could be reliably applied to the wider population of healthy young adults.

3.4 Subject

3.4.1 Inclusion Criteria

Participants were involved in this study if they fulfilled particular criteria. Participants were males aged from 18 to 25 years old who were right-handed, as confirmed by the Edinburgh Handedness Inventory online test found at https://www.brainmapping.org/shared/Edinburgh.php (Robinson, 2021), detailed in Appendix II. Furthermore, only individuals who exhibited memory capabilities within the normal range, particularly those scoring between 50 and 100 on the Multifactorial Memory Questionnaire (MMQ), were chosen. This range, signifying average to very high memory capability, was derived from the interpretation criteria specified in the MMQ manual (Jensen *et al*., 2024; Troyer & Rich, 2018). The MMQ forms, allowed for non-commercial use in clinical, research, and educational contexts, were retrieved from the Baycrest website, as cited in Appendix III at https://www.baycrest.org/Baycrest/Healthcare-Programs-Services/Clinical-Services/Neuropsychology-Cognitive-Health/Clinical-Tools /Multifactorial-Memory-Questionnaire, and the items were retained in their original English version without translation into Bahasa Malaysia.

3.4.2 Screening Procedure

Before participation, all potential participants completed the Information Collection Form (refer to Appendix IV) and a set of screening questionnaires assessing smell sensitivity, allergies, and self-reported memory related to fragrances (refer to Appendix V). These instruments were used to verify that participants met the inclusion criteria and did not meet any exclusion criteria. In addition, all participants provided written informed consent before involvement in the study (refer to Appendix VI).

3.4.3 Exclusion Criteria

Initially, 35 participants were recruited for the study. All participants underwent a screening process using a health and eligibility questionnaire before participation. Based on the screening, individuals were excluded if they reported a history of brain injury, neurological, mental, or psychiatric disorders, substance or alcohol dependence, or current use of psychoactive medication. Participants with olfactory or respiratory conditions, including blocked nose, sinusitis, flu, cough, or any condition that could impair smell perception, were also excluded. Smokers were omitted due to the known effects of nicotine on brainwave activity and cognitive function (Hasan *et al*., 2021). Additionally, individuals with known allergies or sensitivities to the fragrances used in the study were excluded to ensure participant safety.

Following data collection, participants with outlier EEG values or invalid behavioural assessment results were removed from the final analysis. As a result, only 24 participants met all inclusion criteria, produced valid data, and were therefore eligible for further EEG scanning examination and statistical analysis.

3.4.4 Subject Selection

To maintain sample consistency and reduce physiological differences, this research only included male participants. A key factor was the impact of hormonal changes typically seen in women during the menstrual cycle, which can affect brain function, emotional states, and sense of smell. Studies have shown that estrogen and progesterone levels can notably influence EEG rhythms, particularly in the alpha and theta frequency ranges (Torbaghan *et al*., 2023; Bazanova & Vernon, 2014; Sundström and Gingnell, 2014). In addition, the perception of smells and emotional reactions to odors are known to fluctuate during different menstrual phases, possibly adding more confounding variables (Stanic *et al*., 2021; Kafaei *et al*., 2025; Lobmaire *et al*., 2018). The study focused on choosing only healthy male participants of comparable ages to ensure a more consistent neurophysiological baseline, minimize intersubject variability, and improve the internal validity of the findings. This method allowed for a more systematic examination of the direct impacts of fragrance exposure on EEG responses and working memory abilities without the additional complications of hormonal variations.

3.5 Sample Size and Group Randomisation

3.5.1 Sample Size Justification

In the beginning, the study started with about 35 participants. However, due to outlier data and invalid results of behavioural assessments, only 24 were eligible for further EEG scanning examination. The study was completed with a total of 24 healthy male participants, aged between 18 and 25 years old (mean = 21.75 years; SD = 2.15), who were recruited based on purposive sampling. Every participant underwent screening to confirm they had no prior neurological disorders, olfactory issues, or allergies that might disrupt the experimental procedures.

Although the sample size may appear small, it aligns with standards for exploratory EEG studies, where sample sizes typically range between 12 and 30 due to technical complexity, time constraints, and the richness of physiological data obtained (Boudewyn et al., 2023; Luck, 2014). Additionally, the within-subject analysis of EEG power density and memory performance enhances statistical sensitivity, partially compensating for smaller group sizes.

An a priori power analysis was conducted using G*Power (version 3.1.9.7) for a paired *t*-test design (two-tailed), with a significance level of $\alpha = 0.05$, statistical power of 0.90, and an assumed medium effect size (dz = 0.5). As shown in Figure 3.1, the analysis indicated a required sample size of 36 participants. However, due to practical limitations associated with EEG recording procedures and participant availability, including the outliers and data invalidity, a smaller sample was used. Therefore, this study is positioned as an exploratory investigation providing preliminary neurophysiological evidence on fragrance-induced calmness and working memory performance.

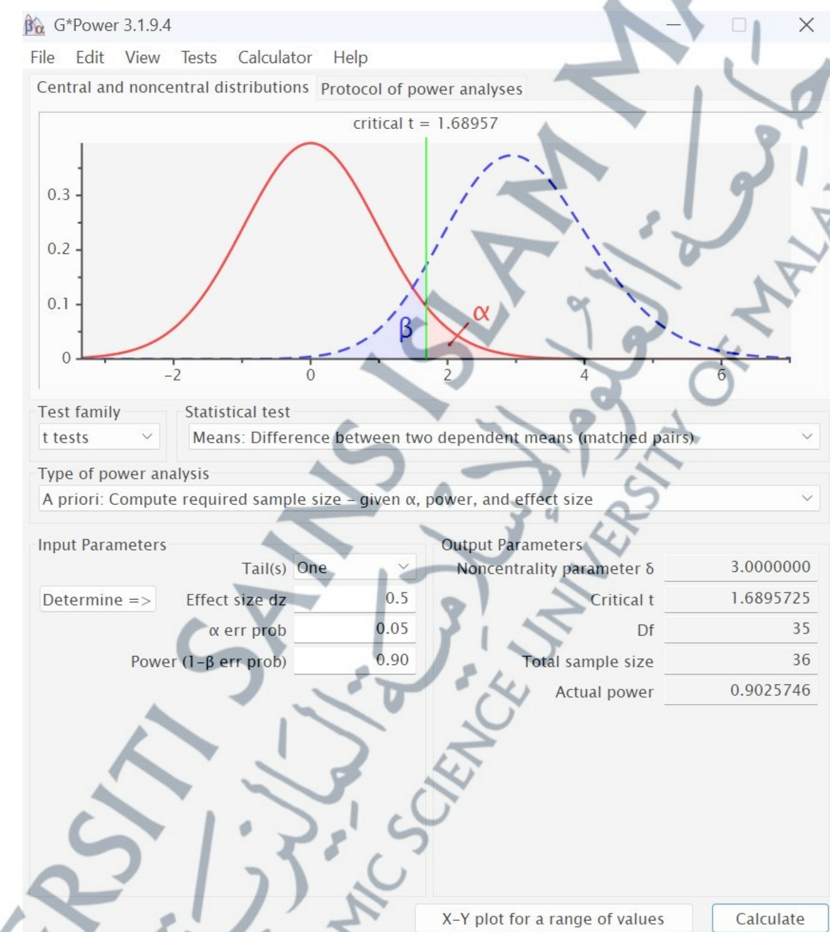

Figure 3.1: *G**Power Sample Size Calculation for the Paired t-test Design

3.5.2 Group Randomisation

Subjects were randomly divided into four groups, with each group containing six participants. Three groups were exposed to various commercial scents identified as

Fragrance A (floral-fruity), Fragrance B (spicy-woody), and Fragrance C (citrus-floral), whereas the fourth group acted as the placebo control group, receiving no active scent. Randomization was performed manually to guarantee equal group sizes and remove potential bias in fragrance allocation.

3.6 Materials and Instrumentation

3.6.1 EEG Recording Device

The main neurophysiological device utilized in this research was the Unicorn Hybrid EEG system developed by G. Tec Medical Engineering. This is a portable, wireless 8-channel EEG device intended for monitoring and recording brain activity in real-time. The system was chosen due to its user-friendliness, excellent signal quality, and appropriateness for research-level applications. The electrodes of interest included EEG1 (Fz), EEG5 (Pz), EEG6 (PO7), and EEG8 (PO8), which correspond to the frontal and parietal-occipital areas typically associated with cognitive and emotional processing. EEG signals were captured and processed with Unicorn Hybrid EEG software, and subsequently examined with Brain Analyzer, where power densities of alpha and theta bands were derived using Fast Fourier Transform (FFT) techniques. Figure 3.2 depicts the Unicorn Hybrid Black EEG System, featuring the headset aligned with the attached electrode.

Source: Pontifex & Coffman (2023)

Figure 3.2: Unicorn Hybrid Black EEG System

3.6.2 Electrode Selection

In this study, the electrodes Fz (EEG1), Pz (EEG5), PO7 (EEG6), and PO8 (EEG8) from the Unicorn Hybrid EEG system by g. Tec Medical Engineering was selected (refer to Figure 2.7), as these sites encompass the frontal, parietal, and parietal-occipital regions based on the literature related to emotional, relaxation responses, attention regulation, and working memory performance.

Fz (frontal midline)/ EEG 1 is widely associated with emotional regulation, attention, arousal, working memory and has been identified as a key site for detecting changes in alpha and beta power linked to relaxation and reduced stress (Prodhan *et al*., 2024; Ratcliffe, 2022). Furthermore, Pz (parietal midline)/ EEG 5 plays a role in internal attention and calm states, often showing increased alpha and theta activity during relaxed or meditative conditions (Ramyarangsi *et al.,* 2024). Parietal areas are also an important area to examine working memory (Wang *et al*., 2024).

In addition, the parieto-occipital electrodes PO7/EEG 6 & PO8/ EEG 8 are involved in sensory and emotional processing and are sensitive to increases in alpha power that typically reflect relaxation and decreased mental effort (Ling *et al*., 2025). Together, these electrodes provide a strong coverage of brain regions involved in both cognitive-emotional control and general physiological calmness, making them suitable for analyzing the calming effects of fragrance exposure and working memory. Table 3.1 shows EEG electrode channels (EEG1–EEG8), their scalp locations, and associated brain regions and cognitive functions (G. tec Medical Engineering, n.d.).

Although EEG data were recorded from all electrodes using the 10–20 system, electrodes C3, Cz, C4, and Oz were excluded from analysis, not due to data quality issues, but to maintain a region-of-interest (ROI) approach and to reduce multiple comparison bias, thereby improving statistical sensitivity and interpretability. Working memory performance, on the other hand, was evaluated separately using the CogniFit application, which provided standardized behavioural measures of non-verbal and visual short-term memory. Therefore, EEG analysis was focused specifically on neural markers of calmness rather than cognitive memory processes. Future studies could include a more comprehensive set of electrodes to explore neural activity across additional cortical regions, such as prefrontal, temporal, central, and occipital areas, to provide a more holistic understanding of how fragrances influence brain activity.

Table 3.1: EEG Electrode Channels, Their Locations, and Associated Brain Regions and Cognitive Functions (G. tec Medical Engineering Website, n.d.)

EEG Channel	Location	Brain Region	Function
EEG1	Fz	Frontal Midline	Executive function, attention, and emotional regulation
EEG2	C3	Left Central (Motor/Somatosensory)	May reflect motor and sensorimotor processing
EEG3	Cz	Central Midline	Motor control, integrative processing
EEG4	C4	Right Central (Motor/Somatosensory)	Similar to C3, on the opposite hemisphere
EEG5	Pz	Parietal Midline	Attention, integration of sensory info
EEG6	PO7	Left Parietal-Occipital	Visual/spatial, memory-related
EEG7	Oz	Occipital Midline	Vision, but also alpha rhythm (rest/calmness)
EEG8	PO8	Right Parietal-Occipital	Visual, attention-related

3.6.3 Fragrance Samples

The olfactory stimuli included three fragrances sourced from SugarBomb Sdn. Bhd. that are available for commercial purchase, with each defined by a unique scent profile: Fragrance A (fruity and floral), Fragrance B (wood and spices), and Fragrance C (citrus-floral). A scentless solution (distilled water) served as a placebo control. The scents were examined through gas chromatography-mass spectrometry (GC-MS) utilizing Agilent Mass Hunter Software to ascertain their chemical makeup, recognizing compounds and their relative quantities. The aroma exposure device consisted of regulated ambient diffusion in a calm, well-ventilated space.

Fragrances were provided at a low concentration (1-10 ppm) via conventional diffuser techniques, allowing participants to passively enjoy the scent through smelling (rather than sniffing), following olfactory research standards.

Participants were subjected to low levels of fragrances to examine their impact on calmness. The acceptable levels for inhalation exposure to fragrances, frequently expressed in parts per million (ppm) or milligrams per cubic meter (mg/m^3), can be obtained from guidelines on occupational safety and research on environmental health. The American Conference of Governmental Industrial Hygienists (ACGIH) suggests Threshold Limit Values (TLVs) for different airborne substances, with general fragrance chemicals, concentrations under 1-10 ppm generally regarded as safe for most groups during short-term exposures (Rana *et al.*, 2025; Mumy, 2024). These guidelines are frequently cited for establishing safe exposure limits in research and industrial environments.

In this research, a fragrance solution was created by mixing 0.5 mL of commercial fragrance with 100 mL of distilled water in a 1:200 ratio (0.5% concentration) and delivered into an ultrasonic diffuser located about 1 meter (100 cm) away from the participant. This ratio maintained exposure levels that were both detectable and safe, adhering to aromatherapy safety guidelines. This dilution was selected based on previous olfactory-EEG research and global fragrance safety standards, which suggest low-intensity exposure (generally <1%) to avoid sensory adaptation or irritation while still producing a neural response (Api *et al*., 2015). This concentration is consistent with safe exposure limits as outlined by the International Fragrance Association (IFRA).

3.6.4 Memory Assessment Tool

The CogniFit digital application was used to evaluate cognitive performance by assessing non-verbal memory and visual short-term memory. The instrument generated quantifiable results, including accuracy rates (in percentages) and response times (in seconds) for comparisons before and after fragrance exposure. This platform was chosen for its reliable cognitive tasks and automated scoring system appropriate for ongoing assessments. Figure 3.3 displays the interface of the CogniFit memory assessment, whereas Figure 3.4 depicts the scores and descriptive outcomes of CogniFit.

Multiple research initiatives have confirmed the effectiveness of CogniFit cognitive evaluation tools in assessing working memory, especially non-verbal and visual short-term memory. The platform is well-known in neuroscience and cognitive psychology studies for its scientifically crafted tasks, based on established cognitive models like the Corsi block-tapping test and n-back tasks (Heaton *et al*., 2024; Berbegal et al., 2022; Morgan, 2018).

CogniFit's memory tasks exhibit strong construct validity, successfully distinguishing among different types of memory functions, such as visual memory, short-term memory, and working memory (Berbegal *et al*., 2022). Furthermore, the application has demonstrated significant test-retest reliability and convergent validity alongside conventional neuropsychological evaluations (Morgan, 2018), establishing it as a trustworthy instrument for clinical and experimental applications. Berbegal *et al* (2022) demonstrated that the platform is being utilized more frequently in both clinical and experimental studies, providing standardized administration, automated scoring, and integrated metrics for reaction time and accuracy. This aids in reducing possible experimenter bias and guarantees improved objectivity and consistency of findings.

Figure 3.3: The CogniFit Memory Test Interface

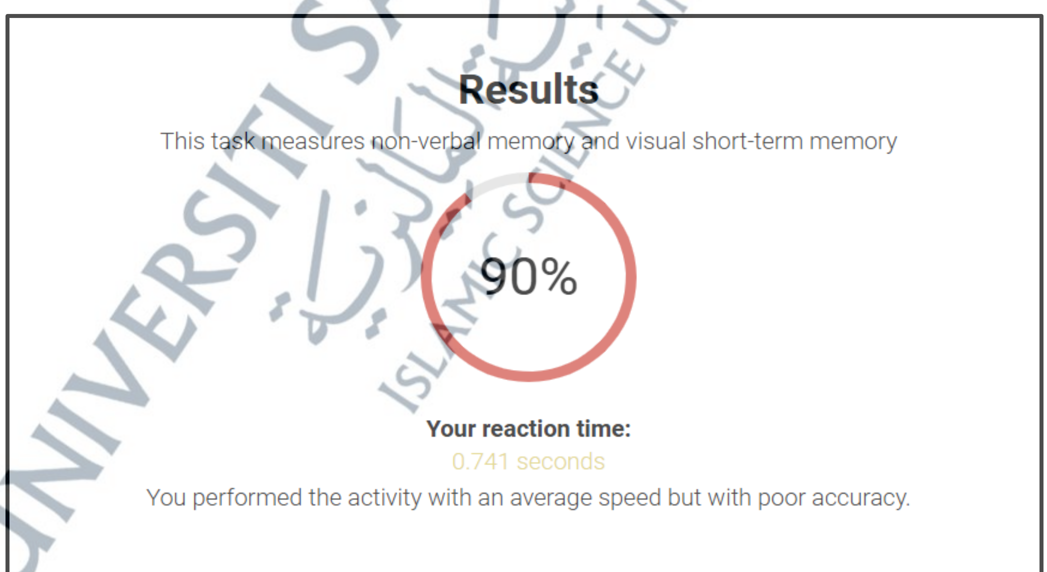

Figure 3.4: The CogniFit Memory Results Interface

3.7 Experimental Procedure

All experimental sessions were conducted at the Imaging and Neuroscience Laboratory, Faculty of Science and Technology, Universiti Sains Islam Malaysia (USIM). Upon arrival, each participant was briefed on the study's objectives, procedures, and safety precautions before providing written informed consent. Participants were screened using a pre-assessment questionnaire to ensure they met the inclusion criteria, which included being in good health, male, non-smokers, and having no known allergies or olfactory impairments. Before the EEG recording, participants were asked to avoid caffeine and strong-smelling substances for at least 12 hours to prevent confounding effects on brain activity or olfactory perception.

Subjects were randomly allocated to one of four groups (Fragrance A, B, C, or placebo) employing a straightforward randomization method. Each participant was positioned comfortably in a tranquil room with soft lighting to reduce outside disturbances. The EEG cap (Unicorn Hybrid 8 system) was applied and adjusted for each person, guaranteeing suitable impedance levels at all eight electrode locations. Baseline EEG data were initially gathered for five minutes while the subject was in a relaxed position, instructed to remain still with their eyes shut. Afterward, participants experienced a blend of fragrances through passive inhalation, with the diffuser positioned about 100 cm from the individuals, avoiding any need for active sniffing following ethical guidelines to prevent trigeminal system activation (Sharma *et al*., 2019; Aucoin *et al*., 2023).

The EEG measurement persisted throughout and following fragrance exposure to monitor immediate neurophysiological alterations. After the EEG session, participants promptly engaged in a working memory task on the CogniFit digital platform. The assignment emphasized non-verbal memory and visual short-term memory via gamified, verified modules. The memory assessment was performed prior to and following fragrance exposure, with accuracy percentage (%) and reaction time (seconds) noted for analysis. Table 3.2 outlines a comprehensive experimental process with approximate durations for each phase, guaranteeing an efficient workflow from participant arrival to data gathering and fragrance exposure. The overall duration for finishing the data collection process for both behavioural and EEG responses was around 50 minutes.

Table 3.2: Experimental Procedure and The Timeline

No.	Activity	Estimated Time (Min)	Activity Breakdown
1	Subject Arrives at EEG Lab	0	Screening Process
2	Briefing Session about Research	5	
3	Filling in Demographic Data	5	
4	Memory Screening Test – MMQ	5	
5	Rest Period	3	
6	Preparation for EEG Cap Placement	5 - 10	Preparation Process
7	Explanation of the Brain Signal Scanning Process	5	
8	EEG Baseline Imaging	0.5	Imaging Process
9	Memory Task -pre	4	
10	EEG *rest with open eyes*	1	Imaging Run
11	EEG *rest with closed eyes*	1	
12	EEG Fragrance Exposure – Group A/B/C/Placebo	1.5	
13	EEG Rest	1	
14	Memory Task- post	4	
15	Procedure to Remove EEG Cap	5	End of Imaging Process
16	Dismissal	0	
	Total:	**46-51 minutes**	

3.8 Data Collection

Three types of data were collected for this study: EEG power density values, working memory performance, and fragrance chemical profiles. EEG data were recorded using the Unicorn Hybrid EEG system with eight dry electrodes placed according to the international 10–20 system. For the analysis of calmness, four key electrodes: Fz (EEG1), Pz (EEG5), PO7 (EEG6), and PO8 (EEG8), were selected based on their relevance to frontal and parietal regions involved in relaxation and attention as explained above. Figure 3.5 shows the subject closed his eyes after finishing the memory task in the process of fragrance exposure while wearing a wireless EEG. Then, after finishing the recording session, power spectral density (PSD) values were extracted for alpha (8–12 Hz) and theta (4–7 Hz) frequency bands both before and after fragrance exposure using the Fast Fourier Transform (FFT) algorithm via the Unicorn Hybrid EEG software and later processed in the Brain Analyser software. Figure 3.6 shows the process of getting the power density values data from the Brain Analyser.

Working memory data was obtained from the CogniFit platform. The platform automatically generated scores for task accuracy and reaction time for each participant before and after fragrance exposure. These results were exported into SPSS for statistical processing. Lastly, chemical composition data for each fragrance were collected through Gas Chromatography-Mass Spectrometry (GC-MS) analysis. Relative abundance and compound percentages were calculated for major volatile components in each fragrance to aid interpretation of their neurophysiological effects.

Figure 3.5: Subject Exposed to the Low Concentration of Fragrance Using a Diffuser

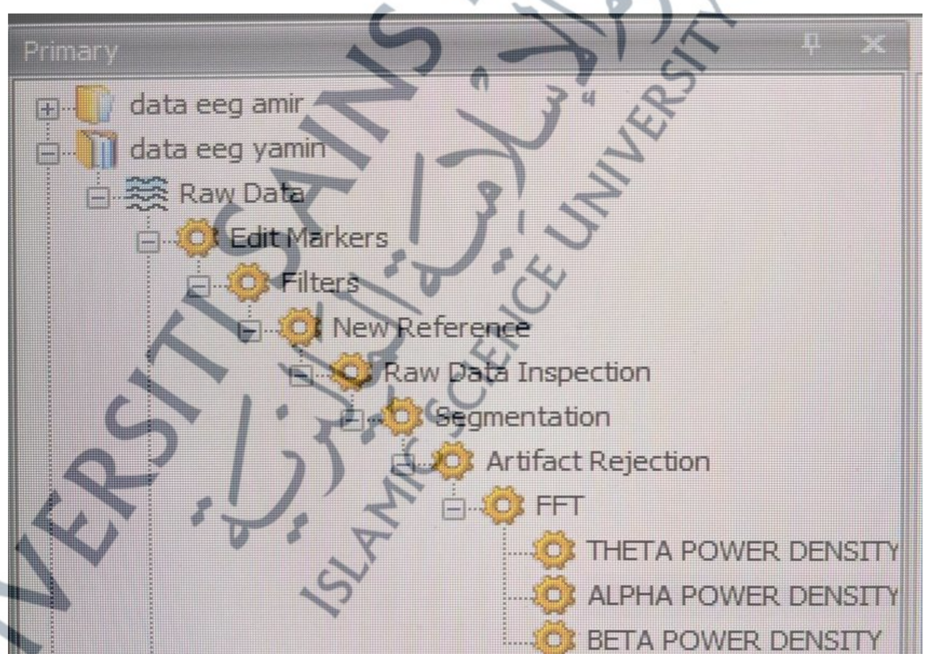

Figure 3.6: The Process Interface for Brain Analysis using Analyser

3.9 Data Analysis

3.9.1 Brain Analysis using Analyser

EEG data were analysed using BrainVision Analyzer 2.0 (G. Tec Medical Engineering). Specifically, a semi-automatic approach was employed, combining automated processing with manual inspection to ensure data quality.

The EEG data analysis followed a structured preprocessing and feature extraction workflow. Initially, raw EEG signals recorded from the Unicorn Hybrid 8-channel system were imported in BDF format, and event markers were reviewed to ensure accurate temporal alignment. These markers also corresponding to different experimental conditions were then, verified and edited. Subsequently, the data were filtered using a 1–40 Hz bandpass filter to remove slow drifts and high-frequency noise while preserving the alpha and theta bands of interest, and a new reference was applied to standardize signals across electrodes. Following this, the raw data were visually inspected, and artifact rejection was performed using both automated detection and manual inspection to remove epochs contaminated by eye blinks, muscle activity, or other noise (Figure 3.6).

Then, the cleaned EEG segments underwent Fast Fourier Transform (FFT) within Brain Analyzer, which decomposes the time-domain signals into their constituent frequencies, allowing calculation of power spectral density (PSD) for each epoch. PSD values were extracted for the theta (4–7 Hz) and alpha (8–12 Hz) bands, both before and after fragrance exposure. Finally, absolute and relative power densities were calculated at the selected electrodes (Fz, Pz, and PO7/PO8) to assess the effects of fragrance exposure on calmness. Overall, this semi-automatic approach allowed for efficient processing while maintaining data integrity, ensuring reliable results for statistical analysis.

3.9.2 SPSS Analysis

IBM SPSS Statistics 28.0 was employed to perform quantitative analysis to analyse the objectives one and three of this research. For EEG data, mean alpha and theta power density values were calculated for each subject across the four selected electrodes, both before and after fragrance exposure. Paired sample t-tests were used to determine whether there were statistically significant changes in EEG alpha and theta power density within each fragrance group.

The same test was applied to working memory scores and reaction time to compare pre- and post-fragrance performance. Statistical significance was set at $p < 0.05$. Exact p-values are reported to three decimal places, except when $p < 0.001$, which is reported as $p < 0.001$. A significance threshold of $p < 0.05$ was used for all comparisons.

3.9.3 Chemical Analysis

In the chemical analysis, qualitative analysis was performed, where the relative abundances of specific fragrance compounds obtained from GC-MS (connected to Agilent Mass Hunter Software) were transformed into compound percentages by dividing each peak area by the total peak area of that fragrance and then multiplying by 100. Although this study did not establish a direct statistical link between chemical composition and EEG data, interpretations were made based on established psychological or neurophysiological effects of significant compounds. This qualitative relationship enabled an investigation into how fragrance formulation might affect neural calmness and cognitive functioning. Table

3.3 below presents a summary of the research objectives, variables, type of analysis, and software utilized in the study.

Table 3.3: Summary of Research Objectives, Variables, Type of Analysis, and Software Used in the Study

No.	Research Objectives	Independent Variables	Dependent Variables	Type of Analysis	Type of Software Used
1.	To quantify the changes in alpha and theta power in EEG signals following exposure to different fragrance types, within each group, as well as between the different fragrance groups.	Alpha and Theta Power in EEG Signals	Different Fragrance Types	Paired t-test	Unicorn Hybrid, Brain Analyzer, SPSS
2.	To explore the potential association between the chemical composition of commercial fragrances and their effects on EEG alpha and theta power density.	Changes in Alpha and Theta Power in EEG Signals	Chemical Components in Fragrance Samples (identified via GC-MS)	Qualitative analysis	GC-MS, Agilent Mass Hunter

3.	To assess the impact of fragrance exposure on working memory performance, specifically non-verbal memory and visual short-term memory, using the CogniFit App.	Memory Test Accuracy Scores, Reaction Time	Fragrance exposure (before vs. after)	Paired t-test	CogniFit, SPSS

3.10 Flowchart of Research Procedure

To provide a clear overview of the research process, a flowchart was constructed to illustrate the sequential steps undertaken in this study, as illustrated in the figure 3.6 below.

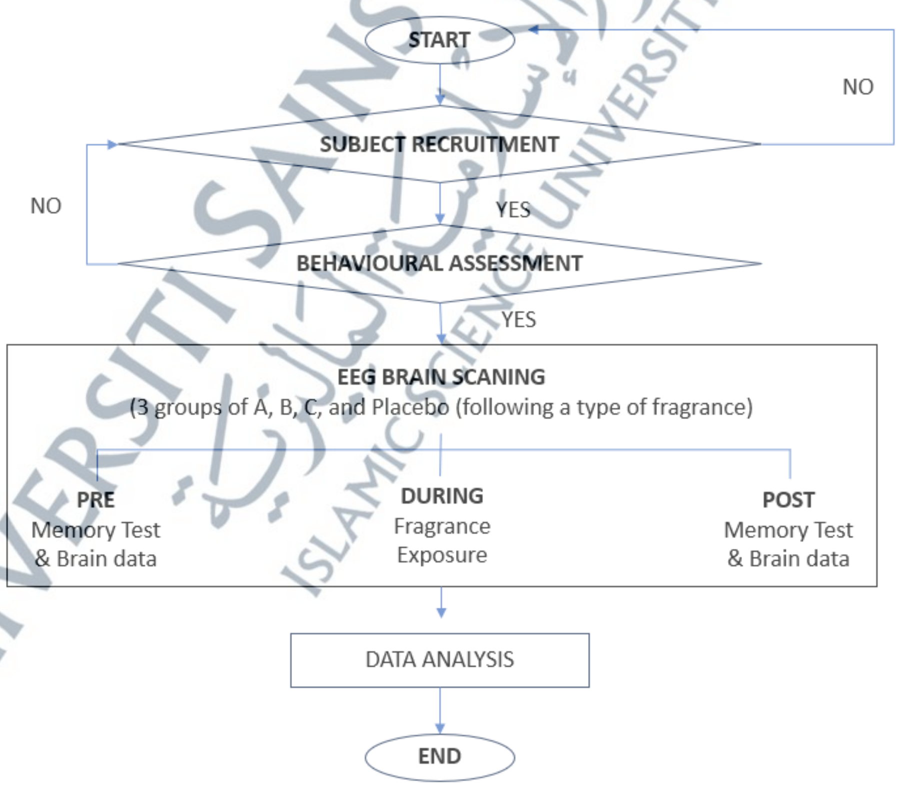

Figure 3.6: Flowchart of Research Procedure

3.11 Ethical Considerations

3.11.1 Subject Vulnerability

During the conduct of this EEG research involving fragrance exposure, ethical considerations concerning participant vulnerability were thoroughly addressed. Each participant received full disclosure about the purpose of the study, the procedures involved, any potential risks, and their right to withdraw freely at any moment without penalty. Informed consent was obtained before participation to ensure voluntary involvement.

To minimize health-related risks, only healthy male participants with no known fragrance allergies or sensitivities were recruited. Fragrances were administered at low concentrations ranging from 0.1% to 1%, under safety guidelines from the International Fragrance Association (IFRA) and occupational exposure standards. This ensured participant safety while maintaining sensitivity to detect neurophysiological effects. Additionally, the Universiti Sains Islam Malaysia (USIM) clinic, located near the research site, was available to provide immediate medical assistance if necessary. No adverse reactions were reported throughout the study.

3.11.2 Declaration of Absence of Conflict of Interest

The research team declared that no conflicts of interest were associated with this study. None of the investigators received payments from external companies or had personal or financial interests in the outcomes. The study was conducted with full independence, guided solely by scientific integrity and ethical principles. All data were analyzed and reported accurately, transparently, and free from external influence. The industry collaborator is aware of any findings obtained from this research, including the negative results.

3.11.3 Privacy and Confidentiality

The privacy and confidentiality of all participants were rigorously safeguarded. EEG recordings and all related data were anonymized and securely stored. Participants were identified only by unique codes, with no use of personal identifiers in any part of the data presentation. Only authorized research personnel had access to the data, which was stored in password-protected files. Data presentation in the final report was done in an aggregated form to prevent the identification of individual participants. A summary of the findings was made available upon request, excluding any personal data. Data retention was limited to the duration necessary for analysis and reporting, following which all data were securely discarded.

3.11.4 Community Sensitivities and Benefits

This study was conducted with respect to the cultural, social, and religious sensitivities of the participants and the broader community. All procedures were designed to avoid discomfort, misunderstanding, or offense. By investigating how fragrance compounds influence brain activity and memory, the research aimed to contribute positively to public knowledge and wellness. The findings may support future applications in emotional regulation, stress management, and cognitive performance enhancement in educational and occupational settings.

3.11.5 Honorarium and Incentives

All participants received a token of appreciation for their volunteerism, regardless of group assignment or study outcomes. It was not intended to influence participation but to express gratitude for the time and contribution of the participants. The distribution of the incentive was handled in a manner that avoided any coercion or bias.

3.11.6 Ethical Approval

Ethical clearance for this research was granted by the Human Research Ethics Committee of Universiti Sains Malaysia (USM) with the approval code: USM/JEPeM/KK/24121070. (Refer to Appendix VII for the letter of approval.)

3.12 Summary

This chapter detailed the methodological framework of the study. It described the experimental design, instruments used, participant selection, fragrance exposure procedures, and analytical methods. The next chapter will present the results obtained from EEG recordings, memory performance scores, and GC-MS chemical profiling.