EFFECT ON RESPIRATION, BLOOD PRESSURE AND CAROTID PULSE OF VARIOUS INHALED AND INSUFFLATED VAPORS WHEN STIMULATING ONE CRANIAL NERVE AND VARIOUS COMBINATIONS OF CRANIAL NERVES

III. Olfactory and Trigeminals Stimulated

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III. OLFACTORY AND TRIGEMINALS STIMULATED

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Two problems are undertaken in this report. 1. To determine whether the respiratory and circulatory changes following short inhalations of various vapors in *olfactory* rabbits (trigeminal cut) and in *trigeminal* rabbits (olfactory fibers cut) are to be attributed chiefly to direct stimulation of the olfactory and trigeminal nerves or to—a, humoral-peripheral and humoral-medulla stimulation from absorption of these vapors; b, secondary humoral stimulation due to the cessation of respiration; c, secondary mechanical-vagus stimulation or lack of stimulation due to cessation of respiration. 2. A comparison is made in olfactory and trigeminal rabbits of the respiratory and circulatory changes obtained from inhalations of a large number of odoriferous and irritating vapors.

Literature. Kratschmer, Gourewitsch, Henry and Verdin, Sandmann, Beyer, Seemann, Roger, and Mayer, Magne and Plantefol state that projection or inhalation of an irritant into the nasal cavities causes a marked inhibition or cessation of respiration.

Mayer, Magne and Plantefol (8), working chiefly with halogens and chloro-methyl-carbonates, concluded that in the upper respiratory tract the response to irritants was greater than for odors, and that dogs were less sensitive to these vapors than rabbits.

According to Kratschmer (1) ammonia, carbonic acid, chloroform, tobacco smoke, electrical and mechanical stimulation of the nasal mucosa do not elicit a respiratory response after sectioning the trigeminal roots.

Beyer (5) maintains that the effects of ammonia and acetic acid are stronger on respiration after sectioning the olfactory than after division of the trigeminal. Agreeable odors are said to accelerate respiration and disagreeable to evoke no change. According to Beyer the coal tar products, especially xylol, cause a complete arrest of respiration. This reaction is said to be fully or even more marked with the trigeminal severed. The aromatic and etheral odors are conducted chiefly, if not entirely, by the olfactory nerve.

Kratschmer (1), Beyer (5), Roger (7), and Brodie and Russell (9) obtained circulatory changes from the projection or inhalation of irritants in the nostrils. Kratschmer and Roger always obtained a preliminary drop followed by a rise in blood pressure, but no preliminary drop is shown in their tracing when the vagi are sectioned. Beyer's peppermint tracing also shows a preliminary drop followed by a rise.

Comparison between the action of certain vapors on respiration and circulation in tracheotomized and in non-tracheotomized rabbits. In this experiment it is apparent that the possibility of humoral-peripheral and humoral-medulla stimulation as the result of absorption is readily eliminated by having the animal obtain its ventilation from a tracheal cannula and insufflating the stimulating vapor into the nostrils, using the same general technical procedure described in the first paper of this series. Olfactory rabbits were used and in nearly every case they were obtained by bilateral severance of the naso-ciliary and maxillary nerves, which was shown in the first report to be as effective as severance of the trigeminal root intracranially. Autopsy was always made to ascertain whether these nerves had been sectioned.

A control graph (fig. 1 A) from olfactory rabbit 616 reveals no change in respiration or circulation from insufflating air saturated with water into the nostrils.

The first graph from xylol insufflation (fig. 1 B) obtained from rabbit (616) exhibits a complete suppression and subsequent depression of respiration, a 22 mm. rise in blood pressure, a slowing of the carotid pulse of 3 beats in two seconds, and an increase of 1 mm. in the height of the pulse waves. It required forty seconds after insufflation for respiration and circulation to regain their normal. Two other xylol records demonstrate slightly weaker respiratory and circulatory changes. An ammonia graph discloses respiration greatly suppressed and brought to a standstill, a rise of 19 mm. in blood pressure, a slowing of the pulse 1.5 in two seconds, and a 1 mm. increase in height of the pulse waves during insufflation.

The xylol and ammonia insufflations were repeated in three other olfactory rabbits with like results.

In a fifth olfactory rabbit (no. 621) this experiment was carried one step further by severing the depressors, vagi and cervical sympathetics at the level of the larynx. This should eliminate any secondary humoral or mechanical-peripheral vagus stimulation or lack of stimulation due to cessation of respiration. Under these conditions insufflations of xylol into both nostrils resulted in a cessation of respiration, a rise in blood pressure of 21 mm., a pulse reduction of 1+ wave in two seconds, but without change in the height of the pulse waves.

One benzol record from the above rabbit portrays a decided drop in blood pressure with no subsequent rise.

For comparison with the xylol insufflation record 1 B, the xylol inhala-

tion record 1 C is selected. It is representative of some twenty graphs taken from a number of olfactory rabbits under veronal-sodium in which the vagi and depressors were sectioned. During stimulation figure 1 C reveals respiration at a standstill, a 12 mm. rise in blood pressure, a

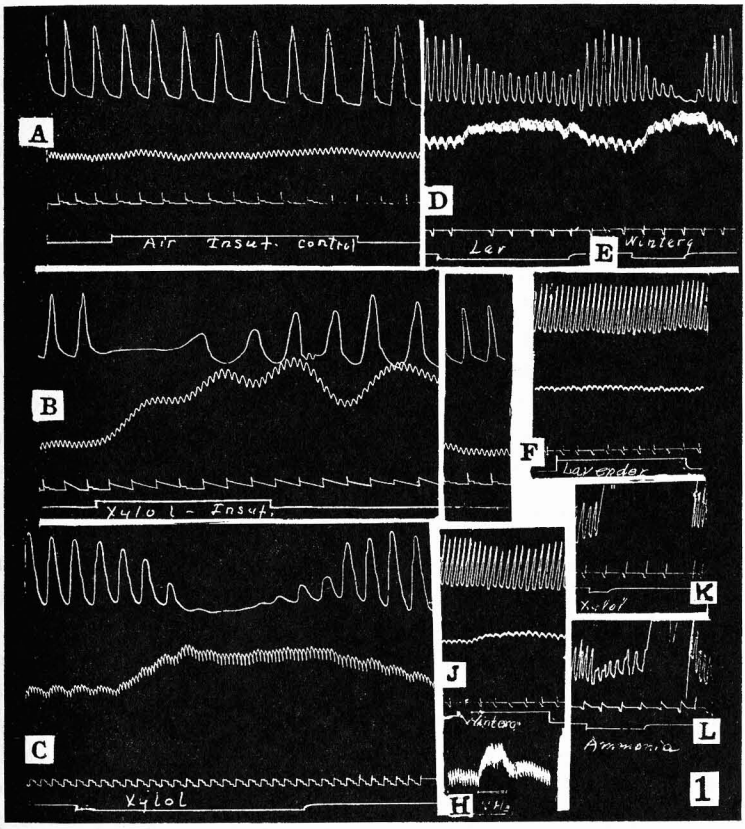

Fig. 1 A and B. Thoracic respiratory and blood pressure tracings, insufflations into the nostrils of a tracheotomized olfactory rabbit, veronal-sodium, time in seconds, space in B represents a one minute interval; C, inhalation-thoracic respiratory and blood pressure tracings, olfactory rabbit, depressors and vagi cut, veronal-sodium, time in seconds; D, E and H, same as C, time in five seconds; H, blood pressure only; K and L, inhalation-thoracic respiratory tracings from olfactory rabbit, no hypnotic, time in five seconds; F and J, inhalation-thoracic respiratory and blood pressure tracings from trigeminal rabbit, veronal-sodium, time in five seconds.

decrease in the rate of the pulse of 1+ in two seconds, and an increase of 2.5 mm. in the height of the pulse waves. Tracings taken during the inhalation of ammonia and acetic acid closely resemble figure 1 C.

Numerous inhalation tracings described in the next section of this paper

from trigeminal rabbits, both before and after double vagotomy, are very similar to the insufflation records described in the first paper of this series, where the animals were tracheotomized and the maxillary branches of the trigeminus were the only functioning, intact, afferent nerves to the nasal mucosa.

COMMENT. It is apparent from a comparison of the insufflation-tracheotomy-vagotomy, respiratory and blood pressure graphs in both olfactory and trigeminal rabbits with similar inhalation-vagotomy graphs that the two are very similar, and that the factors enumerated in the first paragraph of this report take but little part in the general inhalation reactions. The fact that the changes in respiration and circulation are a little more pronounced in the insufflation experiments is probably to be attributed to a higher concentration of the vapors. The writer hopes in the future to be able to explain the cause of the changes in the pulse which take place in figure 1 C and other inhalation graphs after the depressors and vagi have been sectioned.

INHALATION EXPERIMENTS. *Effect of various inhalants on respiration and circulation in normal rabbits.* Thoracic-respiratory and carotid blood pressure tracings were taken from rabbits given two-thirds of a full anesthesia dose of veronal-sodium intravenously and from others not under a hypnotic. The latter were strapped to a board, blindfolded and their ears were plugged with cotton. The respiration in these animals was at first very irregular and greatly accelerated, but finally it became normal. In general the first few graphs were worthless on account of body movements, but after a time fairly reliable tracings could be obtained with only an occasional irregularity. The inhalants were administered from cones held above the nostrils, the distance varying roughly in inverse ratio to the strength of the vapors. At first, for control, a cone saturated with water or some volatile non-odorous substance was placed above the nostrils immediately preceding the cone containing the inhalant, but inasmuch as the first cone never altered respiration or circulation this procedure was discontinued.

Tabulated data compiled from the respiratory and the blood pressure tracings from two normal rabbits under veronal-sodium and two without any hypnotic permit of the following summary. The agreeable odors, oil of bergamot, lavender and anise always show some depression and inhibition of respiration during the period of inhalation. Oil of cloves, orange and rose tracings from one rabbit under veronal-sodium and both non-hypnotized rabbits reveal some depression or depression and inhibition of respiration, least marked in the oil of cloves tracings. Of the disagreeable odors inhaled, none of the asafetida records exhibit any respiratory changes, and only one butyric acid tracing from one of the non-hypnotized rabbits demonstrates any depressor or inhibitory changes in respiration.

The tracings obtained from such substances as peppermint, alcohol, menthol, eucalyptus and camphor always show considerable depression and inhibition of respiration. Respiration is at a complete standstill in all of the wintergreen, ether, chloroform, pyridin and phenol tracings. Records obtained from these inhalants in the non-hypnotized rabbits disclose a sneeze in addition to the complete arrest of respiration. Practically all of the xylol, benzol, formalin, oil of mustard, acetic acid and ammonia graphs from both the veronal-sodium and the undepressed rabbits reveal both a complete suppression of respiration and the sneeze. In the undepressed rabbits the sneeze appears very quickly after inhalation of ammonia, and in both the ammonia and xylol tracings it occurred when the cones were held 8 cm. from the nostrils.

All of the blood pressure tracings which correspond to strong and moderately strong respiratory changes disclose a rise in blood pressure, a slowing and strengthening of the pulse which are in direct proportion to the alteration in respiration. There is never an inhalation-respiratory change without a corresponding circulatory change.

The following tabulated vagus and vagotomy respiratory and circulatory data obtained from a normal rabbit (no. 581) under veronal-sodium at the time of inhalation of ammonia is very similar to corresponding data obtained a second normal rabbit under veronal-sodium.

	BEFORE STIMULATION	DURING STIMULATION
All nerves intact (1)		
Rate of carotid pulse waves	8.5 in 2 sec.	6 in 2 sec.
Height of carotid pulse waves	1.5 mm.	3 mm.
Blood pressure rise		16 mm.
Respiration		Standstill
After cutting depressors (2)		
Rate of carotid pulse waves	10 in 2 sec.	6.5 in 2 sec.
Height of carotid pulse waves	0.5 mm.	3 mm.
Blood pressure rise		20 mm.
Respiration		Standstill
After cutting vagi (3)		
Rate of carotid pulse waves	8 in 2 sec.	7 in 2 sec.
Height of carotid pulse waves	1.5 mm.	2.5 mm.
Blood pressure rise		15 mm.
Respiration		Standstill
After cutting cer. sym. (4)		
Rate of carotid pulse waves	6.5 in 2 sec.	6 in 2 sec.
Height of carotid pulse waves	1.5 mm.	2 mm.
Blood pressure rise		11 mm.
Respiration		Standstill

It is apparent from this table that the relative strength of the circulatory reactions is in the order (2), (1), (3), (4), and the effect on respiration is the same in all four tracings.

A benzol-inhalation graph from a normal cat (no. 580) under veronal-sodium shows a marked depression of the respiratory excursions, a 30 mm. rise in blood pressure, some increase in the height of the pulse waves, but no change in their rate.

Respiratory tracings from a normal rabbit (no. 533) under a full dose of urethan-chloretone portray very similar changes to the rabbits under veronal-sodium for the strong irritating inhalants, but for the mild irritants, the depression and inhibition is only moderate, and there is no response to the agreeable or disagreeable odors, even the disgusting odor of a skunk elicited no response.

The xylol and benzol respiratory tracings from a normal cat (no. 529) under urethan-chloretone reveal but little depression and inhibition.

In some experiments to be reported in a later paper on a pseudo-vagal reaction, a large number of blood pressure graphs were taken from the right vena cava close to the atrium, at the time a rabbit under veronal-sodium was inhaling various substances. A long cannula was inserted into the right jugular until it reached the right superior vena cava, the subclavians and azygos being then about the only veins of any consequence left to discharge their blood into the right superior vena cava. The pressure was recorded by a small saline manometer especially made for this purpose. At the same time the carotid pressure and its pulse were recorded by a mercury manometer.

A venous tracing taken at the time of inhaling benzol reveals a rise in pressure of 8+ mm. as compared with an 18 mm. rise for the carotid. The superior vena cava rise takes place fully as early as the carotid, is more gradual, and the return to normal is quicker. The venous pulse (atrial) waves disclose the same amount of slowing as the carotid waves, namely, a drop of one beat in two seconds. Instead of showing an increase in height of the pulse waves, the venous pulse waves portray a marked decrease in height.

Effect of various inhalants on respiration and circulation in olfactory rabbits. Attention is directed at the outset to the results of the introductory experiments of this report and to the results of the first paper of this series, which indicate that the alteration of respiration and circulation following short inhalations of any vapor, when the naso-ciliary and maxillary nerves are divided on both sides, takes place primarily through stimulation of the olfactory nerve endings. Of six *olfactory* rabbits used in this experiment, two were prepared by sectioning the trigeminal roots intracranially[1]

[1] In rabbits where both trigeminal roots are to be divided intracranially, it is advisable to sever them on different days. A special instrument for this purpose was made from a piece of 2 mm. steel wire. After flattening one end of the wire and bend-

and four by cutting the naso-ciliary and maxillary nerves on both sides. The first two, designated as 1 and 2, had no hypnotic, while the latter, 3 to 6, were given two-thirds to a full dose of veronal-sodium intravenously. In 5 and 6, the depressors and vagi were sectioned and simultaneous thoracic-respiratory and blood pressure tracings were recorded. In 3, respiratory records were obtained before and during hypnosis.

The following generalizations can be made from tabulated data compiled from many inhalation tracings taken from these six olfactory rabbits. The agreeable odors, oil of cloves, rose, orange, lavender, and bergamot cause some depression or depression and inhibition of respiration in rabbits 1, 3, 4, and 5. In rabbit 2 there is some acceleration and depression of the respiratory excursions during the first part of the inhalation period of the agreeable odors and the disagreeable odor, butyric acid, but during the middle and last part of the inhalation period the tracings show an inhibition in place of acceleration; so that the total effect of inhalation of these odors in rabbit 2 would have to be regarded as one of reduced ventilation. Inhalation of rose, orange and oil of cloves elicited no change in respiration or circulation in rabbit 6, but oil of bergamot and lavender (fig. 1 D) altered both respiration and circulation.

Practically all of the oil of anise, peppermint, camphor, menthol, eucalyptus, and alcohol graphs from all six rabbits show considerable depression and inhibition of respiration, together with a rise in blood pressure and some pulse changes.

All of the respiratory tracings obtained during the inhalation of oil of wintergreen (fig. 1 E), ether, chloroform, phenol, pyridin, oil of mustard, formalin, acetic acid, ammonia, benzol, and xylol (fig. 1, C) disclose either a pronounced depression and inhibition or a complete arrest of respiration. Practically all of the respiratory records from the above vapors also elicited a sneeze in the non-hypnotized rabbits 1 and 2, as shown by the xylol and ammonia tracings (fig. 1, K and L).

In olfactory rabbits 5 and 6 the changes in blood pressure and pulse are in direct relationship to the strength of the inhalant affecting respiration, as is revealed by the lavender, wintergreen, and xylol tracings (fig. 1, D, E and C).

Attention is directed to the strength of the respiratory and circulatory

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ing it to fit the contour of the sides and base of the skull, the tip end of the convex surface was ground away on either side so as to leave a median blade which was fairly sharp. With the animal under ether, the operative procedure consisted of cutting a hole about a centimeter in diameter through the temporal bone in front of the external auditory meatus. The flattened end of the instrument was next inserted through the temporal orifice until it reached the place where the trigeminal root leaves the Gasserian ganglion; a few backward and forward movements were sufficient to sever a root with little injury to the brain and none to the olfactory area.

reactions obtained in all the olfactory rabbits from inhalations of the strongly irritating vapors, acetic acid, oil of mustard, ammonia (fig. 1 H, blood pressure only), etc. They will probably have to be ranked next to xylol and benzol as olfactory stimuli.

In two olfactory rabbits not included in the six described previously, where urethan-chloretone was used for hypnosis, the threshold for stimulation was much higher than it was for veronal-sodium. The xylol and benzol respiratory tracings from these rabbits show only a moderate depression and inhibition. Furthermore, the threshold of stimulation of the olfactory nerves by inhalants is demonstrated to be much higher in cats than in rabbits.

Effect of various inhalants on respiration and circulation in trigeminal rabbits. It is apparent from the first paper of this series and the preliminary experiment of this report, that short inhalations of various vapors which alter respiration and circulation in trigeminal rabbits, do so chiefly through stimulation of the sensory endings of the naso-ciliary and the maxillary nerves.

Trigeminal rabbits were prepared by sectioning the olfactory fibers after the manner described in the first paper of this series. Rabbit 1 had no hypnotic and only thoracic-respiratory tracings were obtained. Respiratory tracings were taken from rabbit 2 both before and after giving veronal-sodium. Rabbits 3 and 4 had a two-thirds dose of veronal-sodium and simultaneous respiratory and circulatory records were taken during the time various odoriferous and irritating vapors were inhaled from cones held above the nostrils. Before administering inhalants to trigeminal rabbits not under a hypnotic, the animal was blindfolded, its ears were plugged with cotton, and all of the sensory hairs about the snout were clipped.

A mass of tabulated data taken from these graphs may be presented in the following manner. There is no alteration of respiration or circulation in rabbits 1 to 4 at the time of inhalation from cones saturated with water, hydrogen peroxide and 50 per cent alcohol. Negative results are also obtained in all four rabbits for the agreeable inhalants, oil of cloves, rose, orange, lavender (fig. 1 F), and for the disagreeable odors asafetida, fresh cat's urine, and butyric acid.

Oil of bergamot, wintergreen (fig. 1 J), and anise always elicit some depression and inhibition of respiration and some rise in blood pressure. Menthol, eucalyptus, and 95 per cent alcohol produce about the same changes in respiration and circulation as shown in the wintergreen tracing. In rabbit 2 the respiratory reactions are somewhat more pronounced before veronal-sodium than afterward. Before veronal-sodium, respiration comes practically to a standstill in some of the anise and bergamot tracings, and in the 95 per cent alcohol tracing the suppression of respira-

tion is followed by sneezing. There was a marked tendency in rabbit 1 to sneeze the instant an inhalant was perceived. The only way that a normal tracing could be obtained was to bring the cones very slowly to the nostrils and often this procedure would fail.

The strongly irritating vapors, ether, chloroform, pyridin, phenol, formalin, acetic acid, and ammonia evoke in all four rabbits a marked depression and inhibition of respiration, amounting in most instances to a complete suppression. There is also a considerable rise in blood pressure and a slowing and strengthening of the pulse. In all of the graphs obtained

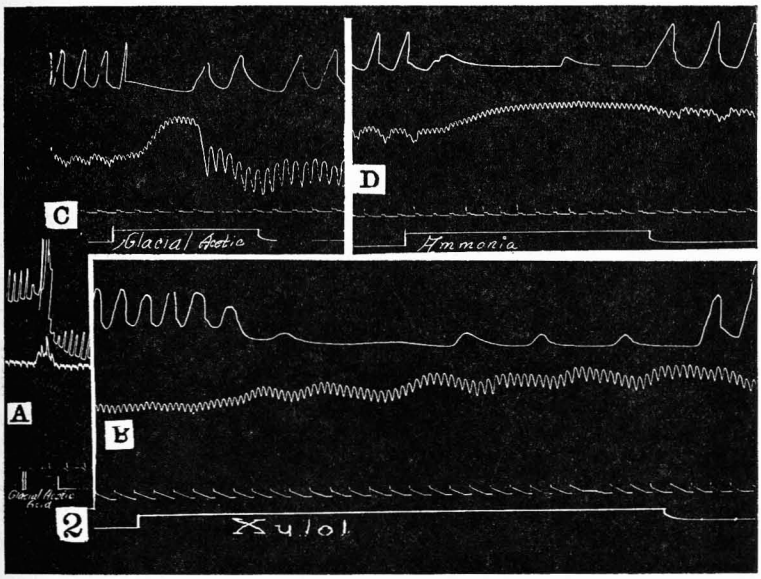

Fig. 2 A. Same as figure 1 F and J; B, inhalation-thoracic respiratory and blood pressure graphs from trigeminal rabbit, veronal-sodium, time in seconds; C, same as B except depressors cut; D, same as C except vagi cut.

from the undepressed rabbits 1 and 2 and all of the acetic acid (fig. 2 A), and ammonia graphs from the veronal-sodium rabbits 3 and 4 the arrest of respiration is followed by a sneeze. It should be noted that the cones containing the milder irritants were held close to the nostrils.

The records from the coal tar products, xylol and benzol, are of especial interest in view of the fact that Beyer regarded xylol as a specific stimulus affecting respiration over the olfactory nerves. All of the xylol and benzol tracings from the undepressed rabbits 1 and 2 and a large number from the veronal-sodium rabbits 3 and 4 disclose a sneeze in addition to the suppression of respiration. Figure 2 B, which is a xylol graph from a

fifth trigeminal rabbit (587) under a full dose of veronal-sodium, reveals respiration practically at a standstill, a rise in blood pressure of 10 mm., a decrease of 1.5 pulse waves in two seconds, and an increase in the height of the pulse waves of 1.5 mm.

A number of records from trigeminal rabbit 555 under urethan-chloretone do not show any respiratory or circulatory changes as a result of inhaling oil of bergamot, anise, peppermint, and wintergreen. Alcohol, ether, chloroform, benzol, xylol, acetic acid, and ammonia evoke considerably weaker respiratory and circulatory responses than the corresponding veronal-sodium records exhibit.

Figure 2 C illustrates a *pseudo-vagal reaction* occurring in an acetic acid-inhalation tracing from a trigeminal rabbit. It consists of a drop in blood pressure, an immediate strengthening and slowing of the pulse, the latter being exactly one-half the previous rate. These gigantic pulse waves continue for a considerably longer time after inhalation ceases than is the rule for pulse changes following nerve stimulation. This reaction may appear at any time during stimulation, after stimulation ceased, or it may take place spontaneously in vagotomized rabbits. Nerve fatigue and benzol stimulation appear to bring it on. This reaction which will be described in detail in a subsequent paper, is probably an ectopic rhythm. It may be present in some of the tracings of other investigators.

Figure 2 D is an ammonia graph from the same trigeminal rabbit as B and C, but obtained after the depressors and vagi were sectioned. It is obvious that respiration is practically at a standstill. That there is no sneeze is due to the fact that the cone was purposely held at considerable distance from the snout. There is a 7 mm. rise in blood pressure, a decrease in the rate of the pulse of one beat in four seconds, and no change in the height of the pulse waves.

It is seen from comparing this record and others like it with similar ammonia graphs taken before vagotomy together with several xylol graphs from this and other trigeminal rabbits with figure 2 B, that sectioning the depressors and vagi does not materially affect the respiratory changes obtained from inhalations. There is, however, less rise in blood pressure and the pulse changes are considerably reduced after sectioning these nerves.

COMMENTS. In rabbits the olfactory and trigeminal nerves protect the lungs from dangerous and irritating vapors by suppression of respiration and by the production of a sneeze.

The chief result of olfactory stimulation from inhalants is one of suppression of respiration; a sneeze is evoked only in non-anesthetized rabbits. Trigeminal stimulation causes both a suppression of respiration and a sneeze; the sneeze is absent in weak stimulation and comes on early in

strong stimulation. As shown in the previous report the vagus reaction is concerned primarily with a cough or spasm, the suppressor effect while usually present, is of little significance except in very weak stimulations.

Contrary to Beyer (5) the general effect from inhalations of agreeable odors is one of depression and inhibition of respiration. Some agreeable odors are effective over the trigeminal nerve as well as the olfactory. In agreement with Beyer my records show that disagreeable odors rarely ever stimulate the olfactory or trigeminal nerves. Also the coal tar derivative xylol proved to be the most effective olfactory stimulant. In addition it is a very efficient trigeminal stimulant. On the other hand, the strong irritants usually classified as trigeminal stimulants are very effective olfactory stimulants also.

Obtaining negative results from cones containing 50 per cent alcohol and from cones containing the non-odorous and non-irritating hydrogen peroxide, demonstrates that the small alcohol content in some inhalants and the evaporation of a volatile substance are not factors for stimulation in any of the foregoing experiments.

Urethan-chloretone apparently raises the threshold of stimulation from inhalations much more than veronal-sodium. The sneeze is more easily elicited in rabbits not under a depressant or under two-thirds of a full anesthesia dose of veronal-sodium than it is under a full dose.

A so-called pseudo-vagal reaction, sometimes taking place during the inhalation of a vapor, results in a drop in blood pressure very similar to the drop in many of Kratschmer's tracings. None of the writer's blood pressure tracings from healthy rabbits show any initial drop preceding the normal rise. A few rabbits suffering from an upper respiratory infection disclosed an initial drop obviously of vagus origin. In these animals the secretions probably protected the mucous membranes for a time so that the olfactory and trigeminal nerves were not stimulated at first, and consequently inspiration went on normally, resulting in the stimulation of the vagus before these vapors reached the endings of the olfactory and trigeminal nerves.

SUMMARY AND CONCLUSIONS

The inhalation experiments on *normal, olfactory* (trigeminals cut) and *trigeminal* (olfactory fibers cut) rabbits and cats confirm the work of others that the inhalation or projection of odoriferous and irritating substances into the nostrils produces marked changes in respiration and circulation. The general effect on respiration is one of depression and inhibition or complete cessation. A strong stimulus may produce a sneeze in a trigeminal rabbit or in a non-anesthetized olfactory rabbit. The circulatory changes consist of a rise in blood pressure and a slowing and strengthening of the pulse.

It is demonstrated by the insufflation experiments in the first subdivision of this report, where similar changes occur in respiration and circulation to those obtained from inhalations of the same vapors, that these changes do not originate from humoral-peripheral or humoral-medulla stimulation as a result of absorption of these vapors, or to secondary humoral or mechanical-vagal stimulation or lack of stimulation due to cessation of respiration.

These respiratory and circulatory reactions may be evoked by stimulation of either the olfactory or the trigeminal endings in the nasal mucosa. In general the reaction is somewhat stronger when both nerves are intact.

Respiratory changes from inhalations. The mild agreeable odors such as extracts of orange, rose, and oil of cloves are the only specific olfactory stimuli found, but at best they cause only a moderate alteration of respiration, and in some rabbits, no change.

Oil of bergamot and anise are usually effective over either the olfactory or the trigeminal. Wintergreen proved to be a fairly powerful stimulant over both nerves.

The disgusting odors have little or no effect on respiration.

Xylol and benzol which are the strongest olfactory stimulants are also powerful trigeminal stimulants, frequently eliciting a sneeze.

Ether, chloroform, formalin, oil of mustard, acetic acid, ammonia, etc., usually classified as trigeminal stimulants, are shown to be almost as effective olfactory stimulants.

Division of the depressors, vagi, and cervical sympathetics at the level of the larynx in no way interferes with the strength of the respiratory reaction in normal, olfactory and trigeminal rabbits.

Circulatory changes from inhalations. Any substance which produces a pronounced or slight alteration of respiration in a normal, olfactory or trigeminal rabbit always causes a correspondingly marked or insignificant change in the circulation.

The alteration of circulation is equally and sometimes more pronounced after severance of the depressor nerves in normal, olfactory and trigeminal rabbits. After double vagotomy the total rise in blood pressure is somewhat reduced; there is also considerable less slowing of the pulse, but the effect on the strength of the pulse is variable.

Inhalation of various vapors results in a rise in blood pressure in the superior vena cava, the same amount of slowing of the atrial pulse as takes place in the carotid pulse, but a conspicuous depression of the atrial pulse waves is evident.

A pseudo-vagal reaction probably caused from an ectopic rhythm is described in connection with certain blood pressure tracings.

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