# INITIATORY AND REGULATORY MECHANISMS GOVERNING SECRETION OF THE FLUID COMPONENT OF INTESTINAL JUICE

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Investigations of intestinal secretion have usually been conducted by Thiry's or by Thiry-Vella's method, i.e., with the intestine completely transected; the data on the role of the neural links of the intestinal wall itself are contradictory. Thus, N. P. Shepoval'nikov [6] did not detect any difference in the secretions of intestinal segments isolated by Pavlov's method (with the seromuscular bridge retained) and by Thiry's method. In B. G. Grebenkin's experiments [1] on a dog with two isolated intestinal segments, identical changes were observed after castration in the secretions of segments isolated by Thiry's and Thiry-Pavlov's methods. However, according to A. N. Tambovtsev's data [4, 5], on isolation of an intestinal segment by Pavlov's method it is possible to detect the stimulating influence of eating on intestinal secretion and the passage of this stimulation along the intestine. In this case the secretion curve varies in accordance with the composition of the food. In the author's opinion, when the neural links are left intact to the greatest possible extent reflex influences are exerted no less actively on the intestinal glands than on the higher-lying branches of the alimentary tract.

We set ourselves the task of elucidating the disputed question of the role of reflex influences, including those exerted by the neural links of the intestinal wall itself, in the secretion of the fluid portion of the intestinal juice. For this purpose we used two types of stimulation, feeding and emotional excitation, i.e., conditions which, in our opinion, caused changes of varying character, duration, and intensity in the functional state of the central nervous system.

## EXPERIMENTAL METHOD

Our investigations were conducted on four dogs with segments of the initial portion of the jejunum isolated by Tambovtsev's modification of Thiry-Pavlov's method [4]. In two of the dogs a segment of the intestine was also isolated by Thiry's method. The juice secreted in response to mechanical stimulation (with a rubber drain of fixed length) was collected every 15 min over a period of 4-6 h. The experiment was begun 30 min after the drain was inserted, i.e., after secretion had somewhat stabilized. Every 30 min the drain was withdrawn slightly and cleared of mucus.

In investigating the action of the alimentary stimulus the experiments involving feeding were alternated with control experiments.

The emotional excitation was induced in the following manner: the dog was stimulated for a 60-min period during the 2nd hour of the experiment by confinement with a cat. The character of secretion under normal conditions was established in preliminary control experiments.

## EXPERIMENTAL RESULTS

In the control experiments intestinal secretion varied substantially at different hours and on different days.

Table 1 shows the averaged data obtained in experiments in which we investigated the influence of a mixed

TABLE 1. Secretion of Intestinal Juice in Dogs Fed a Mixed Diet (Averaged Data)

| Dog's name | Method of isolating intestinal segment | Character of experiment | No. of experiments | Quantity of intestinal juice (in ml) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 1st hr | 2nd hr | 3rd hr | 4th hr | Total quantity of juice |
| | | | | M± m | | | | |
| Novyi | Thiry-Pavlov's method | Control | 5 | 2.58± 0.24 | 4.06± 0.45 | 3.56± 0.60 | 2.28± 0.30 | 12.28± 1.18 |
| | | Feeding before experiment (cereal + meat) | 5 | 3.28± 0.65 | 3.42± 0.19 | 3.16± 0.36 | 3.32± 0.40 | 13.18± 0.70 |
| Renat | The same | Control | 4 | 5.70± 0.79 | 5.98± 0.88 | 5.38± 0.50 | 5.25± 0.91 | 22.30± 1.65 |
| | | Feeding after 1st h of experiment (cereal+milk) | 4 | 6.53± 0.69 | 6.05± 0.76 | 5.78± 0.52 | 4.70± 0.61 | 23.05± 2.53 |
| | The same | Control | 4 | 3.48± 0.63 | 2.95± 0.09 | 3.48± 0.22 | 3.53± 0.40 | 13.48± 0.60 |
| | | Feeding after 1st h of experiment | 3 | 3.87± 1.10 | 4.10± 0.29 | 3.13± 0.54 | 2.63± 0.74 | 13.73± 1.99 |
| Barsik | Thiry's method | Control | 4 | 1.90± 0.34 | 1.68± 0.18 | 2.48± 0.37 | 2.03± 0.20 | 8.08± 0.60 |
| | | Feeding after 1st h of experiment (cereal + + meat) | 4 | 2.05± 0.59 | 2.75± 0.60 | 1.85± 0.24 | 1.50± 0.17 | 8.15± 1.20 |

TABLE 2. Secretion of Intestinal Juice in the Dog Renat on Feeding with Meat

| Expt. No. | Character of experiment | Quantity of intestinal juice (in ml) | | | | |
|---|---|---|---|---|---|---|
| | | 1st hr | 2nd hr | 3rd hr | 4th hr | 5th hr |
| 10 | Control | 2.4 | 5.2 | 2.8 | 4.1 | 5.0 |
| 14 | | 2.7 | 1.9 | 3.6 | 4.2 | 2.2 |
| 15 | | 2.5 | 1.7 | 4.0 | 4.5 | 4.0 |
| 16 | | 3.7 | 5.3 | 4.0 | 3.7 | 4.1 |
| 18 | | 3.1 | 2.7 | 2.9 | 3.2 | 1.9 |
| | After feeding with meat | | | | | |
| 9 | Feeding (200 g of meat after 2nd hr) | 5.5 | 5.5 | 2.4 | 1.5 | 1.7 |
| 11 | | 5.1 | 5.8 | 3.2 | 1.4 | 0.6 |
| 12 | | 5.5 | 7.4 | 7.0 | 4.4 | 4.0 |
| 13 | | 4.1 | 3.0 | 6.7 | 1.8 | 0.7 |
| 17 | | 3.5 | 3.8 | 2.5 | 3.3 | 3.0 |

diet (200 g of cereal and 500 ml of milk or 200 g of cereal and 200 g of meat and bones) on intestinal secretion. The total quantity of juice secreted in the experiments involving feeding was the same as in the control experiments. The slight increase in the quantity of juice produced in the experiments on the dogs Novyi and Renat was not statistically reliable ($P > 0.5$). On comparison of the hourly portions it may be seen that in the experiments on Novyi, who was fed beforehand, the quantity of juice secreted during the 1st h after feeding was the same as that produced during the corresponding hour in the control experiments ($P > 0.2$). Secretion also remained unchanged in the experiments on Renat and Barsik, who were fed after the 1st h. In this case investigation of the results of individual experiments conducted on Barsik by the pair comparison method showed that the slight increase which we observed was statistically unreliable. Thus, the mean difference between the 2nd and 1st hours (M± m) for the segment isolated by Thiry-Pavlov's method was 0.70± 0.91 ($P > 0.5$), while that for the segment isolated by Thiry's method was 0.65± 0.22 ($P > 0.05$).

We were unable to detect any difference between the experiments involving feeding and the control experiments with respect to the character of the secretion or the quantity of juice produced during 15 min periods.

The character of the secretion of the segment isolated by Thiry-Pavlov's method was the same as that of the segment isolated by Thiry's method, both in the control experiments and in those involving feeding.

In addition to the influence of a mixed diet on intestinal secretion, in Renat we investigated this secretion when the animal was fed meat (200 g of beef without bones). According to A. N. Tambovtsev's data [5], there is a quite substantial and prolonged increase in secretion under these conditions. On comparison of the results of the control experiments with those of the experiments involving feeding, as well as of the hourly portions before and after feeding, it may be seen that the quantity of juice secreted did not vary reliably. The fluctuations in secretion after

TABLE 3. Secretion of Intestinal Juice in Dogs during Emotional Excitation

| Dog's name | Date of experiment | Quantity of juice (in ml) secreted during 4 h | |
|---|---|---|---|
| | | Segment isolated by Thiry's method | Segment isolated by Thiry-Pavlov's method |
| | 10 control experiments | | |
| | | M±σ | |
| | | 6.40±1.71 | 10.14±2.24 |
| Barsik | 21/XII 1961 | 6.0 | 9.5 |
| | Emotional excitation during 2nd hour of experiment | | |
| | 22/XII 1961 | 8.0 | 47.3 |
| | 23/XII 1961 | 8.7 | 15.0 |
| | 24/XII 1961 | 8.7 | 15.9 |
| | 25/XII 1961 | 7.7 | 14.9 |
| | 26/XII 1961 | 7.6 | 13.3 |
| | 10 control experiments | | |
| | | M±σ | |
| | | 12.75±3.3 | 12.81±2.95 |
| Ryzhik | 13/VII 1962 | 23.1 | 17.2 |
| | Emotional excitation during 2nd hour of experiment | | |
| | 14/VI 1962 | 21.7 | 36.5 |
| | 15/VI 1962 | 15.2 | 13.3 |
| | 16/VI 1962 | 11.5 | 17.4 |
| | 19/VI 1962 | 12.3 | 12.6 |

feeding with meat were the same as those which occurred during individual hours of the control experiments (Table 2).

Consequently, when the neural links of an isolated segment are retained to the maximum possible extent feeding has no material influence on the secretion of the fluid portion of the intestinal juice and mechanical irritation is a stimulus adequate to the process. We previously obtained similar results for segments isolated by Thiry's method [2]. A. N. Tambovtsev's conclusion regarding the stimulating influence of feeding on intestinal secretion was not confirmed in our investigations. In this author's works the quantity of intestinal juice secreted over a period of hours after feeding was compared only with the quantity produced during the hour immediately preceding eating. The absence of data on control experiments equal in duration to those involving feeding makes it impossible to evaluate the character of the fluctuations in secretion under normal condition and thus the reliability and constancy of the changes observed.

The role of the neural links of the intestine in their secretory reaction was clearly manifested on emotional excitation of the animal. As we showed previously [3], the secretion of an intact or denervated segment of the small intestine isolated by Thiry's method usually increases under the influence of 60 min emotional excitation.

Table 3 shows the results of simultaneous observation of the reactions of two intestinal segments, one isolated by Thiry's method and one isolated by Thiry-Pavlov's method. In the experiments on Barsik the quantity of juice produced by the segment isolated by Thiry's method remained virtually unchanged after emotional excitation, while the secretion of the segment isolated by Thiry-Pavlov's method increased sharply, exceeding the mean value obtained in the control experiments by 16.6σ on the day after emotional excitation. In the experiments on Ryzhik the secretions of both isolated segments increased, but the extent of the increase was considerably greater for the segment whose linkage with the intestinal wall was preserved than for the segment isolated by Thiry's method. The standard deviation was 8.2 and 3.1σ respectively, with a confidence limit of ±2.29σ. Similar relationships were observed when the experiment involving emotional excitation was repeated 25 days later. It must be noted that in other experiments performed on isolated intestinal segments with the intestinal wall transected there was not a single case in which we observed as large an increase in secretion after emotional excitation as in the experiment involving segments isolated by Thiry-Pavlov's method.

The direction of the changes in intestinal secretion after emotional excitation was thus the same regardless of the innervation state of the isolated segment; however, when the neural links were retained to the maximum possible extent through the seromuscular bridge the changes in secretion were considerably more marked.

On comparing the results of the experiments involving feeding and those involving emotional excitation we may conclude that stimuli applied to the central nervous system are not triggering for the intestinal glands. On the other hand, the data obtained are a new confirmation of the existence of central regulation of intestinal secretion, which is specifically effected through the neural links of the intestinal wall and acts to alter the functional state of the intestinal glands.

## SUMMARY

In experiments on dogs with the sections of the small intestine isolated after Thiry-Pavlov (in Tambovtsev's modification) and after Thiry, feeding does not influence the secretion of the fluid portion of the intestinal juice. Following emotional excitation of the animal the secretion in the section isolated after Thiry-Pavlov increases to a much greater extent than that in the section isolated after Thiry.

A conclusion was drawn that the action exerted by the CNS, including that effected through the action of the nervous connections of the intestinal wall, has no "starting effect" on the intestinal glands, but it tends to produce changes in their functional state.

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**All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.**

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