

## The Role of Sense of Smell in Learning and the Effects of Aroma in Cognitive Learning

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**Abstract:** In this study, the role and the importance of the sense of smell were discussed and in the context of the sense of smell, the effects of lemon essential oil aroma on students' attention level, cognitive learning and memory were studied. The study was carried out in English lessons on fifty eight 4th grade primary school students, 29 of which were in experimental group and 29 of which were in control group. The experiment lasted two months. During the experiment, lessons were performed in a classroom atmosphere given lemon aroma in experimental group, while lessons were performed in normal classroom atmosphere in control group. In the research, pre-post test method, independent samples t test and paired samples t test were used. Data gathered from the research, showed that the lemon essential oil aroma increases students' attention level, enhances memory and relating to these it has positive effects on cognitive learning. These results showed that the sense of smell and aromatic stimulus, which had been neglected so far due to the effect of visuality, may have more crucial role on cognitive learning. Thereby, in order to ensure more effective cognitive learning, as a support and addition to visual and auditory stimulus in learning period, the role of aromatic stimulus is worth to be investigated.

**Key words:** Sense of smell and cognitive learning, aroma and learning, lemon aroma and cognitive performance

### INTRODUCTION

Although, learning has been subject of educational science and psychology for a long time, today the questions of what is learning at all, its limits, how and in which way it takes place, are still current. In this matter, behaviourists handle learning as a product of environmental conditions apart from the individual and do not consider biologic and cognitive periods of organism. Whereas, cognitivists pointed out the active characteristics of individual who is perceiving, comprehending and whose stimulus are functioning, in learning<sup>[1-3]</sup>. In recent years, especially neuro-physiologic theorists call attention to biologic aspect of learning. As part of this, in learning period roles of the brain and the sense organs that are sensors of the brain, are gaining importance<sup>[4]</sup>. This situation is an important progress on account of understanding learning with all its aspects.

In spite of this progress, studies which have been conducted so far about learning are overshadowed by the visual and auditory senses in great proportion and the roles of the other senses are almost disregarded. This approach delaying the comprehension of learning with all its aspects, is a product of west culture in which mainly visuality is dominant. In the western culture, seeing and hearing are considered as 'higher' senses and the other senses are considered as 'lower' senses, with the influence of some effective scholars such as Aristo,

Darwin, Freud, Arnheim, Condillac and Kant. In 19th and 20th centuries, visual aids such as photograph, cinema, telescope and television have great influence on this view, in the west societies<sup>[5]</sup>. In this period defined as 'rise of visualizm' the sense of smell was overshadowed by culture and wiped away from modern thought field. Howes<sup>[5]</sup> defines this situation as 'invasion of seeing of other senses' roles in giving meaning to the facts.

Another reason of neglecting the sense of smell is; when compared with the visual and auditory senses, there are not enough researches on the sense of smell. Subjective nature of the sense of smell dependent much on individuality and cultural characteristics, wideness of aromatic communication limits and supposition of the sense of smell has low effect on learning are main reasons of this situation<sup>[6-9]</sup>. However, is the sense of smell really inefficient in learning period? Or was it made inefficient after the illumination period? Most probably second one is true. Some old wisdom words about intelligence such as Nose-Wise, Sagacious, Sage, Sapient which were related to the senses of smell and taste in Latin<sup>[5]</sup>, confirms this view. These examples show that before the illumination period, the concepts of intelligence and skill not only were related with seeing and hearing but with the all senses.

Especially in recent years, the studies on the subject of the effect of various herbal aromas on behaviours of the organism show that the sense of smell does not deserve the name lower sense. On the contrary, the

studies and related literature on this subject show that the aromas have significant effects on important learning behaviours such as attention and concentration, perception, memory, communication skill and mood<sup>[6,10-16]</sup>. Actually, the effects of aromas on the human behaviours and the senses have been known from antique Egypt<sup>[17-19]</sup>. However, researching of the effects of these as aromatic stimulus on learning behaviours has been done in recent years due to the reasons mentioned above.

These researches showing the aromatic stimulus may have crucial roles on learning period are encouraging for questioning the available limits. In order to provide progress and improvement on the subject of learning, such kind of alternative researches that break the available stereotypes are inevitable. Since, when we consider the limitless learning capacity of human being and the fact that we only use a small part of this capacity<sup>[4,20]</sup>, the available data on the subject of learning are far from being satisfactory. Therefore, alternative point of views that are free from cultural prejudices against learning, are important in order to understand learning with all its aspects. At this point, this study searching the effect of aromatic stimulus on learning process can be evaluated as an alternative point of view. Along with the visual-auditory stimulus in learning environment, this approach a representation of aromatic stimulus can be named as aromatic learning or aroma- centred learning.

General purpose of this study is in context of the sense of smell to identify the effects of lemon essential oil aroma on cognitive learning. In the direction of this purpose, hypotheses below are determined.

**H<sub>1</sub>:** There is a significant difference between the attention post-test scores of the experimental group who were taught in an atmosphere given lemon essential oil aroma and the control group who were taught in a normal atmosphere.

**H<sub>2</sub>:** There is a significant difference between the cognitive success post-test scores of the experimental group who were taught in an atmosphere given lemon essential oil aroma and the control group who were taught in a normal atmosphere.

**H<sub>3</sub>:** There is a meaningful difference between the resistance test scores of the experimental group who were taught in an atmosphere given lemon essential oil aroma and the control group who were taught in a normal atmosphere.

**METRIALS AND METHODS**

This study carried out by using pre-test and post-test control group model offer an experimental qualification<sup>[21]</sup>.

**Population and sampling:** The population of this study was 342 fourth grade students of Namik Kemal Primary School in Elazig city centre in the second term. And the samples were 58 students sharing similar characteristics and chosen from the population according to neutrality criterion. Chosen by randomly selection, 29 of these students were in the experimental group and the other 29 students were in the control group.

**Choosing the participants:** In this study, in order to provide neutrality while choosing the experimental and control groups, these criterions were taken into consideration; a) students’ third grade general average of success b) first term success averages of English course c) averages of cognitive success pre-test scores.

The scores of students gathered according to these three criterions were analyzed with independent samples t test and illustrated below (Table1-3).

When the three tables are analysed, it can be seen that

**Table 1: Comparison of third grade general success scores of the students in choosing samples**

Groups	N	$\bar{x}$	S	Sd	t	p	r	p
Experimental	29	8.41	1.40					
Control	29	8.48	1.15	56	-0.205	0.839	0.027	0.839

p<0.05

**Table 2: Comparison of first term English course achievement scores of the students in choosing samples**

Groups	N	$\bar{x}$	S	Sd	t	p	r	p
Experimental	29	5.96	1.68					
Control	29	5.90	1.59	56	0.161	0.873	-0.021	0.873

p<0.05

**Table 3: Comparison of cognitive achievement pre-test scores of the students**

Groups	N	$\bar{x}$	S	Sd	t	p	r	p
Experimental	29	3.14	1.13					
Control	29	3.38	1.21	56	-0.788	0.434	0.105	0.434

p<0.05

there is not a significant difference between the scores of students. So it is found that the experimental and control groups are neutral according to the three criterions.

**Date collection tool:** The data in this study gathered through attention and cognitive success tests. For the attention test, ten attention test questions were picked up from a workbook suggested by Ministry of Education for fourth grade students. This draft test was applied as a pilot application to 30 primary school fourth grade students sharing similar characteristics with the samples (pilot application of attention test). At the end of this application two inappropriate questions were taken out and eight-questioned attention test was formed. Statistical data about the attention test is: difficulty of the test:  $P= 0.532$ , reliability coefficient of the test:  $(KR-20) = 0.79$  and standard deviation of the test:  $(S)=3.28$ .

While preparing the cognitive success test, firstly related literature was investigated and with the views of four primary school teachers of English working in separate schools and two English teaching specialists in university, thirty-itemed English cognitive test draft was prepared. This draft test was given as a pre-application to thirty primary school fourth grade students having similar characteristics with the samples (Pilot application of cognitive success test). Then, the test was analysed and ten items were taken out that were inappropriate according to the difficulty of the test and discrimination indices twenty itemed cognitive success test was prepared. Statistical data about the cognitive success test is: difficulty of the test:  $P=0.531$ , reliability coefficient of the test:  $(KR-20) = 0.81$  and standard deviation of the test  $(S)=3.81$ . Item discrimination indices of the test are between  $(r) = 0.76 - 0.37$ ; item difficulty of the test is between  $(p)= 0.66- 0.44$ .

The attention test scores of the students were calculated from eight and the cognitive success test scores of the students were calculated from ten.

**Experiment:** In this study, the aroma extracted from the pure lemon essential oil was used. The reason of choosing this aroma is; it is among the stimulating aromas and its scent is enjoyed and used commonly in Turkish culture. Because there is a close relationship between the aromatic characteristics the individual and the culture<sup>[7,17,22]</sup>. Pure lemon essential oil aroma was preferred that students would not irritated in the study.

In this study, the teachers taught English courses in the same way in the experimental and the control groups. Aim of the research was kept secret so that the views and the expectations of the teacher would not affect the results of the study (the teacher was told that the research was being done on students' eye health). In order to keep the experimental group students from the

same effects, lemon essential oil was given by means of an electrical machine that evaporates the aroma and it was put to a place students could not see. Proportion of the aroma given to the environment is over the recognisability level. This level was tested before the experiment on ten students in the same age that did not take place in the study. The experiment was carried out in the English lessons, two hours in a week. During the research, lessons were performed with visual-auditory stimulus accompanying with lemon aroma in the experimental group while lessons were performed with visual-auditory stimulus under normal conditions in the control group. The same visual-auditory stimuli were used in both groups (over-head projector, cassette player, visual boards, course book etc.). The reason for choosing English lessons for the research is low-level success in English teaching in primary schools in Turkey.

The physical features of the classroom where the experiment was conducted were: Size of the classroom:  $7.25 \times 6.65 \times 3.12m=150.4m^3$ . Heat:  $19.8^{\circ}C- 23.8^{\circ}C$ . Position of the classroom: on the second storey of the school, south-fronted, a door and three windowed.

**Data Analysis:** In this study, in comparing the experimental and the control groups' the attention and the cognitive success test scores independent samples t test was used and paired samples t test and correlation coefficient were used in comparing the attention and the cognitive test scores of the both group within themselves. For meaningfulness level  $p=0.05$  level was used.

**Limitations:**

1. This study is limited with;
  - a) Third grade general cognitive scores
  - b) First term English course scores
  - c) Cognitive success pre-test scores of students who were as neutral criterions while forming experimental and control groups.
2. The results of this study are limited in terms of the changes that may take place in the performance of the teacher resulting from the effect of aroma on him/her.

**Study Design:** The design of the study can be formulated as below:

Group	Experiment	Control
Neutrality	R	R
Pretest	Attention-success	Attention-success
Environment	X	-
Posttest	Attention-success	Attention-Success
Permanency test	Attention-success	Attention-Success
R: Neutrality		
X: Environment with lemon aroma		

RESULTS

**The role of the lemon aroma increasing students' attention level and its contribution to learning:** Attention, approached differently by behaviourists, cognitivists and neuro-physiological theorists is defined as focusing of the conscious on a certain point, concentrating on the available information and a period that gives direction to behaviours. Attention is a period having three basic elements; general condition of alertness, selectivity and concentration<sup>[2,23-25]</sup>. Attention considered mostly as a field of psychology in 20th century is today handled as a mental period affected by socio-psychological and biopsychological factors.

Attention is one of the most critical variables of learning. Attention has crucial role on recording data to memory and on visual focusing and it is an indispensable part of the teaching<sup>[26-30]</sup>. Even, it can be said that attention is a road to learning. Thus, handles the decrease of cognitive performance as a product of the attention process<sup>[31]</sup>. Hinshaw matches the attention problem with school failure<sup>[32]</sup>. Bearing this in mind, for an effective cognitive learning, it is very important to attract students' attention with interesting and attractive stimulus<sup>[26,33]</sup>. This situation is very important in Turkey for the students taught in classrooms having poor physical conditions.

There are many factors distracting students' attention during the day in such classrooms; uncomfortable and congested sitting positions due to the crowded classrooms, lack of oxygen and especially students' encountering with foreign cultures in English lessons. Therefore, teachers should tend to various attention taking strategies and take care of teaching lives being attractive and interesting. What can teachers do

alternatively in the classrooms where visual-auditory stimuli are used commonly? Can we exceed the limits of the senses of seeing and hearing to attract attention? Or are there other alternative stimuli? When it is considered that teachers have to spend majority of their times and energy for attracting attention, the importance of answering these questions can be understood better.

At this point, aromas can be used as alternative and different stimulus. Teachers, in addition to visual-auditory stimulus, can use aromas such as lemon and they can increase students' attention and concentration and turn classrooms into motivation centres<sup>[34]</sup>. Thus, it is known that were used through this purpose and it worked<sup>[34-38]</sup>

In this study, in order to increase the students' attention level, lemon essential oil aroma was used. Findings are showed below.

**The role of lemon aroma in increasing students' attention:** The results of the independent samples t test, applied for comparing experimental and control groups' attention post-test scores, are shown in (Table 4).

When the table 4 is analysed, a significant difference is seen in favour of the experimental group, between the attention post-test scores of the experimental group taught in a classroom atmosphere given lemon aroma and the control group taught in a normal atmosphere ( $t=7.560$ ;  $p<0.05$ ). The average of the attention post-test scores of the experiment group students ( $\bar{x}=7.03$ ) is higher than the control group's score ( $\bar{x}=3.93$ ) and this can be interpreted as lemon aroma is effective in increasing students' attention.

The results of the independent samples t test, applied for comparing attention achievement scores of the experimental and control groups (Table 5).

Table 4: Comparison of students' attention post-test scores

Experimental	N	$\bar{x}$	S	Sd	t	p
Experiment	29	7.03	1.38			
Control	29	3.93	1.73	56	7.560*	0

$p<0.05$

Table 5: Comparison of the students' attention achievement scores

Groups	N	$\bar{x}$	S	Sd	t	p
Experiment	29	5.93	1.44			
Control	29	2.83	1.67	56	7.583*	.000

$p<0.05$

Table 6: Comparison of the attention pre-post test scores of the control group

Control	N	$\bar{x}$	S	Sd	t	pt	r	pr
Pre-test	29	1.14	0.35					
Post test	29	3.93	1.73	28	-8.749*	.000	0.134	.489

$p<0.05$

Table 7: Comparison of the attention pre-post test scores of the experimental group

Experimental	N	$\bar{x}$	S	Sd	t	pt	r	pr
Pre-test	29	1.10	0.31					
Post test	29	7.03	1.37	28	-22.218*	.000	-0.092	.633

$p<0.05$

Table 8: Comparison of the cognitive success post-test scores

Experimental	N	$\bar{x}$	S	Sd	t	p
Experimental	29	6.62	1.92			
Control	29	5.07	1.39	56	3.532*	0.001

p<.05

Table 9: Comparison of cognitive success achievement scores

Groups	N	$\bar{x}$	S	Sd	t	p
Experimental	29	3.48	1.43			
Control	29	1.69	0.93	56	5.662*	.000

p<0.05

Table 10: Comparison of cognitive success pre-post test scores of the control group

Control	N	$\bar{x}$	S	Sd	t	pt	r	pr
Pre-test	29	3.38	0.21					
Post test	29	5.07	1.39	28	-9.786	.000	0.752	.000

p<0.05

Table 11: Comparison of cognitive success pre-post test scores of the experimental group

Experimental	N	$\bar{x}$	S	Sd	t	pt	r	pr
Pre-test	29	3.14	1.13					
Post test	29	6.62	1.92	28	-13.117*	.000	0.671	.000

p<0.05

When the attention achievement scores are analysed, a significant difference is seen in favour of the experimental group, between the attention achievement scores of the experimental group and control group students ( $t=7.583$ ;  $p<0.05$ ). Although students in both groups have close attention level scores at the beginning of the experiment; control group raised the average of the attention achievement score to  $\bar{x}=2.83$  and the experimental group raised this average to  $\bar{x}=5.93$ , at the end of the experiment. This difference shows the effect of the lemon aroma in increasing the attention (Table 5).

The results of the paired samples t test, applied in order to identify the progress of students within their groups in attention level (Table 6 and 7).

When the both Tables are analysed, it is seen that the control group raised the average of attention test scores from 1.14 to 3.93 at the end of the experiment. Here, the level of attention has increased about 3-45 times. This increase can be related to teacher's using visual-auditory stimulus in classroom. However the experimental group students, taught in an environment in which lemon aroma was given, raised the average of the attention test scores from 1.10 to 7.03. Here, the level of attention is increased 6-39 times. In both groups, the same visual-auditory stimuli are used. The 3-45 times increase of the 6-39, that occurred in the experimental group, can be related to the visual-auditory stimuli that are also used in the control group. The remaining increase of 2.94 times seen in the level of attention may have been effected by the lemon essential oil.

These results are in the quality of supporting similar studies showing that lemon essential oil aroma is effective on the behaviours of organisms<sup>[12,13,15]</sup>. Also this study shows parallelism with similar studies showing the effects of various aromas on attention excitement<sup>[14,39,40]</sup>.

It is stated that, lemon aroma decreases the percentage of making mistakes by alerting people, increasing efficiency and performance and it is used in Japan and Russia through this purpose<sup>[41-43]</sup>.

**The role of the lemon aroma in increasing the cognitive success:** The results of the independent samples test applied for comparing cognitive success post-test scores of experimental and control groups are shown in (Table 8).

When the Table 8 is analysed a significant difference is seen in favour of the experimental group, between the cognitive success post-test scores of the experimental group students taught in an atmosphere given lemon essential oil aroma and the control group students taught in a normal atmosphere ( $t=3.532$ ;  $p<0.05$ ). Although students in the both groups had similar cognitive success level at the beginning of the experiment; the control group students raised their average of score to  $\bar{x}=5.07$ , the experimental group students raised this average to 6.62 at the end of the experiment. These different results in favour of the experimental group in cognitive success may be related to lemon aroma. This result supports the information Hudson and Distel<sup>[8]</sup> stated; aromas are cognitive makers.

When the Table 9 is analyzed, a significant difference is seen in favour of the experimental group, between the average of cognitive success achievement scores of the both groups ( $t=5.662$ ;  $p<0.05$ ). The average of the control group is  $\bar{x}=1.69$ , while the average of the experimental group taught in an atmosphere given lemon aroma is  $\bar{x}=3.48$  at the end of the experiment. This difference in favour of the experimental group can be interpreted as the lemon aroma provides more active participation by increasing the students' attention level and cognitive success. As a result students concentrate

Table 12: Comparison of the cognitive success resistance test scores

Groups	N	$\bar{x}$	S	Sd	t	p
Experimental	29	5.86	1.99			
Control	29	4.14	1.60	56	3.630*	.001

P<0.05

Table 13: Comparison of the cognitive success resistance test scores of the experimental group

Experimental	N	$\bar{x}$	S	Sd	t	pt	r	pr
Post-test	29	6.62	1.91					
Resistance test	29	5.86	1.99	28	2.262*	.032	0.574	.001

P<0.05

Table 14: Comparison of the cognitive success resistance test scores of the control group

Control	N	$\bar{x}$	S	Sd	t	pt	r	pr
Post test	29	5.07	1.39					
Resistance test	29	4.14	1.60	28	4.700*	.000	0.753	.000

P<0.05

on lessons better, observe and listen effectively. Since, cognitive side of learning is always connected with attention<sup>[44]</sup>.

When the Table 10 and 11 are analysed, it is seen that difference between the cognitive success scores of the two groups is significant. The control group students raised their average of the cognitive success scores from =3.38 to 5.07 at the end of the experiment, an increase of 1,5 multiples. However, the experimental group students taught in an atmosphere given lemon aroma, raised this average from 3.14 to 6.62, an increase of 2.11 multiple. This result can be interpreted as lemon aroma increases cognitive success level by raising the students' concentration and attention level. These results support the researches of Ceccarelli *et al*<sup>[12]</sup>, who introduced the positive effects of lemon aroma on healthy perception, cognitive performance and memory. The research results are also supports the studies introducing the positive effects of various aromas on cognitive success and their contribution to writing and mathematical skills<sup>[10,45,46]</sup>. These results showing that aromatic messages may have crucial effects on cognitive learning, pointed out the close relationship between perception and aroma<sup>[7]</sup>.

**The role of the lemon aroma in providing permanent learning and supporting memory:** In an effective learning, as much as the speed and quantity of learning, permanency of what is learnt is also important. Permanency in learning is mostly related to memory; learning and memory periods complete each other<sup>[2,20]</sup>. Özden<sup>[20]</sup> states that in order to provide permanent learning, we need to record separately what we learnt to the neo-cortex in the brain. This means recording image, sound, experience and aroma with learning messages to our brain. It is known that music and various visual-auditory images are used in learning period<sup>[47]</sup>. Surveys on this subject shows that aromatic images and experiences are very effective in recording messages

to memory<sup>[6,14,40]</sup>. Bearing this in mind, it may be expected that lemon essential oil can help recording the messages to memory in a more permanent way by increasing students' attention level. Since, according to Erlauer<sup>[29]</sup> and Dorita<sup>[30]</sup>, attention has crucial role in recording messages to memory.

In the study, in order to test the effect of the lemon aroma in learning, an equal format of cognitive success post-test was applied to the experimental and control groups by changing the places of the questions and choices one month after the experiment (cognitive success resistance test).

The scores of this test were subjected to independent samples t test and paired samples t test. The results are shown in the Table 12, 13 and 14.

When the Table 12 is analysed, statistically significant difference is seen in favour of the experimental group, between the cognitive success resistance test scores of the experimental and control groups (t=3.630; p<0.05). At the end of the experiment, when it is remembered that the average of cognitive success post-test scores of the experimental ( $\bar{x}$ =6.62) and control groups ( $\bar{x}$ =5.07), it is seen that the both groups decreased their cognitive success scores. This means that, in both groups, there has been a little forgetting. However, the experimental group decreased their success post-test scores from  $\bar{x}$ =6.62 to  $\bar{x}$  =5.86 (Table 13); the control group decreased this score from  $\bar{x}$ =5.07 to  $\bar{x}$ =4.14 (Table 14). This finding can be interpreted as lemon essential oil aroma supports memory against forgetting. This situation can be connected with the effect of lemon aroma in increasing students' attention level. Since, attention has an important role in recording new data to memory as a defining and deciding factor<sup>[29]</sup>. The results of this research support similar studies showing that various aromas support memory<sup>[11,13,34]</sup>. Another proof showing that aromas support memory is; individuals losing their sense of smell have problems in remembering<sup>[7]</sup>.

## CONCLUSIONS

The summaries of the research results according to the hypotheses are:

**H<sub>1</sub>:** Lemon essential oil aroma is effective in increasing students' attention level.

**H<sub>2</sub>:** Lemon essential oil aroma is effective in increasing cognitive success.

**H<sub>3</sub>:** Lemon essential oil aroma is effective in preventing cognitive learning from forgetting by supporting the memory.

In this study, it is tried to measure the cooperative effect of the lemon essential oil aroma in increasing students' attention level, supporting memory and cognitive learning. The findings show that the lemon essential oil aroma given to the learning environment as an aromatic stimulus is effective in increasing students' cognitive success levels and providing permanency in learning by increasing their attention level. These findings prove that the sense of smell and aromatic stimulus may have more crucial roles in learning period. Depending on the findings of the research, the roles of lemon essential oil aroma can be ranged as; increasing students' attention level by alerting them, increasing cognitive success and supporting memory. These effects of the lemon aroma in learning period can be formulated as below:

Aromatic stimuli (lemon aroma) ? increase in attention level ? much better visual-auditory focusing? total perception= Effective cognitive learning

These effects of lemon essential oil aroma may be related to its stimulating effect and supporting effect on more total healthy perception of students by supporting visual-auditory stimulus in the classrooms. These findings show that lemon aroma is not opponent to visual-auditory stimulus in learning period, rather it may have take role as a complement in supporting visual-auditory stimulus, increasing effectiveness. Since, total perception which is very important in learning is only obtained by working of all together of all the senses. So a rich multi-sensory environment can be formed for cognitive learning by using visual-auditory and aromatic stimulus together in learning environment.

It is more appropriate to evaluate the positive effects of the lemon essential oil aroma on attention, cognitive success and memory in the limits of this study. In order to introduce the positive effects of lemon and other aromas with all aspects, neuro-chemical and neuro-biological study about the effects of aromas on learning and attention centres of brain and on some matters such as

serotonin, endorphin and adrenalin are needed to be carried out. Furthermore, researches about the effects of aromas on the mood, which have important effects on learning behaviours, should be done.

These results should be evaluated as being pioneer and forming background to such studies.

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