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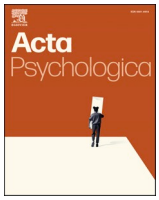
Acta Psychologica 251 (2024) 104643

Contents lists available at ScienceDirect

Acta Psychologica

journal homepage: www.elsevier.com/locate/actpsy



The smell of emotion: How wine tasters' olfactory discrimination abilities are affected by mindfulness and thought suppression, a pilot study

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A B S T R A C T

Measures of emotional response have been linked to sensory stimuli, with many studies reporting an effect of emotional state on sensory perception. However, no study has focused on the association between sensory perception and level of emotional awareness of one's own emotions, ranging from complete awareness to distance from the emotional experience. The objective of this study was to determine how the level of emotional awareness is associated with olfactory discrimination of wines through overall discrimination, and specifically through hedonic and olfactory intensity discrimination. Sixty-one wine connoisseurs were recruited in this pilot study. Differing levels of emotional awareness of one's own emotions were induced by two emotional regulation strategies with antithetical effects: mindfulness and thought suppression. A comparison control group was also tested. Discrimination abilities were measured before and after the emotional manipulation to compare their evolution between the three experimental groups. The results highlight an increase in overall discrimination and olfactory intensity discrimination for the mindfulness group, but a decrease in discrimination via hedonic judgment. Opposite results were observed for the thought suppression group, and no evolution for the control group. This study highlights an association between the tasters' level of emotional awareness of their own emotions and olfactory perception.

1. Introduction

In the brain, there is an overlap between numerous structures involved in emotional response as well as olfactory and taste perception (Veldhuizen, 2010). Furthermore, measures of emotional response linked to sensory stimuli have multiplied in recent decades; various studies have used declarative, physiological, motor, or behavioral measures and focused on simple stimuli which only involved one sense, such as odors (Armstrong et al., 2007; Delplanque et al., 2009), or more complex stimuli such as juice (Danner et al., 2014), or wines (Elali et al., 2023). Numerous works, particularly in the fields of clinical psychology (M'Bailara et al., 2016; Taalman et al., 2017) and olfaction or taste (Dess & Edelheit, 1998), report an effect of interindividual variations in emotional state on participants' sensory capacities and the judgment of products. For example, studies have shown the relationship between depressive symptoms and a reduction in olfactory abilities (Negoias et al., 2010; Pause et al., 2001; Pollatos et al., 2007). Other studies have shown that inducing emotional states modified sensory perception of food stimuli requiring multi-sensory evaluation such as chocolate (Macht et al., 2002) or beer (Desira et al., 2020; Reinoso-Carvalho et al., 2019).

However, to date, there has been no research investigating the relationship between sensory perception and the level of individuals' emotional awareness. This level extends from complete awareness to distance from the emotional experience. According to Boden and Thompson (2015), emotional awareness is a multidimensional construct, including emotional attention to one's own emotional experiences. Garcia-Blanc et al. (2023) define emotional awareness as the capacity to "recognize, understand, and accept own and others' emotions" (p. 135). The present study focuses only on awareness of one's own emotions and does not evaluate awareness of others' emotions. Thus, the way of confronting or, on the contrary, cutting oneself off from one's emotions during sensory stimulation could constitute a factor of individual variability that influences the sensory experience. Changes in emotional awareness levels can be induced by emotion regulation strategies. Emotion regulation has been defined as "the set of processes whereby people seek to redirect the spontaneous flow of their emotions" (Koole, 2009, p. 6). Emotion regulation strategies, such as reappraisal or mindfulness can significantly influence emotional awareness and emotional experience (Herwig et al., 2010). Indeed, according to Koole (2009), emotion regulation may modify emotional states along dimensions such as valence, arousal, and approach/avoidance, with more than 20 different possible strategies. As stated by Koole (2009), emotion regulation may influence several aspects of emotion processing such as

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https://doi.org/10.1016/j.actpsy.2024.104643
Received 11 July 2024; Received in revised form 19 November 2024; Accepted 3 December 2024
Available online 6 December 2024

coherence, intensity, and awareness of the emotional response. Furthermore, individuals who possess strong emotion-regulation skills tend to exhibit a deeper awareness of their emotional states (Barrett et al., 2001; Brown et al., 2007). For example, mindfulness can foster greater emotional awareness (Feldman et al., 2007). Furthermore, by changing one's awareness and linguistic processing of emotions, emotion regulation strategies can alter emotional experience and awareness at the neural level (Saxbe et al., 2013).

Different regulation strategies have various consequences and involve modifications in the activation of different emotional components, such as subjective experience, motor components, and physiological components (Bargh & Williams, 2007; Gross & Thompson, 2007; Reynaud et al., 2012). Among the most commonly used emotion regulation strategies, reappraisal, distraction, mind wandering, mindfulness, or thought suppression can be cited (Hooper et al., 2011; Mc Rae, 2016; Mrazek et al., 2012).

To study the specific effects of different levels of emotional awareness of one's own emotions on sensory perception, it is interesting to focus on antithetical emotion regulation strategies, such as mindfulness and thought suppression. Mindfulness is opposite to suppression, as its goal is "to accept, rather than reflexively act on thoughts and emotions" (Chambers et al., 2009, p. 566). Mindfulness can be defined as an emotional regulation strategy focusing attention and awareness towards all stimuli (internal and external) around the present experience, observing and accepting them without judgment (Knight & Emery, 2022). Erisman and Roemer (2010) present mindfulness as an adaptive regulation of emotional responses, by enhancing awareness and acceptance of emotional experiences, rather than seeking to modify them.

Antithetical to mindfulness, thought suppression can be viewed as an avoidant emotional regulation strategy to control or minimize the behavioral manifestations of an emotion, including the impact of aversive and/or unwanted experiences (Knight & Emery, 2022; Vencatachellum et al., 2021). Indeed, thought suppression is a strategy characterized by the attempt to disconnect from all emotions and sensations. It is an experiential avoidance and inhibition of emotional experiences in contrast to the conscious, non-judgmental nature of mindfulness (Vencatachellum et al., 2021). Thought suppression exercises have been used as a comparison condition in experimental studies on mindfulness, particularly in the context of anxiety regulation and in clinical populations (Eifert & Heffner, 2003; Hooper et al., 2011).

There remains inconsistency in the literature on the specific effects of the two theoretically opposing emotional regulation strategies. While previous studies have tested mindfulness exercises in experimental conditions compared to either a control group (Erisman & Roemer, 2010) or an antithetical comparison group such as thought suppression (Eifert & Heffner, 2003; Hooper et al., 2011; Vencatachellum et al., 2021), few studies have compared the three different conditions in the same study (e.g., Dunn et al., 2009; Knight & Emery, 2022). In addition, a study from Lalot et al. (2014) on the regulation of positive emotions compared mindfulness, suppression, and a control condition. The results showed that mindfulness led to a reduction of positive affect with less valence ratings to video stimuli compared to suppression and the control condition. Furthermore, the mindfulness condition led to less joy expression than the control condition, while the suppression condition led to the least activation of facial expression. This example highlights the interest of having introduced a control group to the protocol, because rather than only highlighting fewer facial expressions of joy for suppression than mindfulness condition, the results also revealed a reduction of those expressions for both groups compared to a control.

As theories postulate that mindfulness training amplifies relevant sensory signals by reallocating attention to the present experience, while attenuating the relative weight given to a priori expectations (Farb et al., 2015), an increase in perceptual abilities would be expected with mindfulness. On the other hand, the opposite effect would be expected with the antithetical strategy, thought suppression. A control group is necessary in order to distinguish the perceptual modifications linked to learning or sensory fatigue from those linked to the emotion regulation strategy.

Moreover, no study to date has presented concordant results between sensory and declarative measures. Only Mahmut et al. (2020) have carried out both types of measurements, finding that the sensory tests performed did not highlight differences between the mindfulness-based training group and the control group, but the self-reports of participants did. This therefore remains to be completed. Apart from rare studies like that of Lefranc et al. (2020), no study has focused on the link between mindfulness and sensory perception. In their study, they did indeed find that higher mindfulness disposition was associated with higher subjective acuity for audition, olfaction, and taste. However, Lefranc et al. (2020) were only interested in participants' predisposition to mindfulness and not in the experience of full awareness during the experiment, or the influence of the connection to emotions on sensory perception specifically.

The organoleptic characteristics of different red wines are a relevant model of sensory stimulation, as this type of stimulus makes it possible to play on fine perceptual differences. Furthermore, wine being shown as both a sensory and an emotional object (Coste et al., 2018; Elali et al., 2023; Oyinseye et al., 2022) seems to be a relevant choice of stimulus for investigating the effects of differing emotional awareness levels on sensory perception. To date, the link between olfactory perception of wines, and more particularly, between olfactory discrimination abilities and the taster's level of emotional awareness of his/her own emotions has never been studied. In sensory studies, discrimination is the ability to detect sensory differences between products and constitutes one of the essential characteristics of sensory perception (De Wijk & Cain, 1994). As discrimination between stimuli can be mediated by differences in intensity and/or quality (ISO 5492, 2009), through discrimination, it is possible to explore several major sub-dimensions of sensory perception, such as hedonic perception or perception of olfactory intensity.

The objective of this study was therefore to determine how the level of emotional awareness of one's own emotions is associated with olfactory discrimination of wines through overall olfactory discrimination, and more specifically through hedonic and intensity discrimination.

Based on previous literature, two hypotheses were developed a priori:

- We expected an effect of emotional regulation strategy on olfactory discrimination skills. Specifically, an improvement in olfactory discrimination was expected for participants most connected to their emotions (regulation through mindfulness), while the opposite effect, a reduction in olfactory discrimination, was expected for participants less connected to their emotions (regulation through thought suppression). No modification was expected for participants on whom no emotional regulation strategy was used (hypothesis 1).
- We expected that participants whose state of emotional awareness had been altered (with mindfulness or thought suppression strategies) would report a modification of their experience after emotion regulation during semi-structured interviews, while participants whose state of emotional awareness had not been modified (i.e., control group) would not report a difference in their experience (hypothesis 2).

2. Material and methods

2.1. Participants

Participants were French-speaking individuals living in the Nouvelle Aquitaine, France area, recruited by phone by a company specialized in consumer studies. Several selection criteria were used to select participants, including:

- consumption of French Bordeaux red wine at least twice a month.

- a minimum score of 5 out of 8 on a wine knowledge questionnaire from Elali et al. (2023). This questionnaire assessed general knowledge about wine, such as grape variety characteristics or wine aromas. It was administered during recruitment by phone.

- a minimum score of 78 out of 195 on the Five Facets Mindfulness Questionnaire (FFMQ, Baer et al., 2006; French version: Heeren et al., 2011), which measures the dispositional trait of mindfulness and was administered by the recruitment company. According to Sezer et al. (2022), trait mindfulness refers to an individual's aptitude for mindfulness, representing inherent levels of mindfulness as a personality trait. This trait shows variability between individuals and is commonly assessed through self-report questionnaires. This minimum cutoff threshold was determined to ensure that participants were receptive to the experience.

- normal subjective sensory perception (without visual, olfactory, taste or somesthesic deficit).

- wine professionals were excluded from the study.

In total, $N = 61$ participants completed the study: 31 men and 30 women. The average age was 46 years ±2 (minimum: 35 years, maximum: 55 years).

The participants were divided into 3 experimental groups balanced according to gender and FFMQ score. A Kruskal-Wallis test revealed that the scores obtained on the FFMQ were comparable between the 3 groups ($K = 0.599(2)$, $p = .741$).

2.1.1. Mindfulness group

$N = 21$ participants (11 men and 10 women) in this group received the "mindfulness" protocol described below to increase their level of emotional awareness. The age range was 35 to 54 years old (mean age ± 95 % confidence interval = 45.8 years ±5.9). The mean score (± 95 % confidence interval) on the FFMQ was 140.2 ± 21.6.

2.1.2. Thought suppression group

The 20 participants (10 men and 10 women) in this group received the "thought suppression" protocol described below to decrease their level of emotional awareness. Ages ranged from 35 to 53 years old (mean age ± 95 % confidence interval = 45.2 years ±5), and the mean score (± 95 % confidence interval) of this group on the FFMQ was 141.1 ± 15.1.

2.1.3. Control group

The 20 participants (10 men and 10 women) in this group were 35 to 55 years old (mean age ± 95 % confidence interval = 46.2 years ±5.4 years). The mean score (± 95 % confidence interval) of this group on the FFMQ was 140.7 ± 13.8. This group followed the "control group" protocol described below, which did not entail to increase or decrease their level of emotional awareness.

2.2. Ethical considerations

For this study, the Local Ethics Committee of the UR4139 Psychology Laboratory issued a notice of compliance with the Code of Ethics for Psychologists (March 1996, updated in February 2012 and September 2021) and the Society's Code of Ethics for French Research of Psychology. Detailed information regarding the experiment was given, including informing participants that the wine evaluation was olfactory, to be assessed by nose only, and an informed consent form was signed by participants before beginning the experiment. All participants received financial compensation (50 euros by check) for their participation and travel expenses. They were able to withdraw from the study at any time without giving a reason.

2.3. Recordings of the protocols

The three recordings were made by a psychologist with knowledge of the different emotional regulation techniques. The recording scripts for the "mindfulness" and "thought suppression" protocols were adapted from the French script used in the study conducted by Vencatachellum et al. (2021). The scripts were adapted to increase the duration of the task from 10 to 15 min, as indicated by various studies as the time necessary to achieve expected effects of mindfulness (Arch & Craske, 2006; Erisman & Roemer, 2010; Lau et al., 2006). The control group listened to a 15-min scientific podcast on the grape vine cycle (Crespy, 1992). All the scripts can be found in supplemental data.

2.4. Procedure

2.4.1. Olfactory discrimination abilities

Six commercial red wines from Bordeaux (France) were selected for the study. The volatile profiles of the wines were determined using Gas Chromatography-Mass Spectrometry analysis coupled with stir-bar extraction to detect olfactory faults (Franc et al., 2009). The concentrations of the different key compounds were below the analytical detection limits for all wines. Five wines were not modified from manufactured commercial quality, while olfactory defects had been added in three other wines (4-ethylphenol, 4-ethylgaiacol, 2–4-6-trichloroanisole), to obtain 8 different wine samples (Table 1).

2.4.1.1. Overall olfactory discrimination: triangle tests. According to Solomon (1990), the triangle test is a psycho-physical task known in the food science field as the most sensitive measurement of discrimination capacities. In order to study the impact of the tasters' state of emotional awareness of their own emotions on their discrimination abilities during tasting, four different triangle tests were set up. During one test, the participant is presented with three sensory samples (wines), two of which are the same, and one of which is different. The purpose of this test is to determine if the two different samples can be distinguished by

Table 1
Triangle test characteristics (PDO: Protected Designation of Origin).

	Triangle test 1	Triangle test 2	Triangle test 3	Triangle test 4
Wine A	2019 wine from the Saint Georges - Saint Emilion PDO	2018 wine from Haut-Médoc PDO with an addition of 300 µg/L of 4-ethylphenol [CAS number 123–07-9] and 30 µg/L of 4-ethylgaiacol [CAS number 2785-89-9] (molecules responsible for the olfactory fault of stables and leather)	2019 wine from the Puisseguin-Saint-Emilion PDO sealed with a technological cork	2020 wine from the Saint Georges - Saint Emilion PDO, first wine of the winery
Wine B	Wine A with 2,4,6-trichloroanisole [CAS number 87–40-1] (molecule responsible for cork taint) at a concentration of 0.4 ng/L	Same wine base as wine A, with an addition of 400 µg/L of 4-ethylphenol and 40 µg/L of 4-ethylgaiacol	Wine A sealed with a natural cork	2020 wine from the Saint Georges - Saint Emilion PDO, second wine of the winery (same winery as wine A, the only difference came from the plot where the grapes were harvested).

the participant. For each participant, each triangle test was presented twice, as in Solomon's (1990) study, to overcome possible biases linked to the order of presentation.

The wines were selected with the help of a professor of oenology at the University of Bordeaux and were practically identical in visual appearance. Pre-tests with a panel of 24 volunteer participants were carried out to ensure that the difference between the chosen stimuli was perceptible, but that the level of discriminability remained moderate. If the task was too easy and tasters had a too high level of correct answers from the start, the scope for development of discrimination abilities between before and after the emotional awareness manipulation would have been reduced.

The test was carried out in accordance with the international standard ISO 4120-2021. The eight wines made 4 pairs and each pair was presented twice to the participants. For each triangle test, the instructions given to the participants were as follows: "For each test, three numbered glasses of wine are offered to you. Smell the three glasses in the order indicated on the sheet. Two are the same, the third is different. For each test, circle the sample number that you perceive to be different. Give an answer in all cases, even if you are not sure".

2.4.1.2. Hedonic olfactory and olfactory intensity discrimination. The same eight wines selected for the triangle tests were also used for the hedonic olfactory and the olfactory intensity discrimination tests. Pre-tests were carried out to ensure that the chosen concentration of olfactory defects added resulted in a decrease in the hedonic rating. It was therefore assumed that it was possible to discriminate wines on the basis of hedonic score. Furthermore, since the addition of two olfactory defects in two of the wines (4-ethylphenol and 4-ethylgaiacol) were made at high concentrations, those wines had a higher aromatic intensity than the others, so it was also assumed that wines were discriminable on the basis of olfactory intensity.

Hedonic assessment was measured using a continuous 10 cm scale for each wine, with the labels "unpleasant" at the left end and "pleasant" at the right end. The instructions were as follows: "Please evaluate the samples presented only by smelling them, in the sequence indicated on the sheet, and indicate to what extent you judge them to be pleasant or unpleasant using the scales below".

Olfactory intensity note was also measured using a continuous 10 cm scale for each wine, with the labels "not intense" at the left end and "intense" at the right end. The instructions were as follows: "Please evaluate the samples presented only by smelling them, in the sequence indicated on the sheet, and indicate to what extent you judge the odors emanating from them to be intense or not very intense using the scales below."

The eight wines were presented all at once in random order so that the participants could compare samples during evaluation.

2.4.2. Experimental design

Participants were randomly assigned to individual 2-h sessions either in the morning (10 AM) or the evening (6 PM) to take part in the experiment. This was due to participant availability and to take into account the ISO 658:2017 standard which highlights that hunger or satiety can influence participants' performance, and that mid-morning and mid-afternoon are therefore the ideal times of day for tasting. At the rate of two sessions per day, the 61 sessions extended over 7 weeks. The room in which the experiment took place was equipped with a non-tinted mirror overlooking another room in which the experimenter was present so that the experimenter would not disturb the participants' concentration and emotional response. For each participant, the protocol followed two stages:

Stage 1: Experimental procedure of olfactory discrimination tests. After the study was explained to participants and informed consent was obtained, an explanation of the different sensory tests to be completed was given to participants. The experimental protocol included the following steps (see Fig. 1):

- Familiarization

In order to familiarize themselves with the different sensory tests, the participants carried out each of the sensory tests once with wines from two different 100 % Cabernet Sauvignon Bag-in-Box®.

- First tasting session

The different sensory tests were performed in the same order for all the participants: overall discrimination, followed by hedonic discrimination, ending with olfactory intensity. For all tests, the order of presentation of the wine samples was randomized for participants within the same experimental group, and this randomized order was kept the same between the experimental groups.

On average, 25 mL of each wine were presented in a standard ISO glass (ISO 3591: 1977). The samples were presented anonymously using a random 3-digit code written on the glasses.

- Listening of the audio recording

Participants were informed that a break would take place between the two tasting sessions, during which they would listen to an audio recording for 15 min:

- Control group: the participants were informed that they were going to listen to a scientific podcast on the grape vine cycle.
- Mindfulness group: the following instruction was given: "You are going to take some time to concentrate on your sensations, emotions, and thoughts. For around fifteen minutes, a recording will guide you to be as attentive as possible to what you feel, to all your sensations, starting with breathing, then your emotions, then your thoughts. The goal is to help you to be as connected as possible to your feelings in the present moment".
- Thought suppression group: the following instruction was given: "You are going to take some time to detach yourself as much as possible from your sensations, emotions, and thoughts. For around fifteen minutes, a recording will guide you to be as detached as possible from your thoughts and feelings, to put all these sensations as far away as possible. The objective is to put your feelings, sensations, emotions at a distance as much as possible, to suppress everything that you may feel".

The recording was broadcast to the participants using a SENNHEISER brand wireless headset, HD 450BT model equipped with an option to cancel surrounding noise. Participants were invited to sit on a sofa and left alone in the room while listening to the recording.

- Second tasting session

After the audio recording was finished, the participants performed the same sensory tests a second time. The order of presentation of the triangle tests and samples was unchanged between the first and second session for each participant to ensure that any changes between the two sessions were not due to an effect of the order of wine sample presentation. Only the 3-digit sample codes for each wine written on the glasses were modified, however participants were not informed that the wine samples and their order of presentation were identical between the two sessions.

Stage 2: Semi-directive interviews. At the end of the experiment, participants were invited to complete a semi-directive interview where they were asked open-ended questions. The objective of these interviews was to verify the effectiveness of the mindfulness and thought suppression protocols and to determine the extent to which their experiences during the study differed between the three groups. The

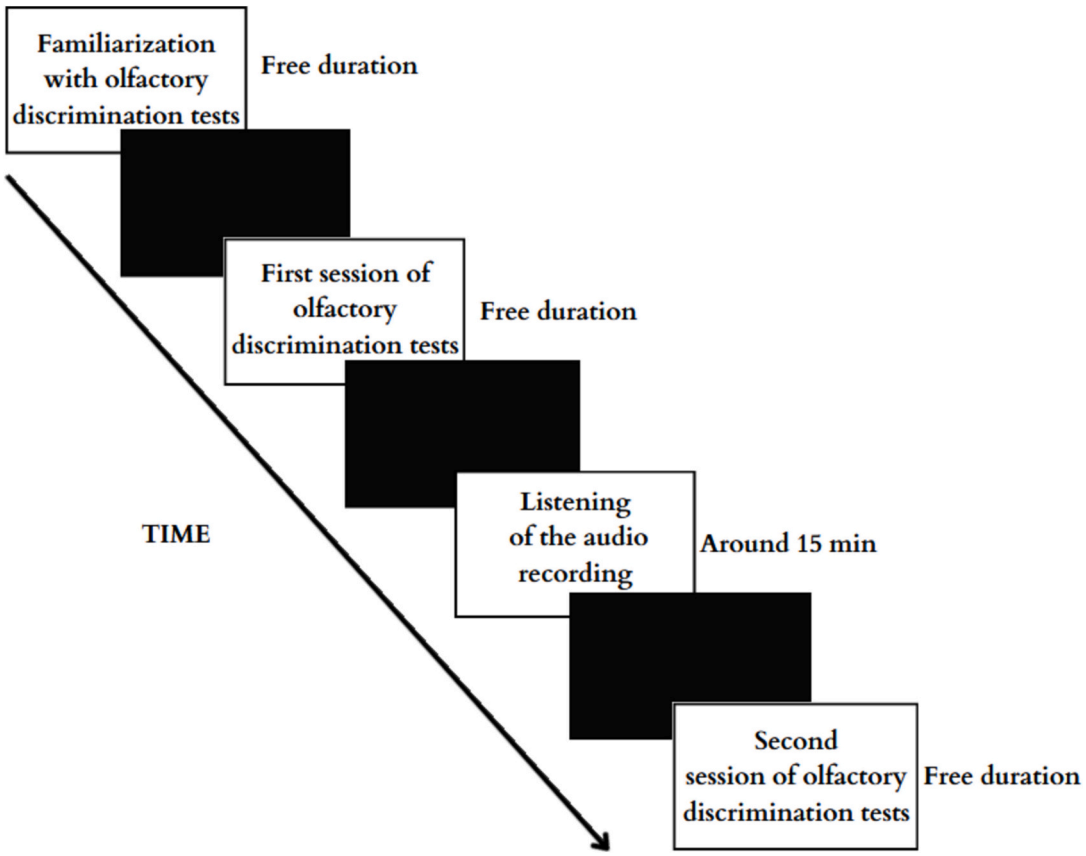

Fig. 1. Schematic representation of stage 1 of the experimental procedure for the olfactory discrimination tests.

interviews were recorded with the informed consent of participants. Response time was free and the questions were the following:

Question 1: What are your general feelings about the experience?

Question 2: To what extent were you able to put into practice the instructions from the recording? (Control group did not receive this question).

Question 3: To what extent did you feel any differences in general between before and after the audio recording?

Question 4: To what extent did you feel more connected or distant from your emotions between before and after the audio recording?

Question 5: To what extent did you feel a difference in your sensory perception between before and after the recording?

2.5. Measures and statistical analysis

2.5.1. Olfactory discrimination test measurements

Quantitative data were analyzed using XLSTAT 2022.3.2 (Addinsoft, Microsoft Excel, Paris, France) software.

2.5.1.1. Triangle tests. Answers were coded in a binary fashion as "single sample correctly identified" (1) or "single sample not identified" (0). The progression of correct answers for each participant was calculated by subtracting the number of correct answers from the first session (ranging from 0 to 8) from the number of correct answers from the second session (ranging from 0 to 8). If the result was positive, the participant's performance improved (progression), if negative, their performance worsened (regression), and if zero, they did not modify their performance.

Z-tests and χ^2 tests were performed to compare proportions of participants in each group whose performance was modified (progression or regression), and participants whose performance was unchanged. Firstly, z-tests were conducted to test for differences in the proportion of participants' performance that was modified (progression or regression) or unchanged within the experimental groups (confident intervals were calculated with the Wilson score). For further comparison, χ^2 tests were conducted to test for significant difference in the proportion of participants whose performance improved, worsened, or unchanged within experimental group.

In addition, for each experimental group, the percentage of correct answers was calculated for session 1 and session 2. For a group of 20, the total number of correct answers could be from 0 to 40 for one session. Analyses were carried out for each triangle test with the sum of correct answers based on the binomial law with B (X, $^1/_3$), X representing the number of trials carried out (H0: no differences between the two tested products) (ISO 4120: 2021). These tests were used to determine whether the participants in each group were able to correctly discriminate wines during the two sessions before and after the audio recording. This approach has been shown to be valid if there are replications (Kunert & Meyners, 1999).

2.5.1.2. Hedonic and olfactory intensity discrimination. The hedonic scores for each wine were measured using a ruler to the nearest tenth of a centimeter, resulting in a continuous score between 0 and 10 for each wine during sessions 1 and 2. As the assumptions for parametric tests were not met, nonparametric Friedman tests were performed for each group to determine if hedonic scores were significantly different among the wines for both sessions 1 and 2 separately. At least one significant difference in hedonic scores would indicate the ability to discriminate wines with hedonic appreciation.

Three scenarios were therefore possible:

- participants rated significantly different levels of pleasantness between the wines using hedonic scores during both sessions, or they did not rate significantly different levels of pleasantness during both

sessions: their abilities to discriminate between wines with hedonic judgment show no change between sessions.
- participants did not rate significantly different levels of pleasantness between wines tasted during the first session but did so during the second session: their abilities to discriminate wines with hedonic judgment show an improvement at the second session.
- participants rated significantly different levels of pleasantness between wines tasted during the first session but did not so during the second session: their abilities to discriminate wines with hedonic judgment show a regression at the second session.

The same approach was applied on olfactory intensity scores (no change, improvement, or regression between the two tasting sessions), with the discriminatory factor being the reported level of intensity of the wines.

2.5.2. Semi-directive interviews measurements

An analysis grid for the debriefing interviews was designed in order to conduct both quantitative and qualitative analyses of the recordings (see Supplemental data).

A nonparametric Friedman test was used as the assumptions for parametric tests were not met, using multiple pairwise comparisons following the Nemenyi procedure to compare the duration of the semi-directive interviews between the groups.

2.5.2.1. Quantitative analysis. The answers to questions 2, 3, and 5 were coded into three categories: "Yes", "No", and "Ambivalent". Responses to question 4 were coded into four categories: "More connected to emotions", "Cut off/disconnected from emotions", "No difference", and "Ambivalent". Answers were considered ambivalent if not clearly subscribing to one answer or presenting conflicting information (see Supplemental data for examples).

For each experimental group, the proportions of the different reponse categories were compared using χ^2 tests, in order to determine whether within each group:

- there was a significant difference in the proportion of participants who succeeded in applying the audio instructions compared to those who did not (except for the control group).
- there was a significant difference between the proportion of participants who experienced differences (general, emotional, sensory) between the two tasting sessions compared to those who did not.
- there was a significant difference between the proportion of responses regarding the nature of the emotional difference felt.

2.5.2.2. Qualitative analysis. A qualitative analysis was carried out as a manipulation check to determine whether the participants' experience during the experiment differed between the three experimental groups. All open responses concerning the general feedback from the study, adherence to the instructions, the nature of perceived differences, and the explanation of these differences between before and after the audio recording were transcribed verbatim into a textual corpus. The corpus was organized by variables created according to the type of responses to the questions asked and by experimental group, for a total of 11 variables in the corpus: *General feedback, Instructions, Nature of general difference, General difference explanation, Nature of emotional difference, Emotional difference explanation, Nature of difference in sensory perception, Difference in sensory perception explanation*, and the three experimental groups (*Mindfulness, Thought suppression, Control*).

The IRaMuTeQ© software (2008–2023 Pierre Ratinaud) was used to analyze the textual corpus for the qualitative analysis. This software provides multidimensional analyses of textual data (Loubère & Ratinaud, 2014). For statistical treatment of the textual corpus, the software identifies "text segments" which are sequences of consecutive occurrences of words (Pélissier, 2017). Next, from the text segments, word occurrences are lemmatized, or linguistically sorted, each word occurrence in the corpus reduced to its root form for analysis. The lemmatization is conducted using dictionaries in the IRaMuTeQ© software (Loubère & Ratinaud, 2014). The IRaMuTeQ© software defines "full" or "active" forms such as lexical content words (e.g., nouns, adjectives, verbs, and adverbs), and function words or "supplementary" forms (e.g., prepositions, articles, auxiliary verbs; Loubère & Ratinaud, 2014). Only "full" or "active" forms were included in the analyses described below, as to have a more specific understanding of the lexical content in the corpus.

The Reinert method (Reinert, 1983) of the IRaMuTeQ© software (2008–2023 Pierre Ratinaud) was used to classify active forms into classes based on clustering of text segments with similar vocabularies, as measured by χ^2 tests of independence (Pélissier, 2017; Vizeu Camargo et al., 2016). Based on this contingency table, the effect size was calculated using Cramér's V. A dendrogram in supplemental data visually presents the results of the Descending Hierarchical Classification (DHC) analysis and χ^2 values represent the degree of association of active forms and the corresponding class (Pélissier, 2017).

An exhaustive list of all active forms with a minimum occurrence of at least five times in the entire corpus and that were clustered in the DHC was first established, resulting in a total of 107 active forms. To further explore the specificity of the three experimental groups, χ^2 tests were carried out to compare the distribution of active forms within the different classes found in the DHC across groups.

3. Results

3.1. Hypothesis 1- modification of olfactory discrimination abilities

3.1.1. Overall olfactory discrimination: triangle tests

There was no significant difference in the proportion of participants whose performance changed (improved or worsened) from the proportion who remained unchanged in the control group ($Z = 0.97$, $p = .33$, 95 % CI [−0.15, 0.55]). On the other hand, the proportion of participants whose performance changed versus unchanged significantly differed in the other two experimental groups, (Mindfulness: $Z = 4.72$, $p < .001$, 95 % CI [0.33, 0.90]; Thought Suppression: $Z = 4.35$, $p < .001$, 95 % CI [0.30, 0.90]; see Fig. 2A). Namely, significantly more participants' performances changed in the two emotional induction groups.

Concerning more specific comparisons within experimental group, there were no significant differences in proportion of participants whose performance was unchanged, improved, or worsened between the two tasting sessions for the control ($\chi^2(2) = 0.6$, $p = .74$) and thought suppression groups ($\chi^2(2) = 2.85$, $p = .24$). On the other hand, a marginally significant difference was observed for the mindfulness group ($\chi^2(2) = 5.57$, $p = .06$), with a higher proportion of participants having improved performance, and a lower proportion of participants not having changed their performance (see Fig. 2B).

Regarding specific performance on the triangle tests, each test having been repeated twice, with $n = 20$ participants for the thought suppression and control groups, and $n = 21$ for the mindfulness group, the number of trials per test for the thought suppression and control groups was 40, with 160 total trials, and 42 for the mindfulness group, with 168 total trials. Participants in the mindfulness group were able to correctly discriminate wines in triangle test 1 during the first and second tasting sessions. They did not discriminate correctly for triangle test 2 during the first tasting session, but did so during the second session. For the third triangle test, participants were not able to correctly discriminate wines during session 1, and a marginally significant difference was observed during the second session. For the fourth triangle test, this group was not able to correctly discriminate wines for either session 1 or 2. Across all the tests, the level of overall discrimination of the mindfulness group for session 1 was more significant at session 2 than session 1 (Table 2).

For the thought suppression group, a marginally significant

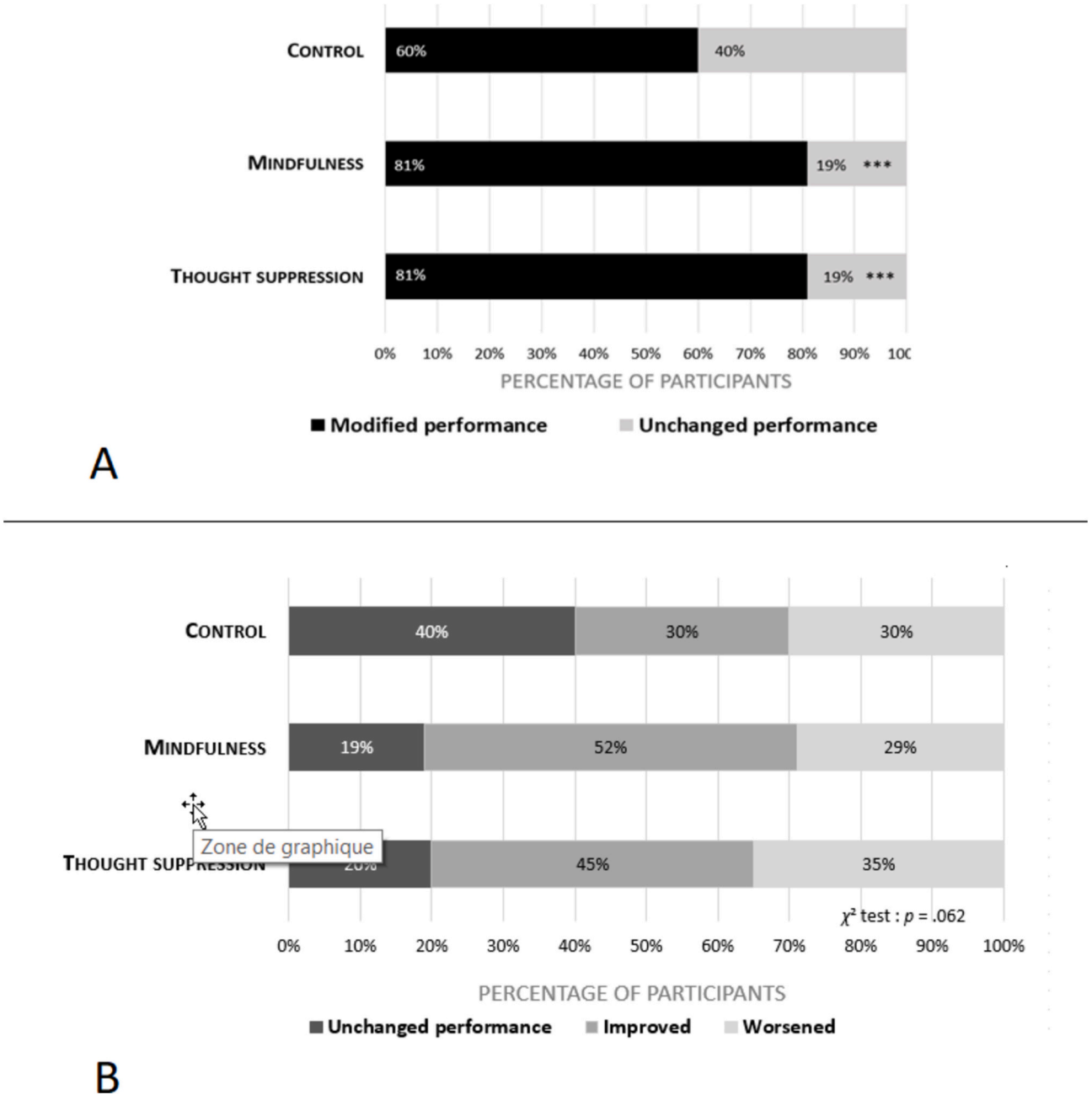

Fig. 2. Evolution of performance on triangle tests by experimental group: (A) whose performance was modified or unchanged; (B) who improved, worsened, or whose performance remained unchanged.
Note: *** $p < .0001$.

difference was observed for discriminatory abilities at session 1 for triangle test 1, but the group did not correctly discriminate during session 2. This group did not correctly discriminate during any of the sessions for triangle tests 2 or 3, and neither at session 1 for triangle test 4. However, they were able to correctly discriminate during session 2 for triangle test 4. Across all the tests, this group did not display correct discriminatory abilities, independent of the session (Table 2).

For the control group, a marginally significant difference was observed during session 1 for triangle test 1, and the participants displayed correct discriminatory abilities during session 2. At both sessions, the control group was not able to correctly discriminate for triangle tests 2, 3, or 4. Overall, the control group did not display any significant discriminatory abilities when all the tests were compiled (Table 2).

3.1.2. *Hedonic discrimination*

A Friedman's test revealed that the mindfulness group was able to discriminate wines with hedonic scores during the first tasting session, ($F(7) = 17.90$, $p = .01$). On the other hand, participants were no longer able to discriminate wines during the second tasting session, ($F(7) = 6.28$, $p = .51$). For the thought suppression group, participants were able to discriminate wines with hedonic scores during the first tasting session, ($F(7) = 22.82$, $p = .002$), and maintained discrimination during the second session ($F(7) = 14.87$, $p = .04$). Lastly, concerning the control group, participants were able to discriminate wines based on hedonic scores during both the first ($F(7) = 18.04$, $p = .01$) and second ($F(7) = 23.06$, $p = .002$) tasting sessions.

Table 2
Percentages of correct answers for overall discrimination during triangle tests by experimental group across both tasting sessions.

		Test 1	Test 2	Test 3	Test 4	Total of the tests
Mindfulness group	Session 1	**48 %**	40 %	36 %	36 %	**41 %**
		***p* = .04**	*p* = .20	*p* = .43	*p* = .43	***p* = .04**
	Session 2	**50 %**	**50 %**	45 %	33 %	**46 %**
		***p* = .02**	***p* = .02**	*p* = .07	*p* = .56	***p* = .001**
Thought suppression group	Session 1	45 %	35 %	30 %	25 %	34 %
		p = .08	p = .47	*p* = .73	*p* = .90	*p* = .49
	Session 2	38 %	33 %	35 %	**48 %**	**38 %**
		p = .34	p = .60	*p* = .47	***p* = .04**	***p* = .12**
Control group	Session 1	45 %	23 %	40 %	28 %	34 %
		p = .08	p = .95	*p* = .23	*p* = .83	*p* = .49
	Session 2	**48 %**	20 %	30 %	33 %	33 %
		***p* = .04**	p = .98	*p* = .73	*p* = .60	*p* = .62

Note. p-values based on the binomial law (X, 1/3). p-values indicated in bold are significant at the < 0.05 level.

3.1.3. *Olfactory intensity discrimination*

For logistical issues, three participants in each group ($n = 9$) did not perform the olfactory intensity test. A Friedman's test revealed that the mindfulness group was not able to discriminate the different wines through olfactory intensity scores during the first tasting session, ($F(7) = 11.60, p = .11$). On the other hand, the mindfulness group was able to discriminate the wines during the second session ($F(7) = 27.74$, $p = .0002$). For the thought suppression group, participants were able to discriminate the different wines using intensity ratings during the first tasting session ($F(7) = 15.00$, $p = .04$). However, this group was no longer able to discriminate the wines in the second tasting session ($F(7) = 9.94, p = .19$). Lastly, the control group was able to discriminate wines both during the first ($F(7) = 18.31$, $p = .01$) and the second ($F(7) = 15.07$, $p = .04$) tasting sessions by olfactory intensity scores.

3.2. *Hypothesis 2 - modification of the lived experience*

The semi-directive interviews lasted from 64 s to 581 s (mean duration ±95 % confidence interval = 209.20 s ± 526.50). The mean duration ±95 % confidence interval was 171.20 s ± 28.70 for control group, 260.50 s ± 53.30 for mindfulness group and 193.50 s ± 43.80 for thought suppression group. A Friedman test and a multiple pairwise comparisons following the Nemenyi procedure showed that the duration of semi-directive interviews was significantly higher for the mindfulness group than for the control group ($F(2) = 8.40$, $p = .02$).

Next, there was a significantly higher proportion of participants who reported successfully following the recording instructions during the experiment than participants who reported failing to follow the instructions, or whose response was ambivalent for both the mindfulness and thought suppression groups (see question 2, Table 3).

For all three experimental groups, the proportion of participants who felt overall differences between the two tasting sessions was higher than those who felt no differences, or whose answer was ambivalent, with at least half of the three groups reporting this (minimum 65.00 %, $n = 13$ in the control group) (see question 3, Table 3).

For the mindfulness group, the proportion of participants who reported feeling more connected to their emotions was significantly higher than that of participants who reported feeling more disconnected from their emotions, who did not feel any differences, and whose response was ambivalent. For the thought suppression group, the proportion of participants who reported feeling more disconnected to their emotions was significantly higher than the proportions of participants who felt more connected to their emotions and whose response was ambivalent. No significant difference was observed between the different responses given by the control group. Three responses were eliminated from this analysis as they could not be categorized according to the coding system (e.g., did not respond directly to the question asked; $n = 2$ from the mindfulness group; $n = 1$ from the control group) (see question 4, Table 3).

For the mindfulness group and the control group, the proportion of participants that noted a difference in sensory perception between the two tasting sessions was higher than those who did not feel any differences, or those whose response was ambivalent. For the thought suppression group however, the proportion of participants that noted a difference in sensory perception between the two tasting sessions was only higher than the proportion of participants whose response was ambivalent (see question 5, Table 3).

Next, concerning the qualitative analysis, the DHC classified 126 text

Table 3
Frequency table of responses to semi-directive interview questions 2, 3, 4 and 5 with χ^2 test results.

		Groups		
		Mindfulness N (%)	Thought suppression N (%)	Control N (%)
Question 2: adherence to instructions	χ^2	11.57 (2) *p* = .003	19.95 (2) *p* < .0001	
	Yes	10 (47.60 %) **a**	14 (70.00 %) **a**	(No question asked)
	No	1 (4.80 %) **b**	1 (5.00 %) **b**	
	Ambivalent	10 (47.60 %) **a**	5 (25.00 %) **b**	
Question 3: overall differences between the two sessions	χ^2	39 (2) *p* < .0001	24.45 (2) *p* < .0001	13.65 (2) *p* = .001
	Yes	18 (85.70 %) **a**	15 (75.00 %) **a**	13 (65.00 %) **a**
	No	2 (9.50 %) **b**	4 (20.00 %) **b**	3 (15.00 %) **b**
	Ambivalent	1 (4.80 %) **b**	1 (5.00 %) **b**	4 (20.00 %) **b**
Question 4: emotional differences between the two sessions	χ^2	31.76 (3) *p* < .0001	26.13 (3) *p* < .0001	6.83 (3) *p* = .077
	More connected	14 (73.7 %) **a**	0 (0 %) **b**	4 (21.1 %) a
	Cut/ disconnected	1 (5.3 %) **b**	13 (65.0 %) **a**	3 (15.8 %) a
	No difference	3 (15.8 %) **b**	5 (25.0 %) ab	9 (47.4 %) a
	Ambivalent	1 (5.3 %) **b**	2 (10.0 %) **b**	3 (15.8 %) a
Question 5: sensory perception differences between the two sessions	χ^2	39 (2) *p* < .0001	11.40 (2) *p* = .003	17.25 (2) *p* = .0002
	Yes	18 (85.70 %) **a**	12 (60.00 %) **a**	13 (68.40 %) **a**
	No	2 (9.50 %) **b**	6 (30.00 %) ab	5 (26.30 %) **b**
	Ambivalent	1 (4.80 %) **b**	2 (10.00 %) **b**	1 (5.30 %) **b**

Different letters marked in bold represent significantly different proportions of active forms between responses within the same group at the 0.05 level (Marascuilo procedure).

segments out of 159 in total, representing 79.25 % of the text segments in the entire corpus. Of these 126 text segments, five classes were distinguished. The dendrogram (see Supplemental data) indicates the active forms most used in the five classes, along with their corresponding χ^2 values. It is important to note that it is possible for an active form to be classified and associated in more than one class (e.g., "emotions" in Class 1 and Class 3), as a class is a cluster of text segments that contain active forms (Pélissier, 2017).

Going down on the hierarchical classification, class 4 constituting 20.6 % of the classified active forms was named **General Feedback**, based on the active forms associated such as "interesting", "nice", "enriching", "curious", "disturbing", and the variable *General experiment feedback*, which was also significantly associated with this class ($\chi^2(1) = 77.69, p < .001$). Next, class 1 containing 14.3 % of classified forms was named **Emotional Task** and included active forms associated with the emotionally-focused experimental task, such as "thoughts", "mind", "exercise", "turn off", "emotions", "breathing", "concentration", as well as two variables, *Instruction* ($\chi^2(1) = 18.53, p < 0{,}001$) and *Explication of emotional difference* ($\chi^2(1) = 5.87, p = .02$). Including 19.8 % of the forms, class 2 was named **Sensory Perception** and consisted of a vocabulary of related active forms such as "hedonic", "note", "intensity", "pleasantness", "triangle", "aversion", as well as three variables, *Nature of sensory perception difference* ($\chi^2(1) = 27.62, p < .001$), *Nature of general difference* ($\chi^2(1) = 6.97, p = .01$), and *Mindfulness Group* ($\chi^2(1) = 6.65, p = .01$). Next, class 3 was named **Emotional Effect** and included 22.2 % of classified active forms that were also related to the emotional task, but more described the emotional effect of the task. For example, terms such as "connected", "discovery", "emotions", "show", "detach", "control" were associated, in addition to two variables *Nature of emotional difference* ($\chi^2(1) = 17.79, p < .001$) and *Control Group* ($\chi^2(1) = 9.68, p = .002$). Lastly, class 5 constituting 23 % of classified active forms was named **Sensory Task** as the associated terms pertained to this part of the experimental procedure, with active forms such as "look for", "objective", "nose", "olfaction", "saturate", "smell", "instruction", "wine". Additionally, two variables were significantly associated with this class, *Explication of sensory perception difference* ($\chi^2 = 7.78(1), p = .01$) and *Explication of general difference* ($\chi^2(1) = 5.79, p = .02$). The variable *Mindfulness Group* displayed a marginally significant association with this class ($\chi^2(1) = 3.00, p = .08$).

Additional χ^2 tests were also conducted in order to compare the frequencies of active forms in each class between the three experimental groups. Then, the frequencies of individual active forms as grouped by the five classes and used by the three experimental groups were found and summed, resulting in the total frequency of active forms by class and experimental group (Table 3). A greater number of active forms was observed for the mindfulness group ($n = 581$) than for the thought suppression group ($n = 480$) and the control group ($n = 503$) ($\chi^2(2) = 7.43, p = .02$, Marascuilo procedure, p-value $\leq .05$).

Despite the small to medium effect size, an overall χ^2 test revealed that the frequency of active forms was dependent on class and experimental group ($\chi^2(8) = 44.23, p < .001$, Cramér's V = 0.12). The thought suppression group employed significantly more active forms of class 1 "emotional task" and fewer active forms of class 2 "sensory perception" than the mindfulness and control groups. The mindfulness group used significantly more active forms of class 5 "sensory task" than the control group. No difference between groups was observed for class 3 "emotional effect after recording" and for class 4 "general feedback on the experience" (Table 4).

4. Discussion

The objective of this study was to determine whether the level of emotional awareness of one's own emotions was associated with olfactory perception of wines through overall sensory discrimination abilities, hedonic appreciation, and olfactory intensity discrimination. The main result of this study highlights an association between the tasters' level of emotional awareness of their own emotions and their olfactory perception for the three discrimination abilities studied.

Hypothesis 1. Modification of olfactory discrimination abilities.

As expected, there was no significant difference in the proportion of participants whose performance changed versus unchanged overall on the discriminatory triangle tests between the two testing sessions in the control group, for whom no emotion regulation strategy was used. A significant improvement was observed for only one of the triangle tests, which could be attributed to a learning effect of the task. Also as expected, no change was observed for discrimination by hedonic appreciation or olfactory intensity in the control group.

Overall discrimination abilities were indeed affected in the two emotional induction groups (mindfulness and thought suppression). For both groups, the proportion of participants whose performance during the triangle tests changed between the two tastings was significantly higher than those whose performance unchanged after the audio recording. In other words, a modification of one's connection to

Table 4
χ^2 test results of frequency of active forms by class and experimental group.

		Group				
		Mindfulness n (%)	Thought suppression n (%)	Control n (%)	Total	χ^2
Class						44.23(8) **p < .001**
Class 1		**75 a**	**96 b**	**42 a**	213	
Emotional Task	% in Class	(35.2 %)	(45.1 %)	(19.7 %)	(100 %)	
	% in Group	(12.9 %)	(20.0 %)	(10.4 %)	(14.5 %)	
Class 2		**151 a**	**78 b**	**96 a**	325	
Sensory Perception	% in Class	(46.5 %)	(24.0 %)	(29.5 %)	(100 %)	
	% in Group	(26.0 %)	(16.3 %)	(23.8 %)	(22.2 %)	
Class 3		**119 b**	112 ab	**121 a**	352	
Emotional Effect	% in Class	(33.8 %)	(31.8 %)	(34.4 %)	(100 %)	
	% in Group	(20.5 %)	(23.3 %)	(30.0 %)	(12,4 %)	
Class 4		62 a	66 a	54 a	182	
General Feedback	% in Class	(34.1 %)	(36.3 %)	(29.7 %)	(100 %)	
	% in Group	(10.7 %)	(13.8 %)	(13.4 %)	(12.4 %)	
Class 5		**174 b**	128 ab	**90 a**	392	
Sensory Task	% in Class	(44.4 %)	(32.7 %)	(23.0 %)	(100 %)	
	% in Group	(29.9 %)	(26.7 %)	(22.3 %)	(26.8 %)	
Total		581	480	403	1464	

Different letters marked in bold represent significantly different proportions of active forms between groups within the same class at the 0.05 level (Marascuilo procedure).

emotions, whether moving closer to them or detaching oneself from them, seemed to induce a modification in the overall olfactory perceptions of the Bordeaux red wines studied.

Even if overall discrimination abilities were modified, the thought suppression strategy did not induce an improvement in overall discrimination abilities that was greater than that observed for the control group. As with the control group, participants in the thought suppression group only significantly increased their performance on one triangle test. Participants in the thought suppression group were still able to discriminate after the audio recording with hedonic appreciation, but less so than during the first tasting session. However, participants in the thought suppression group were no longer able to discriminate wines through olfactory intensity ratings after the audio recording.

The mindfulness group, on the other hand, increased its overall olfactory discrimination abilities between the two tasting sessions, with a significant increase for two triangle tests and the total tests, and a marginally significant increase for one triangle test. In addition, the participants in this group were able to discriminate wines with olfactory intensity during the second session compared to the first session. In a previous study, Mahmut et al. (2020) did not demonstrate a significant effect of mindfulness on the perception of odors and the ability to identify them compared to a control group. However, in their study, the mindfulness exercise consisted of 5-min self-sessions (instead of the 15 min necessary to achieve expected effects of mindfulness according to Arch and Craske (2006), Erisman and Roemer (2010) and Lau et al. (2006)), twice a day outside the laboratory, and the olfactory measurements were carried out by the participants themselves. The authors maintained that the participants reported smelling odors more often in their daily lives after the mindfulness sessions.

Concerning the hedonic evaluation, the mindfulness group in the present study could no longer discriminate the samples using this score, while certain samples nevertheless presented olfactory faults in high concentration. This can be explained by the state of acceptance without judgment induced, an inherent characteristic of mindfulness. These results are indeed consistent with Arch and Craske's (2006) study that demonstrated in the emotional evaluation of stimuli with affective valence, lower negative affect, less emotional lability, and a greater desire to stay in contact with aversive photos in the mindfulness group ("focused breathing") compared to a mind wandering group ("unfocused attention"), and a group that deliberately worried ("worrying group"). The researchers interpreted these results as a more adaptive response to negative stimuli. Other researchers have also hypothesized that mindfulness would increase tolerance for unpleasant emotions and sensations (Eifert & Heffner, 2003; Levitt et al., 2004). On the contrary, with positive stimuli, Papies et al. (2012) found a decrease of the approach reaction during an approach-avoidance task to attractive food stimuli by participants in their mindfulness condition used. The authors explained this as a better control of impulsive responses using mindfulness. This reduction in the avoidance of aversive stimuli and in the approach to attractive stimuli could lead to the observed decrease in hedonic judgment abilities found in the present study.

Hypothesis 2. Modification of the lived experience.

A significantly higher proportion of participants declared having succeeded in following the instructions compared to those who had not succeeded, both for the mindfulness and thought suppression groups, suggesting that the differences observed between the mindfulness and thought suppression groups would not be due to differences in the ability of the two groups to apply the instructions.

Most participants in each of the three groups noticed a general difference between before and after the audio recording, as well as a difference in sensory perception for the control and mindfulness groups. However, the results presented above show that the control group remained relatively consistent in its performance compared to the other groups. This could therefore suggest both a learning effect of the different sensory tasks between the two sessions, and also an effect of suggestion through the open questions asked (e.g., "Did you feel any differences in your sensory perception between the first and second session?").

Regarding the change in emotional awareness after listening to the audio recording, as expected, participants in the thought suppression group most often reported being "disconnected/cut off" from their emotions than "more connected" or than ambivalent answers. In addition, the textual corpus analysis revealed that the thought suppression group used significantly more terms belonging to the "emotional task" class compared to the other two groups, and less terms belonging to the "sensory perception" class in comparison to other groups. A paradoxical effect was therefore observed for the thought suppression group regarding emotions: having to actively think about emotions in order to get rid of them, and the mental work necessary to suppress them, seemed to direct a more active and focused concentration on the emotional content. This is consistent with the literature supporting this "ironic effect" of thought suppression, namely that attempting to divert attention to a response can result in increasing the targeted emotional response (Knight & Emery, 2022). Accepting emotions could lead to their disappearance more quickly, unlike, and paradoxically, trying to suppress them (Wegner, 1994). Participants in the thought suppression group might thus have been more occupied with the active mental work of suppressing emotional content, which may have taken over concentration during the sensory task. This mental work focused on emotions to the detriment of perception could further explain why this is the only group that did not have a higher proportion of participants who reported feeling sensory differences after listening to the audio recording.

As expected, the participants in the mindfulness group were those who reported being "more connected" to their emotions more often than "disconnected/cut off", "no differences", or than an ambivalent answer during the interviews. In addition, the textual corpus analysis showed that the mindfulness group used significantly more terms belonging to the "sensory task" class than the control group. For the mindfulness group, there seemed to be more passive mental work, more accepting of the experience, and therefore more available to concentrate on the sensory content. Mindfulness practice consists of paying attention to all stimuli (internal and external) with acceptance and without judgment (Knight & Emery, 2022). This non-judgmental acceptance of one's emotions by the mindfulness group and greater availability for sensory experience seems to imply a richer lived experience, with a longer duration of the semi-structured interviews for this group than for the control group, and a higher proportion of active forms used in this group than in the other two groups.

Limitations

Mindfulness and thought suppression strategies imply complex interrelated facets such as acceptance, observation, and non-judgment in mindfulness, and thoughts, feelings, and behaviors for thought suppression (Knight & Emery, 2022). Different experimental designs may call upon differing facets of the two strategies, making it difficult to replicate and understand their effects in scientific experiments, as well as taking into consideration interindividual variability in the application of these strategies. The present study being a pilot study, the choice of regulation strategies was based on existing literature. Mindfulness and thought suppression were chosen because they have been proven to have antithetical effects (Vencatachellum et al., 2021), but considering the ironic effect observed for thought suppression, other strategies could have been chosen in opposition to mindfulness, such as mind wandering. This regulation strategy is sometimes used as a control condition in experimental research on mindfulness, as also considered to be antithetical to the latter. It is a passive, unregulated mental state of unfocused attention that consists of letting the mind wander freely, without focusing on specific thoughts (Hooper et al., 2011; Mrazek et al., 2012). Another limitation of this study is that initial discrimination abilities

between groups were unequal. Indeed, at the first tasting session, the performance of the mindfulness group on the triangular tests was already higher than that of the other groups. It would be interesting to reproduce this study by balancing the different groups in terms of sensory abilities.

5. Conclusion and perspectives

No previous study has been conducted in order to understand how a specific individual's emotional state at the moment of sensory stimulation would impact his/her perception. By placing participants in the most ecological conditions possible, this study was able to examine different levels of emotional awareness of one's own emotions by bringing participants closer to or further away from their own emotions, and not by inducing new emotions with a modification of context (e.g., presentation of images, videos, etc.). The major innovative result was to place wine tasters' emotional awareness of their own emotions as a factor of individual variation that could impact olfactory perception. This study placed participants in different experimental conditions which may reflect everyday life states that individuals can put themselves in depending on context, but also depending on their personal propensity to either accept or cut themselves off from their emotions, resulting in different olfactory experiences. The lack of modification in discrimination abilities in the control group makes it possible to attribute the modifications occurring in the other groups to the regulation strategies used. Furthermore, the use of qualitative measurements with semi-structured interviews in addition to quantitative measurements with sensory tests provides further supportive evidence of the observed effects. For this study, the sample size was limited due to practical considerations and because this was a pilot study. This could have reduced the statistical power to detect significant differences. Therefore, it would be both interesting and necessary to reproduce this study with a larger sample of participants to gain better insights of effect sizes.

CRediT authorship contribution statement

Inès Elali: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Katia M'Bailara:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Conceptualization. **Victoria Sanders:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Gilles de Revel:** Resources, Methodology. **Laurent Riquier:** Investigation. **Sophie Tempere:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization.

Funding

This work was supported by La Région Nouvelle-Aquitaine and Le Conseil Interprofessionnel du Vin de Bordeaux.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Sophie Tempere reports financial support was provided by Interprofessional Bordeaux Wine Council. Sophie Tempere reports financial support was provided by Nouvelle-Aquitaine Regional Council. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.actpsy.2024.104643.

Data availability

Data sharing is not applicable to this article. The dataset generated during this research is not publicly accessible due to the privacy and confidentiality commitments made to the study participants.

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