



A Cross-Sectional Survey Analysis of the Human Olfactory Senses for Perfumes and its Alternations due to COVID-19

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ABSTRACT: Perfumes are created by a fine blend of fragrant compounds, essential oils, various fixatives, and liquid solvents. They bestow a pleasant smell on the human body, animals, objects, and surroundings. In today's environment, people wear perfume to conceal or enhance their natural odour. Some people even wear perfume to be unique or special and have a characteristic aroma. Perfumes can also increase one's self-confidence and self-esteem. Following this context, this study aims to evaluate the odour families preferred by males and females and the odour families they find appealing to the opposite sex. This paper and its findings scrupulously define the odour families and raw materials used in perfumery and pose a question to neuroscientists about the further scope in areas of brain development and unravel the mysteries behind the preference of gender-based division of odour families. It also shows the statistics of how the COVID-19 global pandemic had decreased the usage of perfume during the trying times of lockdowns and restrictions.

KEYWORDS: Gender preference, Human Olfactory sense, Neuroscience, Perfumery.

INTRODUCTION

**“A WOMAN WITHOUT A PERFUME IS A WOMAN WITHOUT A PAST
AND A COUTURIER WITHOUT A PERFUME IS A COUTURIER WITHOUT A FUTURE....!”**

The fragrance has played a key role in human history. Our sense to smell is one of the most fundamental elements which helps us to perceive our surroundings. People are inspirational as each one craves to be 'Prettier', 'Richer', 'Happier' and better than our neighbours and people around us.

Fragrances are made from various plants and their parts like roots, woods, twigs, leaves, flowers, seeds and fruits or obtained from natural gums. The hypnotic action of perfumes has played an important role in religious ceremonies from ancient times.

Over the last 35-40 years there has been a growing interest in perfumes. The potential requirement of fragrance is unimaginable and this is one of the fastest-growing and the greatest opportune industries whose requirements are unending. (J., 2017)

Perfumery is a subject rooted in science. It is more subjective than objective. Originating as an art, evolved into a science and progressively required technical and analytical inputs to meet the specific requirements of the customer and meet the expectation of the end consumer.

With all these innovative changes, the perfumer's job continues, as ever, with more pressure, demands and likes however there is no danger for the perfumers even with modern computers and electronic noses.

LITERATURE REVIEW

Historical Standpoint

Although some authors argue that the concept of developing perfumes originated in Arabia.

Katherine Medici, the wife of King Henri II brought modern perfumery to France and developed Grasse as a perfumery centre. (Aminalli, 2008)



In 1690, simple herbal water called Hungary Water was first developed and sold only to the wealthy. However, in 1861, **Kekule** discovered the structure of benzene which led to the development of organic synthesis with odour and aromatic compounds mainly from petroleum by-products.

In the 17th and part of the 18th century, perfume creation was simple. These then existed as Eau de cologne, Lavender Water, Hungary Water, Rosewater etc. These blends were of great success but then the general complaints were that there is not much variety and they are not long-lasting.

When demand/ expectations for stable and long-lasting perfumes increased, perfumers started developing scents with animal secretions, which started giving long-lasting products but with the bad, unpleasant, faecal odour of animals. Perfumers then came up with the idea of masking this unpleasant odour by using Tonka and Vanilla Extracts which were sweet and powerful enough to mask the bad and unpleasant odour (Aminalli, 2008).

The structure of perfumes now became as follows (Aminalli, 2008):

Citrus Oils, Herb Oils, Lavender Oils + Animal Secretions + Tonka/ Vanilla Extracts

These were later than that defined as a base note, heart note and Top note odour. A sense of fatigue was developed amongst perfume users due to the lack of variety which resulted in the development of the flower oil extraction industry where natural flower oils were created in the purest form, at high prices. However, down the line, the advent of synthetics replaced natural wherever possible and today perfumes are usually created with either synthetic or reconstituted natural oils (RCO). Jean Carle's: Father of Modern Perfumery diagrammatically represented a perfume, in the 1940s, (Carles, 2019)

TOP: 15-20%

MIDDLE: 30-40%

BASE: 45-55%

Neurobiological Standpoint

Human Olfactory System:

The process of smelling is termed olfaction and part of the human system engaging in the smelling process is called the olfactory system. Our human brain is mainly divided into three parts – the limbic system, thalamus and hypothalamus.

Limbic System: It takes care of the sense of smell, and thereby emotions of love, hate, desire, aggression, feelings, moods and sexual behaviour and the most important being memory and creativity.

Thalamus System: It takes care of other senses like Vision, Taste, Feel, Touch and Sound.

Hypothalamus System: It is responsible for the restoration of physiological equilibrium such as blood glucose levels, hormone levels, and body temperature. That is, it takes care of overall normal health conditions jointly with pituitary glands.

The process of smelling, 'olfaction' takes place through a combined system called as 'olfactory system' consisting of the nostrils, olfactory bulb, its nerves and the limbic system of the brain.

On the surface of the olfactory bulb, there are small hair-like things called Primary Neurons or epithelium. There are approximately 15 million primary neurons in a single olfactory bulb. On each primary neuron, there are several branches called secondary neurons. They are very delicate and require a protective layer and hence are suspended in a layer of mucus. (Groom, 2012)

Olfactory Process:

Any liquid when held near one of the nostrils evaporates and vapours enter the nostrils and start hitting the mucus membrane. The waves/ ripples are created in the mucus membrane then make neurons vibrate which then produces mechanical impulses which will be passed on to the olfactory nerve. The olfactory nerve then converts these mechanical impulses into electrical signals and passes them on to the Limbic System of the brain. The limbic system then analyses these signals and compares them with the existing signals stored in the memory and if the signals match with any of the existing ones, then it immediately recognizes them by name.



The whole process, although explained thoroughly, is very complicated (Sharmeen, 2021). The ripples created on the mucus membrane depend on these two factors:

- Molecular Weight of the substance
- The speed with which it hits the mucus membrane.

Chemistry Standpoint:

Perfumery Raw Materials:

The bringing together of aromatic materials to produce something more pleasing to the nose than the individual components themselves is the 'art of perfumery'. Traditionally, perfume raw materials are divided into natural and synthetics, which is based on their origin. Natural raw materials are divided into Essential Oils, Resinoids and Isolates. Synthetics are divided according to the way they are synthesized, that is, Organic Synthetics and Chemical Reactions. There are about 250-300 active natural ingredients used in perfumery and about 15,000 synthetics, however, only about 4000-5000 are actively used regularly. (G.O., 2009)

Natural Raw Materials:

For obtaining natural raw materials, physical separation techniques like distillation, expression and extraction are used. Entire plants, flowers, seeds, fruits, leaves, woods, roots and also the resins exuded by plants and scent glands of animals such as musk deer, civet, etc. can be used as raw materials. Essential Oils are prepared by the process of Distillation and expression. Resinoids are obtained by the extraction of Gums/ Tears exuded by certain plants by using suitable solvents such as Alcohol (Camps, 2007). Isolates are the concentrated main ingredients of essential oils obtained by the method of fractional distillation. For Example, Lemongrass oil contains citral as the main constituent, to the extent of a minimum of 70% to 99% level is possible. Then this is considered as an isolate and is usually mentioned as citral Ex Lemongrass, i.e., Citral extracted from lemongrass Oil. Many times, these isolates are directly used in perfumery creation. (Web, 2019)

Essential oils:

"The volatile nature of essential oils makes them useful as fragrances" (Burnett C.L., 2019). Certain complex mixtures of terpenes along with some aliphatic and aromatic compounds are among natural fragrances that contribute to a perceived aroma. Steam distillation is the most common way of extracting essential oils after harvesting plants. Other methods are enfleurage which is the extraction of essential oils from flower petals by fat, and physically crushing fruit peels which are called expression or solvent extraction. Commonly, expression is used to get essential oils from citrus fruits like lemon and orange. Naturally, many plants contain essential oils. There are certain parts of a plant that can provide a chief source of essential oil. These include flowers and inflorescence like lavender, rose, and ylang-ylang; leaves (peppermint, rosemary), peels (lemon, orange, tangerine), bark (cinnamon), wood (sandalwood, cedarwood), resin (Myrrha), seeds (cardamom, anise), fruits, berries, roots and rhizomes (ginger) (Tongnuanchan Phakawat, 2014).

The oils most used in the top notes of fragrances comprise the ones that evaporate quickly, are comparatively inexpensive and are not very long-lasting. These are the notes that fade first owing to their molecular structure. They are easily recognised and responsible for the first impression of a scent. The characteristics are fresh, uplifting and fast-acting. "According to many perfumers, the four most popular top notes are orange, lemon, grapefruit and bergamot" (Aromatics, 2020). The middle notes emerge after the top notes evaporate. This note is also called the heart note and consists of a well-balanced and longer-lasting note. They enhance the overall tone of the scent. The smell of the middle notes takes a little more time to develop. Their quantity in a perfume is half that of the top notes and twice the amount used in base notes. They often have a soft floral tone and are occasionally blended with spices such as clove or cinnamon. Popular examples are lavender, peppermint, lemongrass and eucalyptus. The final base note merges with the heart notes to create the essence of the perfume. Their position is to deliver a lasting impression. After the other notes have faded, these are the notes you still smell because they stay on the skin or surface for longer hours. These oils tend to be deep and rich and the most popular ones are cedar and patchouli.

Fragrances can be categorized based on their concentration of essential oils. The most concentrated one is 'parfum', these are usually the most expensive and longest-lasting containing 20 to 30% oil concentration, therefore having a less alcohol percentage than other types. Eau de Parfum (EDP) has oil concentrations between 15 to 20%, these are made to last for at least four to five hours. An Eau



de Toilette (EDT) has an essential oil concentration of 5-15%. These are cheaper than EDPs and are the most popular. It can last for up to two to three hours. Colognes have the lowest fragrance concentration (2- 4%) and high alcohol content, hence being cheaper than the previous ones. It tends to usually last up to two hours. Essential oils are insoluble in water and soluble in alcohol and ether. They are volatile oils and generally colourless liquids at room temperature. (Nicolai., 2008)

Synthetic Raw Materials:

Synthetic fragrances are designed to mimic natural scents. Often, they are longer-lasting and more potent. A perfume comprises 78 to 95 % ethyl alcohol because alcohol is a good base for perfume substances as it evaporates quickly and leaves the components on the skin or clothing, moreover, it has a scent of its own that gives a refreshing effect. The lasting power of an aromatic compound varies depending on its speed of evaporating. A perfume can have several fragrance classes like 'fruity', 'floral', 'woody' or 'citrus' notes. Several perfumes today have synthetic compounds that offer them special characteristics like an odour booster. The path for modern perfumery began in 1856 when the first isolation took place by extracting tonka beans with 80% ethanol. In 1884 the first synthetic molecules were used in a perfume called Fougere Royale. Chanel No. 5 was one of the first perfumes that contained synthetic ingredients, created by modern chemistry and made it big.

Today, Modern perfumers have nearly an infinite range of raw materials accessible to create fragrances. At first, chemists had to face the challenge of isolating and identifying fragrant chemicals from natural products, later the struggle was to synthesize and commercially produce natural-identical chemicals for the growing industry of perfumery. Then finally, new chemicals were devised and synthesized for their odour profiles. This now offers more creativity.

There are two types of synthetic raw materials, the ones obtained by chemical reactions such as esters, aldehydes, lactones and methyl ionones (violet notes) and there are isolates that are extracted from natural products like indole (found in jasmine), linalool (found in lavender) or musks. An isolate is almost twice the price of its corresponding essential oil. (Gill, 2017)

Aldehydes in Perfumery:

Although organic compounds are present in many natural sources, as discussed above, they can also be reproduced synthetically. Aldehydes (R-CHO) are a very important functional group in perfumery. Aldehydes have a variety of smells, those with lower molecular weight have a stinky malodor. On the other hand, the one with a higher molecular weight has pleasant aromas. These are aliphatic (linear) compounds and their scents can vary from citrus to soapy. We can easily identify some aromatic aldehydes by their smell. Benzaldehyde has an odour similar to almonds. However, generally speaking, such chemical compounds give a soapy-lemony- floral touch to perfumes. (Wikipedia, 2021)

Aldehydes with 8 – 18 carbon atoms are most commonly used in formulating a modern perfume. An octanal aldehyde (C8) is a fruity liquid. It is a powerful compound found in citrus fragrances. A nonanal aldehyde (C9) is a clear brown liquid, insoluble in water with a rose-like odour. When employed at high levels, it is a significant part of citrus and rose notes. The c-10 decanal is also evocative of orange and lemon. The 11-carbon undecanal (C-11) is a unique compound that conveys a bitter and fresh effect in cologne formulas.

C-12, dodecanal (lauraldehyde) is a colourless liquid that is present in many fragrances because of its intensity and how it has different qualities depending on how it is used. Dodecanal smells like violets and lilacs. Tridecanal (C13) specifically smells like grapefruit (citrusy smell). It can even enhance the smell of musk in a scent. Undecanal (C14) is an amalgam of peach aldehyde. It falls under the category of lactone (an organic compound that contains an ester). The odour profile is sweet and fruity (peachy), even if used in small amounts it is a potent compound. Aldehyde C-16 is quite reminiscent of sweet candy. It is also called strawberry aldehyde. Along with a strong fruity tone, this compound has a secondary hint of floral honey making it very good for floral formulations. Gamma- Nona lactone (C18) is a creamy compound and according to Arctander (perfumer), "this is one of the most frequently used lactones in perfumes. Its field of application ranges from the finest luxury perfumes to the inexpensive masking odour" Some famous perfumes that contain aldehydes are Chanel No. 5, Lancome Climat, Givenchy L'interdit and D&G Sicily. It was Chanel No. 5 that popularized the usage of aldehydes in perfumes. (Arctander, 2000)

Ketones and other functional groups used in perfumery:

Ketones also have a carbonyl group (C=O) but instead of hydrogen, they have radicals -R present on both sides (R-CO-R). This functional group too has a pleasant odour and is commonly found in musky perfumes. It is used in making acetophenone, which



can create jasmine, strawberry and cherry fragrances. Natural molecules are organically synthesized. They are chemical compounds that are often cheaper and stable than natural ingredients, an example is Vanillin (vanilla), which has a vanilla scent. Schiff's Bases are formed by combining methyl anthranilate with fragrance aldehydes, and this creates unique aromas. Methyl anthranilate is widely used in modern perfumery. (Company, 2021)

Synthetic Vs Natural:

We can say that even though some synthetic products come from purely chemical reactions like petroleum, a majority of them come from nature, giving the example of rhodinol from rose and hedione from jasmine. A synthetic product is stable and monolithic, continuously reproducible. Natural products are a bit more fragile; they can change according to climatic conditions or there can be shortages due to climatic changes or simply not always readily available. A synthetic perfume would be stable and longer-lasting and diffuse better than an all-natural perfume. Some may debate that a synthetic perfume misses something that naturally brings but actually "in a creative workshop in Paris, Odile wanted to recreate the smell of jasmine, he made a participant smell the absolute jasmine sambac and its reconstitution based on the chemical molecule, and surprisingly the one that inspired her the most was the reconstitution. This proved that the synthetic fragrance pleases just as much."-Anais Fournail, lecturer at ISIPCA, Paris. (Tongnuanchan Phakawat, 2014)

Hazards:

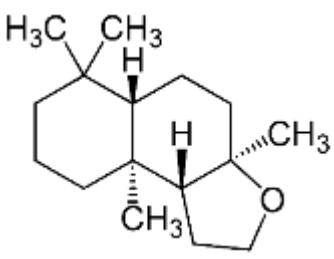
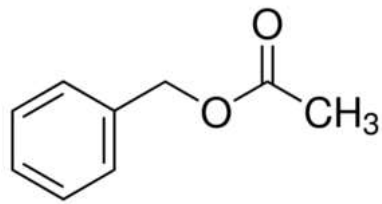
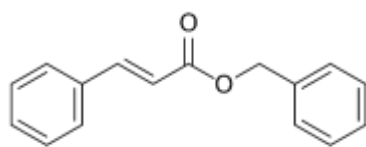
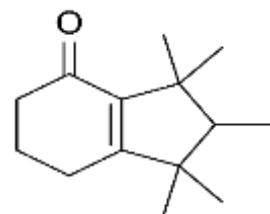
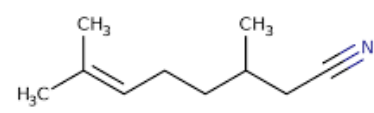
Many brands use laboratory-made synthetic chemicals that imitate natural oils as they are relatively costlier but unfortunately, synthetic fragrances may not contain all the benefits of a natural plant-based essential oil and sometimes may even be harmful for human application. For example, some man-made fragrances have phthalates, they are known to be endocrine disruptors. Even benzene derivatives are known carcinogens.

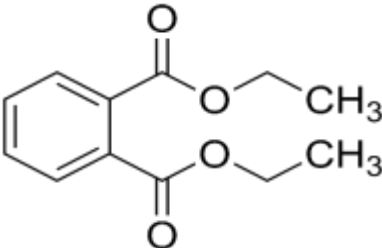
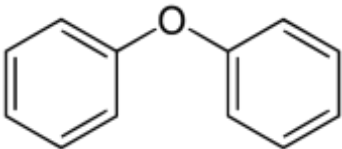
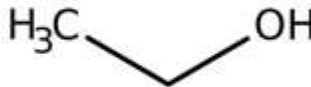

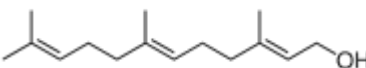
Perfume on a cosmetics ingredients list uses a complex mixture of many chemicals. More than 4000 chemicals are used in fragrances at present, including masking agents that prevent the brain from perceiving some fragrances/ odours. According to the U.S food and drug administration (1991), 95% of these chemicals are derived from petroleum but some are possibly harmful. Nowadays, waste by-products can be used to make fragrances having floral aromas. These are then sold in masses for less money. MSDS listed 20 ingredients on the hazard waste list- like acetone, benzyl alcohol and benzene. (Valek, 2021)

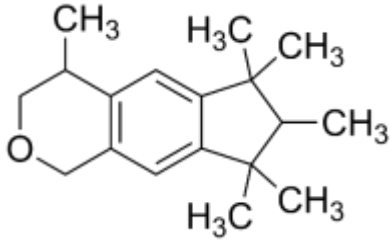
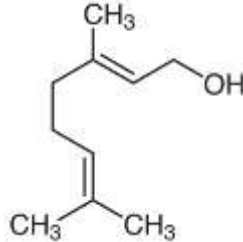
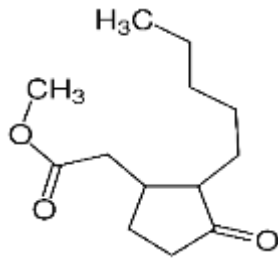
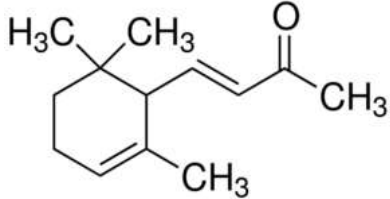
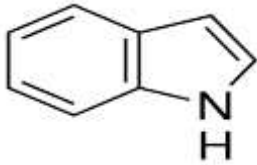
Several perfumes on the market contain chemicals that can cause allergies, respiratory problems or dermatitis, along with unfavourable physiological effects like headaches and nausea, however, since so many ingredients are used to make a perfume and companies are not obliged to list all its ingredients on the label so it is hard to point out a single culprit. However, using synthetic raw materials brings creativity and at the same time provides sustainability by using renewable materials which helps preserve natural resources. (Conceicao, 2019)

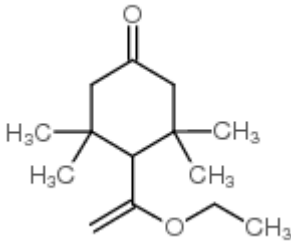
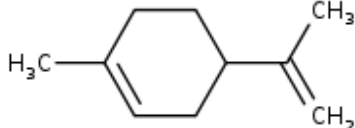
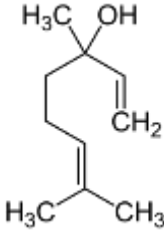
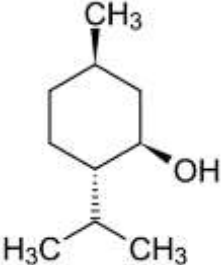
Some Common Fragrance ingredients are as follows by the (Perfumers World Ltd, 2021) (Company, 2021)

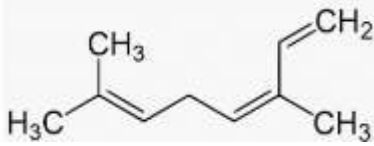
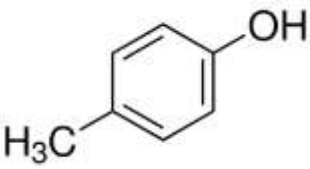
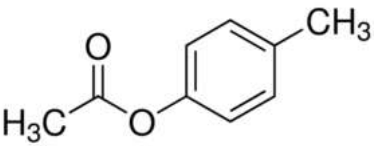
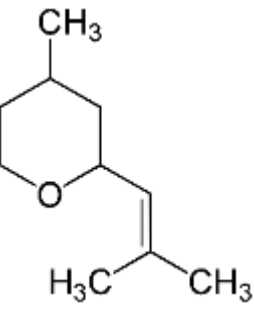
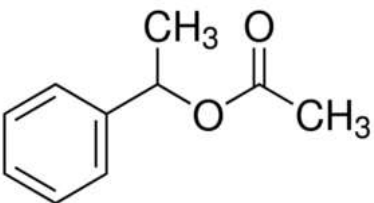
Ingredient	Characteristics	Chemical formula
A		
Acetaldehyde	It is used in perfumery to impart a fruity scent.	

Ambroxan	A very popular synthetic compound has a dry musky, amber, animalic smell.	
B		
Benzyl acetate	Has a robust floral, jasmine aroma. Synthetic and naturally synthesized compliments white flowers well. It has a fruity strawberry odour as well.	
Benzyl cinnamate	As the name suggests, it has a cinnamon scent. Spicy note.	
C		
Cashmeran	A synthetic aldehyde with a floral, spicy, musky odour.	
Citronellyl nitrile	The refreshing, lemon-like scent is used in many citrus fragrances.	

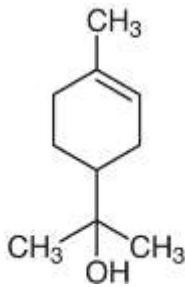
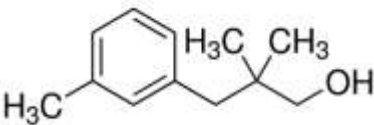
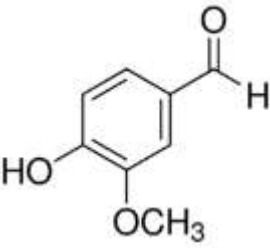
D		
Diethyl phthalate	It is odourless but is used to blend all the ingredients in a fragrance. Can be derived from phthalic acid.	
Diphenyl ether	It has a distinct geranium and rose scent. It is a popular ingredient in floral perfumes.	
E		
Ethanol	Most common alcohol used in perfumery. Helps perfume spread out.	
Eugenol	Perfumers use this ingredient to create a spicy, clove-like scent that reminds you of autumn.	
F		
Farnesol	Creates a floral odour.	

G		
Galaxolide	It has floral and woody tones and gives off quite a unique musk-like scent.	
Geraniol	Geraniol is added to perfumes for a floral scent.	
H		
Hedione (Methyl dihydrojasmonate)	Soft floral jasmine notes with a touch of citrus, are used in the middle note.	
I		
Ionone	A violet scent, sweet and slightly powdery.	
Indole	Very widely used in perfumery, it gives a floral smell in low concentrations.	

K		
Kephalis	Very versatile ingredient. Modern synthetic note. Rich and warm woody- ambery with a hint of tobacco smell.	
L		
Limonene	Colourless liquid found in rinds of citrus fruit with a lemon-like smell.	
Linalool	It is a terpene; it has a spicy-floral characteristic smell and it is present in many floral fragrances.	
M		
Menthol	Can be naturally found in coriander and mint leaves have a fresh minty smell.	

Myrcene	It has a peppery, terpenic, spicy and balsamic-like odour and is very useful in rose, celery and carrot-like compounds.	
O		
Orange oil	Orange oil is extracted from the rinds of oranges, zesty.	
P		
P- cresol	It has a strong floral smell and is usually used as a base note to enhance other scents.	
Para cresyl acetate	Strong and rich floral narcissus smell.	
R		
Rose oxide	Used as a top note to give a green floral smell. It also has a sweet, fruity and citrus scent.	
S		
Styrallyl acetate	It has green leafy, gardenia, sweet, metallic and rhubarb-like notes.	
T		



Terpineol	The aroma is similar to that of sweet peach. It has a lilac odour.	
Trimethylbenzene propanol	Smells fresh, it is used to give a floral, lily in the valley scent.	
V		
Vanillin	This ingredient gives a product a vanilla smell.	
Y		
Ylang ylang	A popular fragrant flower lush and sweet aroma.	

RESEARCH METHODOLOGY

The research encompasses, an explanatory sequential mixed-methods research (QUANT → QUAL). In this research, we explored the mixed-methods research paradigms by Johnson & Onwuegbuzie (2004), through which we conducted a survey to collect data quantitatively, and then validate the information through interview discussions with other people. The importance of combining the two methods was to obtain a large volume of data, more quickly, using an online survey form but at the same time to validate – through intricate human complex behaviour – the data outcomes. There was no detailed triangulation explored to develop a model between the two data sets but to validate the outcome of each other.

Survey Design:

The nomothetic study was conducted online using a survey (cross-sectional) form from Qualtrics for 5 days to know more about the gender-based preference of the odour families and around 445 people participated in the survey. Qualtrics platform was used to design and create a survey that was hosted by a unique web link address. Our survey specifically highlighted that the participation was voluntary and all the information collected will be anonymous, would be kept confidential, and will be used only for educational purposes.

Respondents were asked about their:

- Demographic information
- Detailed selection of odour families, the respondents would prefer on themselves and the opposite sex
- Effect of Covid-19 on the frequency of usage of perfume.



Respondents were asked to answer the 21 items questionnaire which were classified into the following themes:

Demographic Information collected information based on gender, age and geographic location.

Detailed selection of odour families: (Options were pre-given in the questionnaire)

1. Do you like/ use perfume? (If the answer was selected as No, the survey was completed)
2. Frequency of perfume usage in a day?
3. Fragrance families, do you prefer for yourself?
 - There were 8 different options and each option redirected the user to the further classification of the odour preference. For example: If a person selected floral as one of the odour families, the sub-question had options such as Rose, Jasmine, Lavender, Lily etc.
 - Similarly, if a person chose fruity, the sub-question gave options like Pineapple, Apple, Mango, Berries, Banana, Strawberry, Exotic Fruits etc.
 - Fragrance families you find appealing to the opposite sex? The following question also had sub-questions just like the previous question.
5. Arrange the factors that influence you while purchasing perfume?
 - a. Fragrance
 - b. Brand
 - c. Price
 - d. Packaging
 - e. Quality (Long Lasting)
6. What perfume are you currently using?
7. What is/are your favourite perfume brand(s)?

Covid-19 effects:

1. Due to the ongoing pandemic we usually tend to stay indoors, how would you describe your usage of perfume during this period? (Options provided were as follows)
 - Decreased
 - Slightly Decreased
 - Stayed the same
 - Slightly Increased
 - Increased

Interviews:

Qualitatively we analysed the study through interviews with a few participants (an equal number of males and females), and the interviews were brief and short addressing 3 important themes – what odour did they like, what odour they like on a person of the opposite sex and has the effect of COVID-19 affected their perception of smell. Through personal comments, two of the co-authors simultaneously conducted the interviews to ensure that all comments were recorded and analysed for their content. The interviews are conducted on Zoom Conference Application and transcribed with its automation in verbatim.

DATA ANALYSIS AND RESULTS

The data were analysed using the built-in Qualtrics analyser and support for internal consistency using Cronbach's Alpha, while the Spearman-Brown Equation was used to provide a rough estimate on the reliability of the data if it was repeated for more persons. A descriptive form of statistics represented in percentages has been utilized to report the finding and to develop inferences based on the analysis. Likewise, transcribed interviews were thematically coded into 3 distinct topics (described in Table 2).

Gender-Based Analysis:

A total of 400 people responded to our survey completely. 50.50% of them were female, 47.75% were male, 1% were 'Other' and 0.75% preferred not to say. Out of this 60.25% (241) of them like and use perfume regularly, 32% (128) of them use it occasionally and 7.75% (31) of them don't at all. Demographic information is represented in the figures and table below.

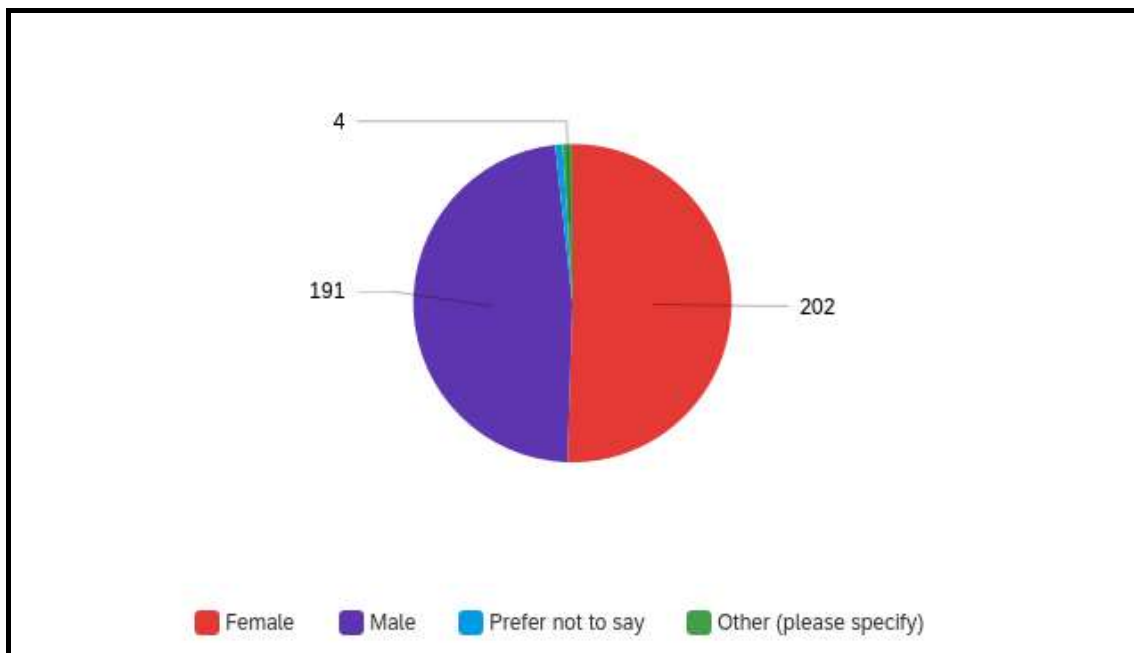


Figure 1: Number of people who wholly took part in our survey

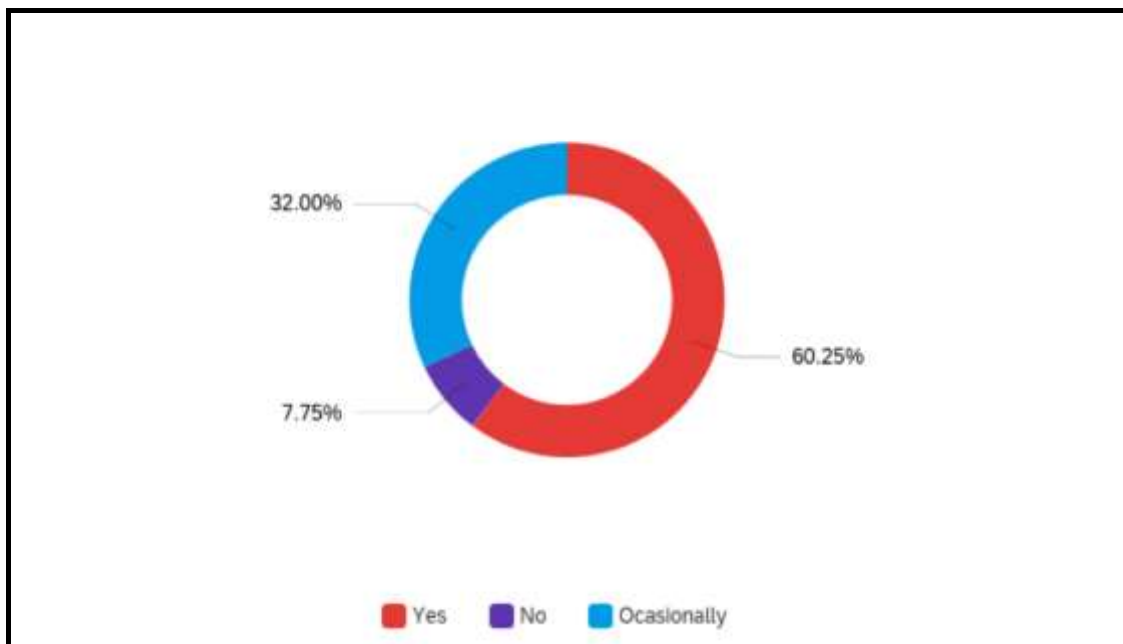


Figure 2: Percentage of people who like/use perfume and who don't.

Table 1: The age distribution of our participants

Age Gap	%	Count
13-18	9.25%	37
18-30	73.50%	294
30-50	13.50%	54
50+	3.75%	15
Total	100%	400

A. Females:

Based on the responses we got from females (202 out of 400 in total and 143 of them were in the age range of 18 to 30 years old), taking the top three most preferred odour groups, it is evident that a major number of females that use perfume, regularly and occasionally like to use **floral** fragrances on themselves (**28.28%**, 140 counts), running up to this in second place is the choice of a **fruity** smell for self-use (**18.59%**, 92), and in third place is **citrus** (**13.54%**, 67) and then Chocolate/vanilla (12.93%, 64). We further divided the families of Floral, fruity and citrus to get a clearer idea of what specific smells are particularly popular amongst females as these odour families are huge with hundreds of aromas. For the floral family, we learnt the scent of **lavender** is most popular, with 36.23%-96, then **jasmine** and **lily** with 58 (21.89%) and 53 (20.00%) votes respectively. For the fruity families, 39.26% (64) women mostly prefer the smell of **berries** (like strawberry, and blueberry) on themselves, they also love **exotic fruits** such as passion fruit, melons, peaches, litchi, etc. 36.81% (60). Classifying citrus, **lemon** was mainly preferred (55.24%, 58) and then **orange** (24.76%, 26). Some chemical compounds that give a floral touch to perfume are Diphenyl ether, Geranyl acetate, Hydroxy citronellal, linalool, indole and methyl dihydro jasmone. Chemicals like acetaldehyde, benzyl acetate, ethyl acetoacetate, and Ethyl maltol help with fruity sweet scents whereas for a citrusy fragrance, Citronellyl nitrile, Limonene, and Orange oil are common compounds used in many modern perfumes. These compounds are all described in the table above.

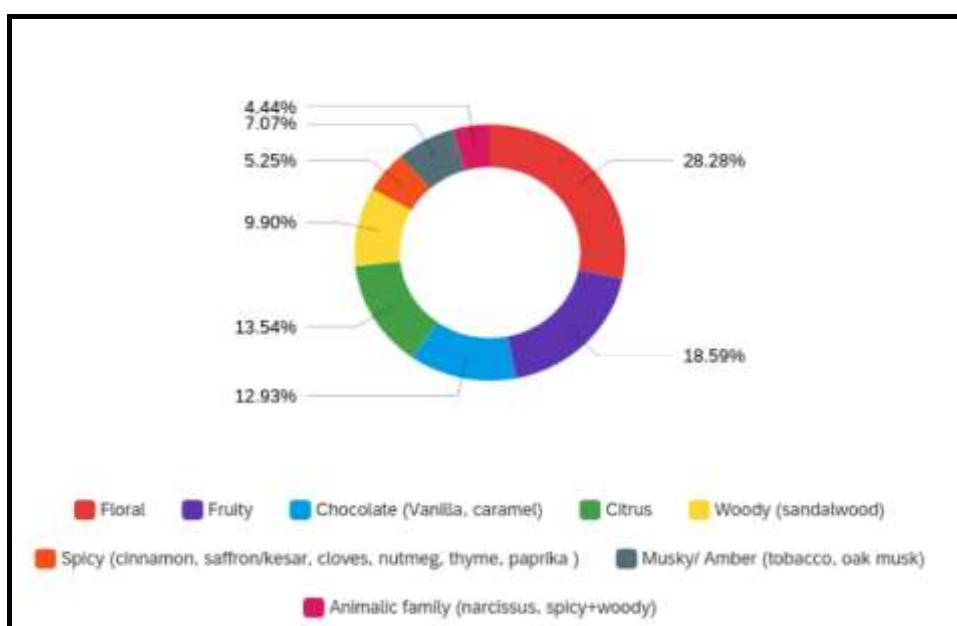


Figure 3: What Fragrance families do females prefer on themselves

When asked about what the odour family is, the results were interesting. Similar to what we had predicted, the choice that is most attractive to women is **Musky/Amber** (tobacco, oak musk) with **22.87%** (86) of the total votes. Second comes **woody** (sandalwood) having **16.76%** (63) votes, and in third place is **Spicy** (cinnamon, saffron, clove, nutmeg, thyme, paprika) having **12.77%** (48). Kephalis (woody- ambery) Benzyl cinnamate, Eugenol (spicy) Benzyl salicylate (musk) Cashmeran, Myrcene (spicy) Dihydro pentamethyl indanone, Iso E super (woody) are some popular ingredients with these characteristic scents. From the results of our survey, what females consider first while purchasing a perfume is their preferred fragrance followed by the quality of a perfume.

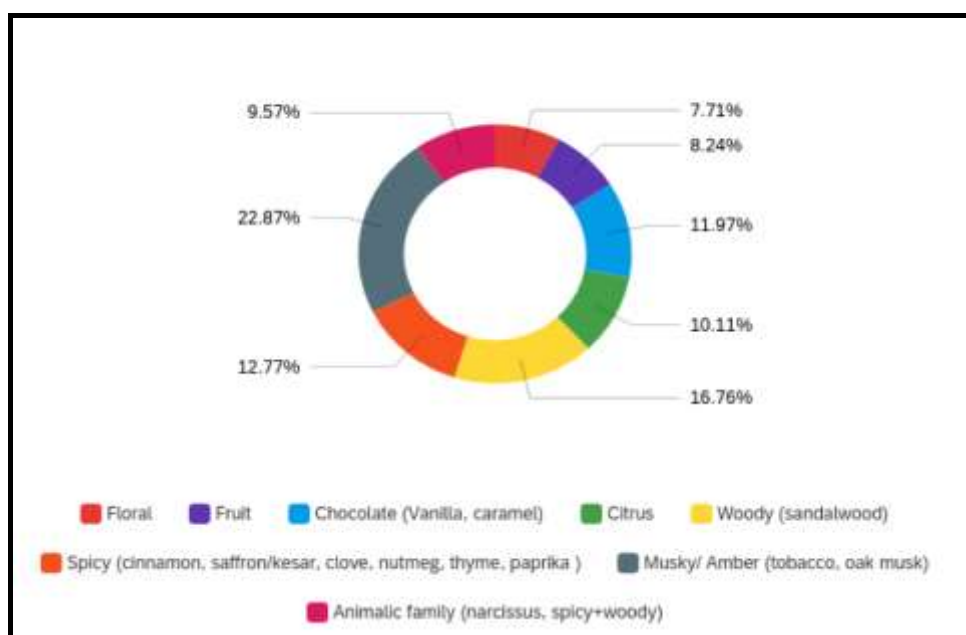


Figure 4: What Fragrance families do females prefer on the opposite sex

B. Males:

Out of 400 true responses, 191 were from males. 148 of them were in the age range of 18-30 and 166 resided in India. 107 (56.02%) of them like and use perfume, 68 (35.60%) chose occasionally and 16 (8.38%) of them don't. Out of 171, 163 which is a majority, use perfume from 1-3 times a day. When asked what perfume they prefer on themselves, to our surprise, the **floral** family was again the most popular choice with **21.08%** (78) votes, then a tie between **fruity** and **woody** families with **14.05%** (52 each). Then **Citrus** with **12.16%** (45) votes. The family of Musky/ Amber and Chocolate was also close with 11.89 (44 votes each). In the Floral family, **lavender** got the most votes (29.03%, 36) followed by **rose** (26.61%, 33) and then **jasmine** (22.58%, 28). Within the fruity family, **Exotic fruits** (35.00 %, 28) and **Strawberries and berries** (30.00%, 24) got the most votes. **Lemon** in the citrus family got 46.27% (31) of votes.

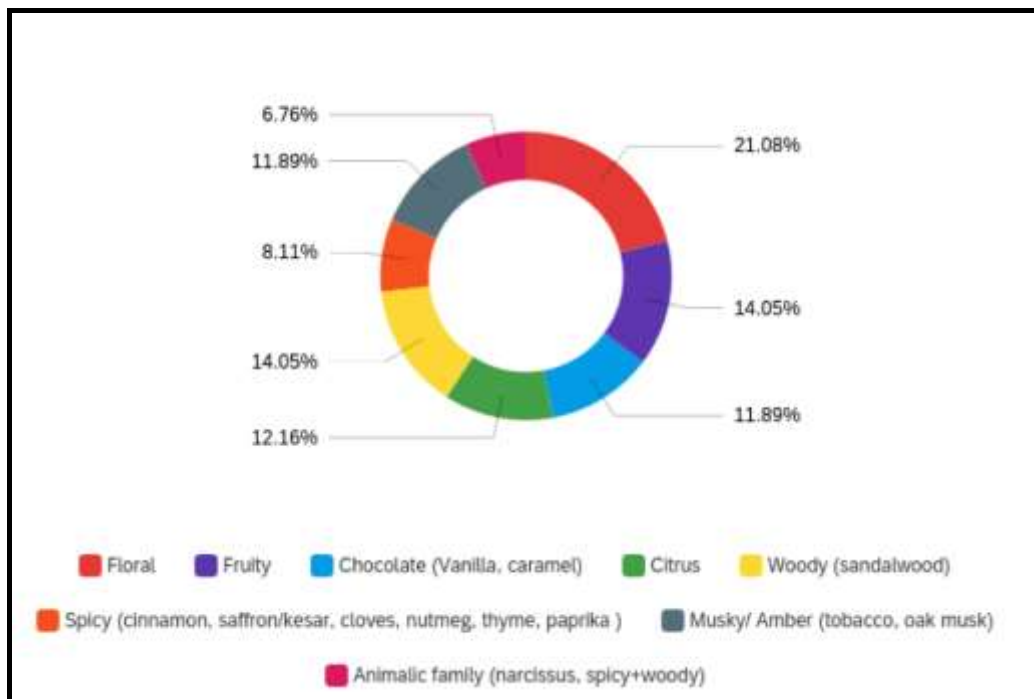


Figure 5: What Fragrance families do males prefer on themselves

For the question of what they like about the opposite sex, they preferred floral, fruity and sweet odours. The **floral** family got (26.67%, 96) – rose (30.11%, 53), lavender (28.41%, 50) and jasmine (23.30%, 41), then was **fruity** (18.06%, 65) – berries (36.84%, 42) and Exotic fruits (34.21%, 39), and third was **Chocolate** (vanilla, caramel) (15.83%, 57). For men too, fragrance is the most important factor when it comes to purchasing a perfume. Brand, quality and price are secondary. Paco Rabanne and Dior are some of the men’s favourite brands of perfumes.

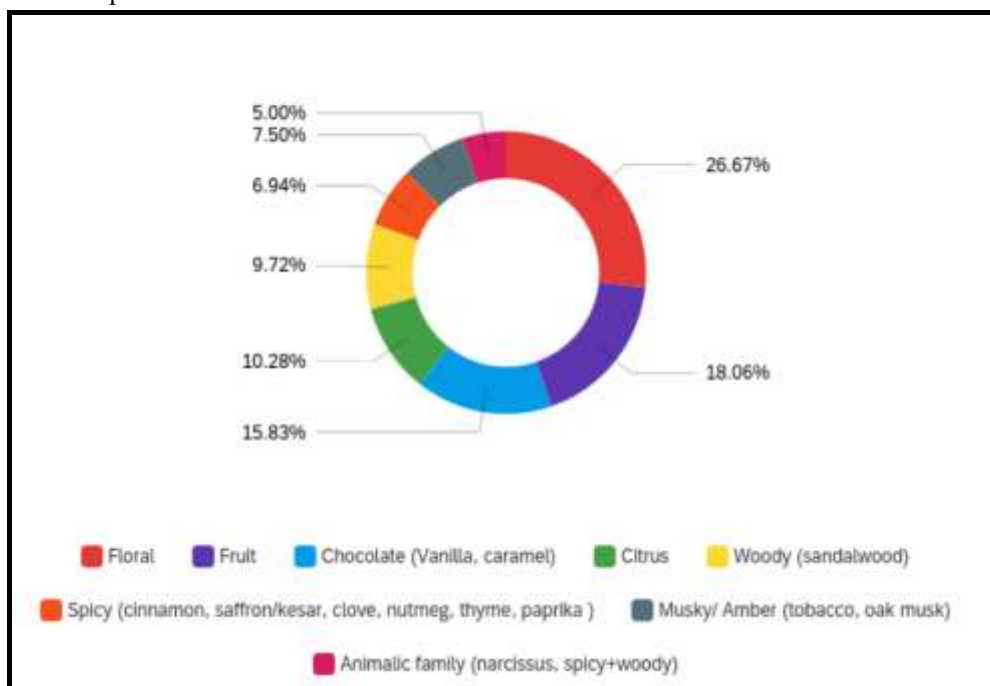


Figure 6: What Fragrance families do males prefer on the opposite sex



During the time of Covid-19, the use of perfume by the majority of our survey takers (male and female) has decreased drastically for 69.30 % of our respondents as shown in the figure below.

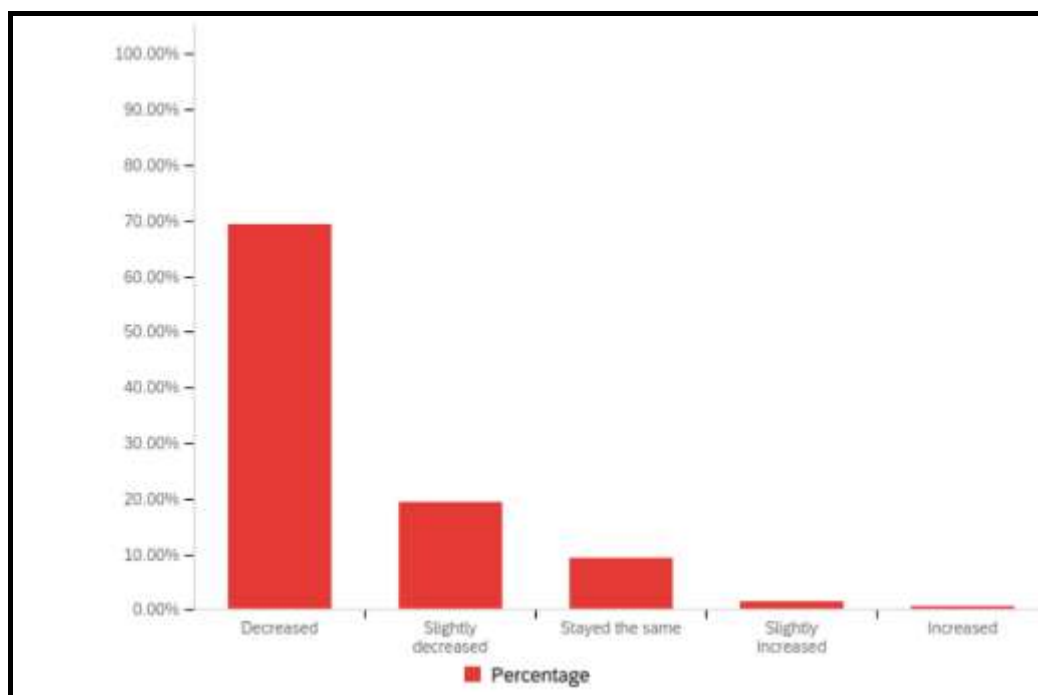


Figure 7: Decrease in the usage of perfume during the global pandemic.

INTERNAL DATA VALIDATION

The data were analysed for internal consistency with the use of Cronbach’s Alpha which was found to be 0.854, an acceptable range as described by Archer et al. (2015). While the result obtained with the application of the Spearman-Brown Equation produced a value of 0.798 to present the reliability of the data in terms of its repeatability.

Interview Analysis:

The interviews were thematically categorised into 3 themes and were classified based on gender responses (as described in Table 2). Common choices made by males and females resonate with the outcomes quantitatively obtained. Even the results addressing changes in the usage of perfumes due to COVID-19 validate the results from the survey.

Table 2: Thematically categorize responses from interviews

Male			Female		
Odour families, prefer on themselves	Odour families, find appealing to the opposite sex	Change in the frequency of usage of perfume due to COVID-19?	Odour families, prefer on themselves	Odour families, find appealing to the opposite sex	Change in the frequency of usage of perfume due to COVID-19?
Woody, musk, Jasmine (animalic)	Floral (sweet), Fruity (strawberry)	Slightly decreased	Floral (like rose), Chocolate, fruity	Musk (hot, amber), Woody, Animalic, Spicy (cinnamon, ginger-like)	Decreased



Spicy (cinnamon-like), Floral and Citrus	Vanilla, floral (like a rose), sweet musk	Stayed the same	Floral (all kinds), sweet citrus, fruity (like pineapple or strawberry)	Musk, Floral (harsh), Citrus, Woody, Animalic	Decreased
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Sarthak Jain and Somiwon Modi conducted the interviews on the 10th of March 2022. Amongst the interviewees, 50% of them were men and the other half were females. These individuals have never seen, filled or been given access to our research survey or its results. We conducted these interviews to verify the data that was collected by our survey as well as to add authenticity to our research.

After the interviews, we averaged out all the responses from the survey and the interviews. We then compared the data and, to our delight, we discovered their replies were mostly corresponding to the data collected by our survey responses. Hence this shows that the data collected by our survey and its analysis is reliable. Getting the same reactions from the interviewees and the people who filled out our form supports the fact that our results are viable and trustworthy.

A question to neuroscientists: Scope for future research

It is quite evident that we as humans wear perfumes to firstly smell nice, showcase confidence and highlight individuality. Familiar scents can trigger and bring back memories of certain times. Perfumes and scents also make you attractive to others by acting as an aphrodisiac.

What we want to know, for further research, is that,

- Are there certain aromas or chemical compounds that trigger a part of the brains of males and females?
- How can certain chemical compounds used in perfumery bring out such an excitation?
- Why do females prefer to wear floral and fruity scents on themselves while preferring a rather musky, woody or spicy scent on the opposite sex? Males too like to use floral notes on themselves along with woody and citrus notes but are attracted towards floral, fruity and sweet chocolate and vanilla notes.

From our survey, quite several males chose 'Dior Sauvage'; '1 Million' and 'Invictus' by Paco Rabanne as the perfume they are currently using. 'Dior Sauvage' is a best seller for males in France, it contains compounds such as ambroxan and Hedione, giving a mix of spicy, musky citrus and warm floral notes. '1 million' is a spicy and woody fragrance. 'Invictus' is woody and aquatic with citrus and Hedione jasmine as middle notes and a woody base. Most women find these perfume scents quite alluring. Females chose perfumes from brands such as Chanel, Carolina Herrera- Good Girl, and Miss Dior, which are profusely floral, fruity, and sweet smells. Future research concerning these questions is of great scope in the field of neuroscience.

CONCLUSION

To conclude, this paper provides a small glimpse of what and how much goes into creating a perfume that satisfies the nose as well as the brain. The results we got from our self-assessment questionnaire are built on the gender-based preferences of odour families males and females like to wear on themselves as well as what they like on the opposite sex. Based on our data, many Women like to use floral, fruity and citrus fragrance families on themselves and are mostly drawn towards men who wear musky, woody and spicy perfumes. Men too like to use floral scents on themselves followed by woody, fruity and citrus notes. They are fond of women wearing sweeter floral, fruity, cocoa, and vanilla scents. It is also seen that the scent of lavender along with jasmine and rose is greatly admired by both genders. Fragrances that contain aromas of berries like strawberries, blueberries and exotic fruits like melons, peaches, passion fruit, cherries and citrus fruits are also quite popular in modern perfumery. A wide range of factors can be the reason for certain interpretations of fragrances by males and females and we as researchers are keen to find out what they are. As one correctly said, "I don't believe that the perfumer is just a nose, the true perfumer is a human being, mind and a philosopher who tries to express sensibility and who gives it to us to know and to appreciate".

The paper is a report analysis of an empirical social neuroscience finding, that could pave the wave for biological and chemical researchers, in the field of perfumery, to design fragrances based on the neurological pieces of evidence and sociological consideration presented in this paper.



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CONFLICT OF INTERES

The authors declare that there was unified agreement upon the research design, data collection and analysis and that there exist no conflicts concerning this empirical study.

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