The Effect of Olfactory Stimulation on Word Retrieval Performance in Aphasics

Ok-ran Jeong* · Young-Mi Lee**

ABSTRACT

The present study attempted to determine the effect of olfactory stimulation on word retrieval deficit in Korean aphasics. Eleven nonfluent and 9 fluent aphasic patients served as subjects. The 20 subjects' age ranged from 14 to 65 with the mean of 43.0 (SD: 17.6). A neurologist examined them and diagnosed that they had no visual, auditory, and olfactory impairment.

The study consisted of 2 experiments: Experiment I included visual stimulation while experiment II included visual and olfactory stimulation. The subjects were presented with 19 pictures for them to name in the experiment I, whereas they were exposed to the 19 pictures along with the corresponding olfactory stimulus in the experiment II. The 19 items included soy sauce, chilly pepper, Kimchi, chewing gum, cigarette (smoked), soybean paste, lemon, banana, alcohol (wine), apple, fish, vinegar, cuttlefish (dried), milk, rose, sesame oil, melon, coffee, and perfume. The results were as follows: First, olfactory stimulation tended to improve aphasics' word retrieval deficit although the improvement was not statistically significant. Second, the nonfluent aphasics seemed to take more advantage from olfactory stimulation compared to the fluent aphasics. Third, olfactory stimulation (olfactory + visual) did not produce a different naming performance compared to visual stimulation in the pre- and post-test when the pre- and post-test was composed of naming tasks through auditory + visual stimulation. Fourth, the fluent aphasics performed better with unpleasant olfactory stimulus while the nonfluent aphasics performed better with pleasant olfactory stimulus.

Keywords : olfactory stimulation, visual stimulation, word retrieval deficit

1. INTRODUCTION

The most frequently used stimulus in aphasia therapy is visual and auditory combined. Clinician presents a picture or an object with verbal explanations of the target word to prompt the patient. An additional mode of stimulation includes tactile stimulation wherein thepatient touches the object and feels the sensation, which assists

* Dept. of Speech Pathology, Taegu University
** Samsung Medical Center

in naming the object. Finally, olfactory stimulation can be utilized and may act as a strong prompter in his/her word retrieval performance.

The efficacy of olfactory stimulation in aphasia therapy, however, has not been systematically investigated. Thus, it has not been used in an ordinary therapy session. The reasons that olfactory stimulation is not frequently used is that there are many objects with no smell and that preparation of smelly objects is sometimes troublesome.

Each sensory stimulation evokes one's memory but the degree to which it can be facilitated is different. Taste and olfaction are especially strong facilitators of remembrance (Kim et al., 1994). Babies recognize their mothers with smell, and adults can also recognize their spouses and children with smell only (Brownlee & Watson, 1997). In addition, it has been argued the olfaction is one of the most powerful stimulators in memory of certain events, figures, or places which are associated with the specific smell (Kim et al., 1994; Axel, 1995).

Olfaction is one of the most uninvestigated senses in the field of language rehabilitation. Furthermore, the handful of studies conducted thus far had inconclusive results. Vandette (1964) and Smithpeter (1976) found that olfactory stimulation was helpful means of language stimulation in aphasics. On the other hand, Goodglass (1968) demonstrated that there was no difference among stimulus modes.

The present study, therefore, systematically investigated the effects of olfactory stimulation on aphasics' naming performance in the comparative stimulation framework of visual (VIS) stimulation only and visual plus olfactory (VIS + OLF) stimulation. In addition, this study examined the effect of the type of olfactory stimuli (pleasant item vs. unpleasant item) on word retrieval deficit since it has as of yet not been investigated.

The specific research questions to be answered were:

1) Does VIS + OLF stimulation improve aphasics' word retrieval deficit as compared to VIS stimulation only?
2) Does VIS + OLF stimulation produce a different naming performance in fluent versus nonfluent aphasics?
3) Does VIS + OLF stimulation improve aphasics' naming performance if tested by auditory and visual stimulation mode pre- and post-intervention as compared to VIS stimulation only?
4) Does the type of olfactory stimuli (pleasant smell vs. unpleasant smell) produce a different naming performance?

2. METHODS

Subjects

Twenty either in-patients or out-patients with aphasia residing in Taegu

participated in the study. The the subject selection criteria included the following:

First, adult aphasic diagnosed by a neurologist and a certified speech-language pathologist,

Second, chronological age of 65 or under

Third, no structural impairment of visual, auditory, and olfactory organs.

Table 1 shows the individual characteristics of the subjects.

Table 1. Characteristics of the Subjects.

subject	sex	age	etiology	PO (mos)*	hand-edness	education level	occupation	aphasia type
S1	F	65	hemorrhagic CVA**	2	R***	elementary school	farmer	fluent
S2	M	35	TBI****	3	R/L	college	teacher	fluent
S3	M	64	hemorrhagic CVA	0.3	R	elementary school	none	fluent
S4	M	24	TBI	2.5	R	sophomore in college	student	fluent
S5	F	49	TBI	25	R	middle school	business	fluent
S6	M	19	TBI	15	R	3rd yr in high school	student	fluent
S7	M	59	ischemic CVA	2	R	elementary school	laundromat owner	fluent
S8	M	44	ischemic CVA	15	R	high school	business	fluent
S9	M	33	TBI	20	R	high school	business	fluent
S10	M	52	hemorrhagic CVA	2	R	high school	business	nonfluent
S11	F	17	TBI	27	L*****	2nd yr in middle school	student	nonfluent
S12	M	14	TBI	100	R	2nd yr in elementary school	student	nonfluent
S13	M	56	hemorrhagic CVA	1	R	elementary school	engineer	nonfluent
S14	M	52	hemorrhagic CVA	11	R	college	teacher	nonfluent
S15	F	26	hemorrhagic CVA	3	R	college	teacher	nonfluent
S16	M	65	hemorrhagic CVA	4	R	elementary school	doorman	nonfluent
S17	F	56	hemorrhagic CVA	27	R	middle school	none	nonfluent
S18	M	56	hemorrhagic CVA	0.7	R	middle school	engineer	nonfluent
S19	M	53	Ischemic CVA	27	R	college	architect	nonfluent
S20	M	20	TBI	35	R	2nd yr in high school	student	nonfluent

* PO (mos) number of months post-onset ** CVA cerebrovascular accident

*** R right **** TBI traumatic brain injury ***** L left

Materials

The Taegu Aphasia Diagnostic Test (Jeong, 1994) was administered to 20 subjects to classify their aphasia type.

The 19 stimuli used in the VIS + OLF stimulation included soy sauce, chilly

pepper, Kimchi, chewing gum, cigarette (smoked), soybean paste, lemon, banana, alcohol (wine), apple, fish, vinegar, cuttlefish (dried), milk, rose, sesame oil, melon, coffee, perfume. Each stimulus was put in a plastic camera film container so that every stimulus looked the same and was differentiated only by the odor. The 19 items were selected out of 36 preliminary items. Ten examiners strongly agreed that the 19 items were identifiable only by the smell, were picturable, were familiar, and had 3 or fewer number of syllables.

In addition, the 19 stimuli were divided into 2 groups for a later analysis. The first group was pleasant olfactory stimulus (chewing gum, lemon, banana, apple, rose, sesame oil, melon, coffee, perfume) and the other group was unpleasant olfactory stimulus (soy sauce, cigarette, fish, vinegar). Fifty college students participated in the grouping procedures. They answered the survey questions and an 80 % or above agreement on either 'pleasant smell' or 'unpleasant smell' determined the group. The items which did not reach an 80 % level of agreement (chilly pepper, Kimchi, soybean paste, alcohol, cuttlefish, milk) were eliminated in the grouping. Therefore, only 13 items were included in either the pleasant or unpleasant olfactory stimulus category.

Nineteen 20cm X 15cm color picture cards were used in the visual stimulation. The items were the same items used in the VIS + OLF stimulation. The pictures were presented in Appendix B.

Ten 20cm X 15cm color picture cards and 10 auditory stimulation sentences were used as a pre- and post-test (naming). Appendix A shows the 10 sentences. The target words included refrigerator, lighter, fan, towel, newspaper, shoes, glasses, key, wallet, and knife.

Procedures

The study consisted of 2 experimental conditions. The experiment I was visual stimulation and experiment II was visual + olfactory stimulation. The study employed a within-subject design in which each subject participated in the 2 experimental conditions. The time lapse between the 2 experiments was at least 24 hours. Furthermore, the order of the experiments was counterbalanced to rule out the learning effect.

Prior to the experiment, the subject had a trial session with 2 items which were not included in the experiments, cosmetics and muscle-ache reliever (phas). The trial session was completed to ascertain the subjects' comprehension of the experimental procedures and increase the validity of the study.

In experiment I, the experimenter said to the subject "I am going to show you 19 pictures. Then I would like you to name them." The experimenter visually presented the stimulus with no auditory stimulation. The stimulus was eliminated after 30

seconds if the subject did not respond.

In experiment II, the experimenter said to the subject "I am going to show you a picture. At the same time I will give you a film container, and you smell it while you look at the picture, then I would like you to name it." The experimenter showed a picture while presenting the film container which had the smell of the item inside under the subject's nostrils. The next item was presented if the subject did not respond within 30 seconds.

The presentation order of the 19 items (experimental condition) as well as the 10 items used in the pre- and post-test condition (refer to Appendix A) followed random orders that were computer generated. This was to eliminate the probable ordering effect among words.

3. RESULTS

Quantitative Data Analysis

Table 2 shows the raw score of the correct response for each subject.

Table 2. Naming Performance of the Experiment I and Experiment II.

Subjects	Experiment I: VIS Stimulation	Experiment II: VIS+OLF Stimulation
S1	7	10
S2	1	1
S3	5	5
S4	6	6
S5	6	6
S6	16	14
S7	17	18
S8	16	17
S9	0	0
S10	0	0
S11	0	0
S12	0	0
S13	3	12
S14	0	0
S15	4	13
S16	2	1
S17	4	5
S18	0	0
S19	4	1
S20	14	15

The data was subjected to a t-test. Table 3 shows the results. There was a strong tendency that the visual + olfactory stimulation produced improved word retrieval performance although it was not statistically significant.

Table 3. T-test results on Naming Performance in Experiment I (visual stimulation) and Experiment II (visual + olfactory stimulation).

	M	SD	t	sig.
visual stimulation	5.2500	5.8658		
			1.416	.173
vis+olf stimulation	6.2000	6.5018		

A t-test did not show a statistical significance on naming performance as a function of aphasia type (fluent vs. nonfluent). However, it appeared that nonfluent aphasics performed better in visual + olfactory stimulation compared to visual stimulation only.

A 2-way ANOVA failed to prove a statical significance on naming performance pre- and post-test when the pre- and post-test results were elicited by visual + auditory stimulation with 10 items (refer to Appendix A).

A 3-way ANOVA was employed to analyze the type of olfactory stimulus (pleasant vs. unpleasant) had impact on the type of aphasia (fluent vs. nonfluent) and the type of stimulation (vis vs. vis+olf). It showed a statistical significance on naming performance as a function of the type of olfactory stimulus. The results were presented in Table 4. The pleasant olfactory stimulus produced better word retrieval performance in nonfluent aphasics whereas unpleasant olfactory stimulus produced better word retrieval performance in fluent aphasics.

Table 4. The 3-way ANOVA Results on Naming Performance. The variables included the type of olfactory stimulus (pleasant vs. unpleasant), the type of aphasia (fluent vs. nonfluent), and stimulation mode (vis vs. vis+olf).

source	F	sig.
pleasant unpleasant*fluent nonfluent	14.053***	.001
pleasant unpleasant*vis*vis+olf	.281	.602

Inter-observer reliability of the experiments was calculated using the following formula and was 99%; (number of items the 2 inter-observers agreed on / total number of items) X 100.

Qualitative Data Analysis

The data was categorized into 3 groups. The first group consisted of the subjects who produced a prominently higher correct response in Experiment II (vis + olf stimulation). Seven subjects produced higher scores in Experiment II, among whom 3 subjects (S1, S3, and S15) showed remarkably better scores.

Their common characteristics could include the post-onset, etiology, and size of the lesion. They were still in the spontaneous recovery stage. It was advocated that spontaneous recovery took place within 6 months post-onset, especially 2-3 months (Vignolo, 1964; Cutton, 1969; Kertesz, 1977). In addition, they suffered from hemorrhagic CVA and the lesion was relatively focal.

The second group consisted of the subjects who produced a higher correct response in Experiment I. Three subjects (S6, S16, and S19) produced somewhat higher correct response. The difference, however, was negligible unlike in the first group. It was hard to find their common characteristics.

The third group consisted of subjects with no response in Experiment I as well as Experiment II. Five subjects (S10, S11, S12, S14, and S18) did not verbally respond, which, in turn, makes no difference between Experiment I and Experiment II. They showed a large lesion and suffered from global aphasia or near-global aphasia.

4. DISCUSSIONS

Olfaction does not have a large cerebral cortex unlike vision, audition, and taction. Thus, neurologists have not paid much attention to it compared to other senses. However, olfactory stimulation has a strong effect on recalling old memories. The efficacy of olfactory stimulation in language rehabilitation is one of the areas that needs the most investigation. The present study revealed several exciting and interesting results.

Olfactory stimulation showed a strong tendency to produce better performance compared to visual stimulation although it did not reach a statistical significance. However, the number of subjects who participated in the study was relatively small and most patients were severely aphasic and 5 of them did not respond in either experiment. Considering the above facts, the difference between olfactory stimulation and visual stimulation deserves some attention. The present study compared correct response on naming performance. However, reaction time can be a sensitive dependent variable to prove the function of olfactory stimulation. A future study can systematically investigate it.

One may argue that olfactory stimulation employed in this study appears to produce better word retrieval performance because it is bisensory stimulation (visual + olfactory) compared to unisensory stimulation (visual). However, it has been proved that providing multiple sensory stimulation results in information overload and poor language performance in severe aphasics.

It was very interesting that the type of olfactory stimulus (pleasant vs. unpleasant) and the type of aphasia (fluent vs. nonfluent) showed a relationship that nonfluent aphasics performed better with pleasant smells while fluent aphasics performed better with unpleasant smells. It is hard to explain the reason with the present data. In addition, clinicians can use the information when planning a therapy session

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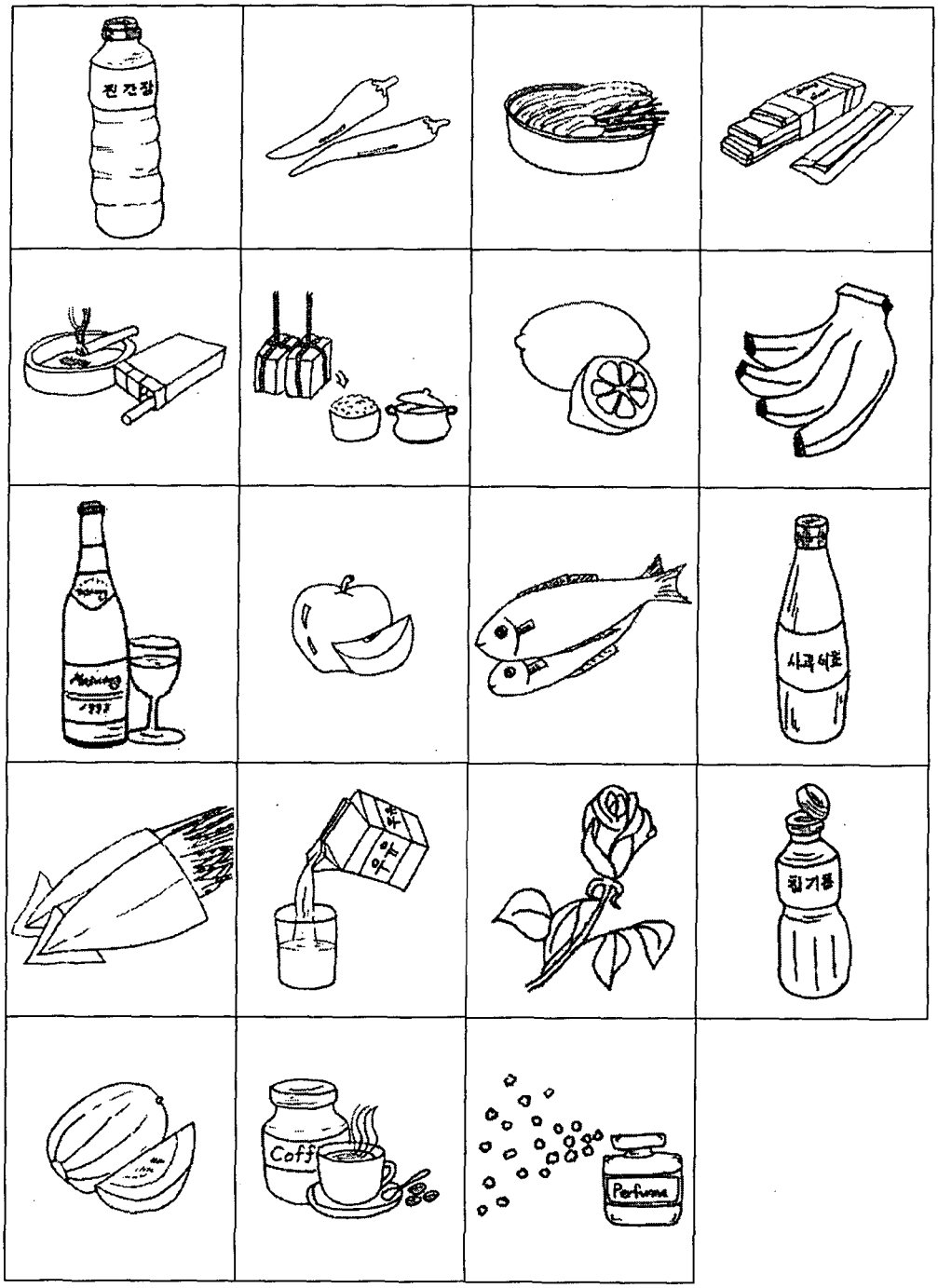
Appendix A. Pre- and Post-test Used. Ten stimulus sentences were presented with the corresponding picture cards.

Stimulus Sentences	Experiment I: visual stimulation		Experiment II: visual + olfactory stimulation	
	pre-test	post-test	pre-test	post-test
Where do you keep food in summer? (refrigirator)				
What do you light the cigarette with? (lighter)				
What do you turn on to get some cool air in a hot summer day? (fan)				
What do you wipe your face with after washing? (towel)				
What do you read to see the news? (newspaper)				
What do you wear on your feet? (shoes)				
What do you wear to see better? (glasses)				
What do you unlock the door with? (key)				
Where do you keep your money or I.D.? (wallet)				
What do you cut fruits with? (knife)				
Total				

Appendix B. The Picture Cards Used in the Visual Stimulation and Visual + Olfactory Stimulation.



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▲ Ok-ran Jeong
Dept. of Speech Pathology
Taegu University
2288 Daemyung-dong Nam-ku
Taegu, 705-033 KOREA
Tel: +82-53-650-8274
e-mail: oj@biho.taegu.ac.kr

▲ Young-Mi Lee
Samsung Medical Center
50 San Ilwon-dong Kangnam-ku
Seoul, 135-710 KOREA
Tel: +82-2-3410-2735
Fax: +82-2-3410-0052