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To cite this article: O.V. Filiptsova, L.V. Gazzavi-Rogozina, I.A. Timoshyna, O.I. Naboka, Ye.V. Dyomina & A.V. Ochkur (2018) The effect of the essential oils of lavender and rosemary on the human short-term memory, *Alexandria Journal of Medicine*, 54:1, 41-44, DOI: [10.1016/j.ajme.2017.05.004](https://doi.org/10.1016/j.ajme.2017.05.004)

To link to this article: <https://doi.org/10.1016/j.ajme.2017.05.004>



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Published online: 17 May 2019.



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## Original Article

# The effect of the essential oils of lavender and rosemary on the human short-term memory



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## ARTICLE INFO

### Article history:

Received 9 November 2016

Revised 31 March 2017

Accepted 7 May 2017

Available online 27 May 2017

### Keywords:

Lavender essential oil

Rosemary essential oil

Short-term memory

Ukraine

## ABSTRACT

The research results of the effect of essential oils on the human short-term image and numerical memory have been described. The study involved 79 secondary school students (34 boys and 45 girls) aged 13 to 17 years, residents of the Ukrainian metropolis. Participants were divided into three groups: the control group, "Lavender" group, in which the lavender essential oil was sprayed, and "Rosemary" group, in which the rosemary essential oil was sprayed. The statistically significant differences in productivity of the short-term memory of the participants of different groups have been found. Therefore, the essential oils of rosemary and lavender have significantly increased the image memory compared to the control. Inhalation of the rosemary essential oil increased the memorization of numbers, and inhalation of the lavender essential oil weakened this process.

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## 1. Introduction

In today's world there are many factors that adversely affect the human mental health. The number of children with the attention deficit hyperactivity disorder has increased, and among adults the cases of Alzheimer's disease have become more frequent. Therefore, not only identification of risk groups by such important characteristics as memory, attention and the response rate, but also the study of the possibilities of their correction are relevant. It is desirable to use natural compounds with a decreased risk of side effects compared to synthetic components of drugs. Considering the current methods of alternative medicine aromatherapy is highly popular and reasonably trustworthy among the professionals. The topicality of studying the effects of essential oils is induced by a number of advantageous points, namely, the relatively high rate of their impact, ease of use, safety and relatively low costs. Essential oils are used for various purposes: skin cleansing and skin tonicity, hair wetting and hair nourishment, wellness massage and psychophysiological effects.<sup>1</sup>

The knowledge of the biological effects of many essential oils was passed on from generation to generation mainly through just observations without scientific evidence. For example, it is considered to be traditional that the essential oils of rosemary and peppermint have the stimulating effect on the central nervous

system, and the essential oils of ylang ylang and lavender, vice versa, exhibit the sedative effect. The current studies, which allow selecting specific combinations of essential oils, are able to explain their biological activity previously perceived *a priori*. Thus, the rosemary essential oil is used in aromatherapy for a relatively long time; however, its effects on the human body, particularly on the nervous system, have not been sufficiently studied. In one study involving 20 healthy volunteers who inhaled the rosemary essential oil the subjective feelings of the participants and objective indicators of the autonomic nervous system (the body temperature, the heart rate, the rate of respiration and blood pressure) were assessed. The electroencephalogram was also taken in the participants of the study. The measurements were performed before, during, and after inhalation of the essential oil. The results demonstrated a significant increase in blood pressure, the heart rate and the rate of respiration after aromatherapy. The volunteers noted that they felt more refreshed. Analysis of EEG also showed the stimulating effects of the rosemary essential oil on the brain wave activity.<sup>2</sup> The similar study was carried out with participation of 20 volunteers who inhaled the lavender essential oil. It was shown that under the action of the oil components there was a decrease in blood pressure, the heart rate and the skin temperature of the subjects. These changes indicated a reduction in the activity of the autonomic nervous system. The self-assessment of mood demonstrated that the participants under study felt more active and relaxed.<sup>3</sup>

Peer review under responsibility of Alexandria University Faculty of Medicine.

<http://dx.doi.org/10.1016/j.ajme.2017.05.004>

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To date, the data on the effect of essential oils of different groups on the human cognitive abilities, in particular memory, have been accumulated. The similar work was carried out in model animals. The effect of two different essential oils of lavender obtained from *Lavandula angustifolia* ssp. *angustifolia* Mill. (Lamiaceae) и *Lavandula hybrida* Rev. (Lamiaceae) on the activity of nervous processes on the background of introduction of scopolamine alkaloid to rodents in the dose of 0.7 mg/kg was studied in male rats of Wistar line to induce the model of dementia. The chronic use (daily for 7 days) of the essential oils of lavender led to the numerous positive effects: manifestations of anxiety significantly decreased, antidepressive effects and improvement of the spatial memory were observed.<sup>4</sup>

The effects of aromatherapy were studied in the elderly, some of them suffered from Alzheimer's disease. The aromatherapy lasted for 28 days. For the experiment the essential oils of rosemary and lemon were used in the morning, while the essential oils of lavender and orange were used in the evening. The results of the study showed a positive effect of the aromatherapy on cognitive indices of the participants of the study.<sup>5</sup> The studies were conducted to assess the effect of 1,8-cineole containing in the rosemary essential oil on the cognitive performance and mood of a person. The study involved 20 healthy volunteers. Before and after the experiment the cognitive indices and the mood change were assessed in points. At the end of the experiment the subjects were taken the venous blood for determining 1,8-cineole in the serum. The results obtained showed that the concentration of 1,8-cineole absorbed into the bloodstream by inhalation of the rosemary essential oil was positively associated with the effectiveness of the tasks proposed. It was also shown that the rosemary essential oil contributed to improvement of the speed and accuracy of task performance. The effect of the essential oil on mood was not particularly noticeable.<sup>6</sup>

Not only the inhalation of essential oils can have a positive impact on memory in human and animals. It was shown in rats that the subchronic administration of the rosemary extract of *Rosmarinus officinalis* L. per os in the dose of 200 mg/kg improved the long-term memory in rodents on the background of introduction of scopolamine alkaloid. The hypothetic mechanism of action, which was the basis of the memory improvement, was the inhibition of acetylcholinesterase in the rat's brain.<sup>7</sup> In another work the effects of different doses of the rosemary extract introduced to male rats of Wistar line (50, 100 and 200 mg/kg/day) within 12 weeks on learning and the spatial memory, as well as on the survival of neurons in the hippocampus (the region of the brain being responsible for transition of the short-term memory into the long-term one, or the so-called consolidation), were studied. According to the results of the study the extract of rosemary in the dose of 100 mg/kg contributed to restoration of the information retrieval from the memory. The effect of the plant extract in higher doses was less pronounced.<sup>8</sup> In the elderly at the age of 75 at the beginning of the study the use of the powder from rosemary dry leaves in different doses affected the memory rate in various ways. The rosemary powder had a positive effect in the lowest dose (750 mg), and it had a negative impact on this process in the highest dose (6000 mg). The conclusion about the positive effects of small chronic doses of rosemary, which were similar to those used in cooking, was made.<sup>9</sup> It is expected that diterpenes contained in rosemary inhibit the death of neurons induced by a number of factors *in vitro* and *in vivo*, thus presenting the therapeutic potential when treating Alzheimer's disease.<sup>10</sup>

There is evidence that preferences to essential oils may be related to gender and ethnicity. Thus, in one study the attractiveness of the essential oil among Hispanic and white secondary

school students was assessed. The results of the study demonstrated that inhalation of the essential oil of orange was associated with happiness in girls. In addition, Hispanic girls considered the odor of the essential oil of orange to be soothing more often than white girls. On the other hand, Latin American males described the odor of peppermint as "energetic" more often than white students.<sup>11</sup>

Ukraine is a multiethnic state.<sup>12–16</sup> As shown by our previous studies, the Ukrainian population is polymorphic by the taste sensitivity<sup>17</sup> and is characterized by a peculiar sexual dimorphism and unique distribution of a number of behavioral characteristics.<sup>18,19</sup> It is expedient to study the possible effects of different factors, in particular the effect of essential oils, on cognitive features of the Ukrainian population previously unstudied in this respect. The aim of the present study was to analyze the effect of the essential oils of lavender and rosemary on characteristics of short-term image and numerical memory of secondary school students living in the modern Ukrainian cities. The oils were selected on the basis of their opposite effects on the central nervous system: the lavender essential oil is a sedative, and the rosemary essential oil is a stimulant.

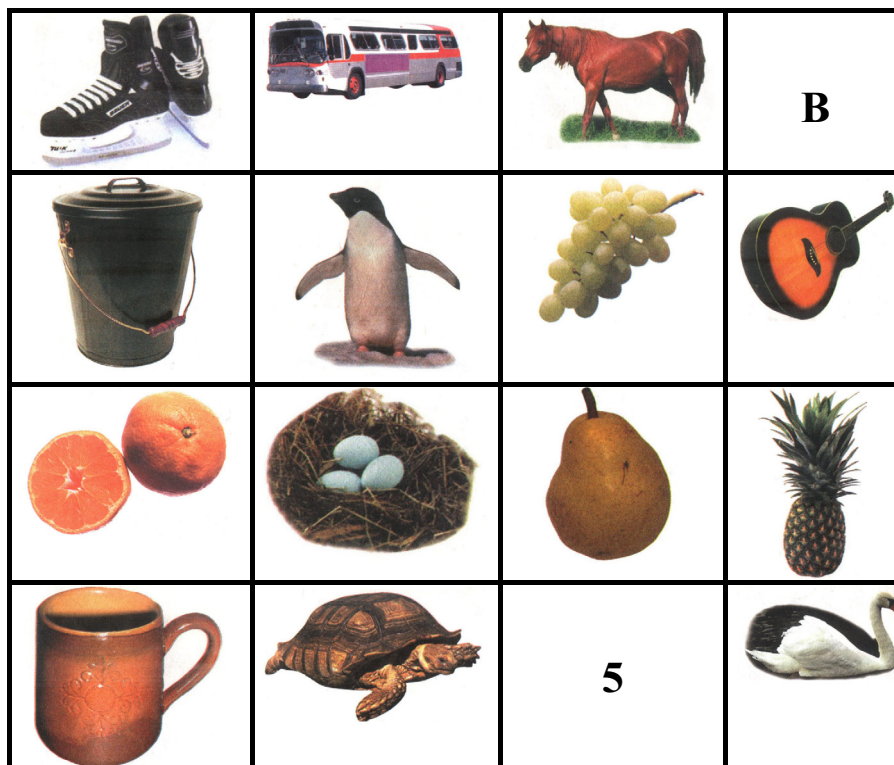
## 2. Materials and methods

The study involved 79 secondary school students (34 boys and 45 girls) aged 13 to 17 years. The volunteers were natives of the city of Kharkiv – the second largest metropolis of Ukraine. All participants of the experiment were divided into three groups. The first group was the control group where the students were not exposed to any essential oils. In the second group ("Lavender") the lavender essential oil was sprayed, and the third group ("Rosemary") inhaled the rosemary essential oil. The total volume of a class, where the study was conducted, was about 120 m.<sup>3</sup> In each of the four corner of the class a standard Petri dish was placed. It was filled at the bottom with a tap water of room temperature in a volume about 15 ml and 10 drops of an essential oil under study was poured in each of the Petri dish. The procedure was made before the participants arrival. The time between pouring the essential oil and the time of experiment was about 10 min, and it was enough for spreading the particles of the oil in the room and obtaining a character odor. All the windows were closed during the experiments to prevent leakage of the essential oil evaporations. The participants of the study were not informed about the presence of aromas of essential oils in the room. The collection of information was conducted taking into account the ethical principles when dealing with a person in accordance with the Declaration of Helsinki. All participants of the experiment gave the written consent to participate in the study, completed the questionnaire, which included a list of issues of the demographic nature, and their cognitive features were tested.

### 2.1. Characteristics of the methods for cognitive studies

#### 2.1.1. The "Memory for images" method

The method is intended to study the short-term image memory. The essence of the method lies in the fact that the subject was shown a table with 16 images for 20 s. The images should be remembered, they should be reproduced in the form for 1 min. The task was to remember as many images as possible for 20 s. In 20 s the table was removed, and the subjects should record the images that they remembered. The test results were assessed by the number of the images correctly reproduced.<sup>20</sup>



2.1.2. The “Memory for numbers” method

The method is intended to assess the short-term visual memory, its volume and accuracy. The task was as follows. For 20 s a person was presented a table with 12 double-digit numbers, which should be remembered, and after the table was removed, the numbers should be recorded in the form. As many numbers as possible should be remembered for 20 s. The short-term visual memory was assessed by the quantity of the numbers correctly reproduced.<sup>20</sup>

23	45	64	38
86	37	15	41
29	14	91	75

Kruskal-Wallis test was used in the work. This statistical criterion is for testing the equality of several samples. Kruskal-Wallis test was highly significant at  $p < 0.05$ . In this case, the characteristics of different experimental groups significantly differ from each other. The median values, lower and upper quartiles were also calculated. The database was formed in the *Microsoft Excel* program. The calculations were made in the *Statistica 6.1* program.

3. Results and discussion

The preliminary analysis showed no statistically significant differences between genders, and it was the reason to combine them in one group. The analysis of the results of the study conducted indicated that the essential oils of rosemary and lavender significantly increased the image memory of the subjects compared to the control. In “Lavender” group the median value of correctly reproducible images was 9, and in “Rosemary” group it was 9.5. The median was 7 in the control group. Despite the fact that participants of “Rosemary” group exceeded participants of “Lavender” group by the median values this difference was not statistically significant (Table 1).

The results obtained were not consistent in a certain way with the studies previously conducted by other authors describing that the essential oil of lavender significantly reduced the efficiency of the short-term memory, the reaction time of memory and attention compared to the control. In contrast, the rosemary essential oil significantly increased the memory efficiency although reduced the memory rate.<sup>21</sup> At the same time, a parallel can be drawn between the results of our study and another work, in which the effect of aromatherapy with the lavender essential oil in relation to the level of anxiety was studied. In particular, the anxiety of patients was studied according to the State-Trait Anxiety Inventory by Spielberger in 2–3 days after coronary artery bypass surgery in a clinic of Iran. After surgery the patients of the experimental group inhaled the lavender essential oil, in the control group distilled water vapors were inhaled. In general, the patients who inhaled the lavender essential oil showed a somewhat lower level of anxiety than the patients in the control group, but these differences were not statistically significant.<sup>22</sup> Therefore, presumably the lavender essential oil had no significant inhibitory effect on the processes in the brain, which could result in reducing the short-term memory effectiveness. It can be assumed that the insignificant effect in reduction of anxiety could even have a

**Table 1**  
The median value of correctly reproducible images and comparison of p-values according to Kruskal-Wallis test in different groups (n = 79).

Group	Lower quartile	The median value of correctly reproducible images	Upper quartile
Control	5	7	9
“Lavender”	8	9	12
“Rosemary”	8	9.5	11
p-Values according to Kruskal-Wallis test			
Groups	Control	“Lavender”	“Rosemary”
Control	–	0.00049	0.003516
“Lavender”	0.00049	–	1.000000
“Rosemary”	0.003516	1.000000	–



**Table 2**

The median value of correctly reproducible numbers and comparison of p-values according to Kruskal-Wallis test in different groups (n = 79).

Group	Lower quartile	The median value of correctly reproducible numbers	Upper quartile
Control	4	6	7
"Lavender"	3	5	7
"Rosemary"	5	7	9

p-Values according to Kruskal-Wallis test			
Groups	Control	"Lavender"	"Rosemary"
Control	–	0.389582	0.273372
"Lavender"	0.389582	–	0.007676
"Rosemary"	0.273372	0.007676	–

positive impact on the perception of information by secondary school students and its processing. In fact, the sedative, anxiolytic effects of the lavender essential oil, as well as its ability to stabilize mood were described. Thus, it can be used in therapy of nervous diseases.<sup>23</sup>

Between the control and experimental groups there was no statistically significant difference in reproduction of numbers in the numerical memory. However, the statistically significant difference was found between "Rosemary" group and "Lavender" group. The median value of correctly reproducible numbers was 5 in "Lavender" group, and it was 7 in "Rosemary" group. For comparison, it should be noted that the median value was 6 in the control group (Table 2). Therefore, when inhaling the lavender essential oil the productivity of numerical memory significantly decreased compared to the results of "Rosemary" group. It is consistent with the fact that lavender is traditionally considered as a sedative essential oil, and rosemary, on the contrary, is a stimulant.

In the study by other authors the effect of the aromatherapy with ylang ylang (sedative) and peppermint (stimulant) on memory was anticipated: inhalation of the essential oil of peppermint improved memory; ylang-ylang worsened it, and in addition, contributed to the increase in time of processing the information. At the same time, in relation to subjective feelings the essential oil of peppermint increased the alert state of the body, while the essential oil of ylang ylang decreased it, as well as led to a pronounced sense of calm.<sup>24</sup>

However, it should be noted that effects of essential oils on the human behavior may be rather unexpected. For example, it was shown that in the presence of the sprayed lavender essential oil the level of trust of a person toward other people increased. In contrast, when inhaling the essential oil of peppermint people became less trusting, and in a role play they were willing to entrust money to strangers less readily. Such studies are important for the potential impact on the consumer behavior, negotiations, and conclusion of transactions.<sup>25</sup> In regards to the effect of essential oils on the cognitive abilities, and, in particular, on memory, the currently existing scientific data can be also supplemented in the near future.

#### 4. Conclusions

Despite the fact that in the world literature the fragmentary research of the relationship of essential oils with the characteristics of the human behavior is known the population of Ukraine remains unstudied up to the present moment. The results obtained complete the information about the effects of essential oils on the human short-term memory and contribute to the study of possibilities for correction of the short-term image and numerical memory. Tests identifying the effect of the essential oils of rosemary and lavender on the cognitive features of students and the results obtained in our study have demonstrated that there are statistically significant differences between the values of the short-term memory of the par-

ticipants of different groups, namely: the essential oils of rosemary and lavender have a statistically significant increase of the image memory of the participants of the study compared to the control. In relation to the short-term numerical memory in "Rosemary" group and "Lavender" group the statistically significant difference has been also found. The results of our studies complete the currently known information concerning the effect of essential oils on the expression of the human cognitive functions.

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