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A contribution to the Physiology of the Splanchnic area, including observations on temperature-topography, and on the action of
1. Chloro-
2. Morphine.
3. Curare.
4. Branchy stimulation on temperature.

Wiliam Lamb
Note.
The work described in this paper was undertaken at the suggestion of Professor H. von E. B. K. O. S. S. Z. Z. Z., whom I have to thank for much kind advice and many important suggestions, regarding the method of conducting the experiments.
The experiments were performed in the Physiological Institute Berlin during the Winter Session of 1879.

Yew Tree House, Shrewsbury
London S.W.
26th April 1881.
Temperature and Topography. Historical Introduction.

Ludwig, in his Lehrbuch der Physiologie, gives the following results of temperature observation on different parts of the body, the auxiliary temperature being taken as a standard of comparison.

Under the tongue 22°-23° C warmer than the axilla; bladder, rectum, vagina 8°-10° also warmer than the axilla. The subcutaneous nerves, but liver is, according to Becquerel & Brechet's thermo-electric observations, 1°38° -1°83° cooler than the skeletal muscles. This may seem to be a great difference between two parts in such close anatomical connection, but, according to Adeniowicz, the muscles form the boundary between the inner warmer zone and the outer cooler zone of the body.

The temperature of the separate zones of the animal body, he finds, diminishes gradually and continuously in a radial direction from a certain fixed point in the cavity. But this uniform fall only goes a certain length—not all the way to the periphery. And the point or boundary (Rücklaufgrat) is anatomically coincident with the limit of the muscular layer of the trunk. Beyond the boundary grage, the fall of temperature is very rapid, the curve inclining quickly to the abscissa line. Martin estimates the difference between skin & intestine at 1°C,—considerably less than it would be according to Becquerel & Brechet, who gave the temperature of the intestine as somewhat higher than that of the lungs or brain. The pelvic temperature, according to Davy, is higher than that of the brain, and the temperature is highest and about equally high in the heart.

1. Ludwig, Lehrbuch der Physiologie 1861 Bd II S 722
5. Essai sur la conduction & comparaisons de la chaleur, Acad. de St-Pétersbourg 1857 p 141
6. An account of some experiment on animal heat, Philo. Trans. 1874 Vol III p 390
lungs, liver, and neighbouring viscera. Davy asserted that the temperature of the skin covering parts where the vessels are large, the volume of blood great, was higher than elsewhere, the supported this theory by the following observations. On the 6th rib on the right side of the king, beneath was 27.1° R. while at a corresponding point on the left side, where the heart beats, it was 27.3° R. The temperature of the spine was 28.6° R.; over the middle of the shin bone 26.4° R.; middle of calf of leg 27.1° R. He also found the temperature of the Achilles equal to that of the vessels in the leg. Several of Davy's results have been disproved by Claude Bernard, others still await confirmation.

H. Roger examined the distribution of heat in the superficial vessels accessible parts in children. Arteria tectorum differ considerably. Hunter inserted a thermometer into the wall of various depths, found at a depth of 1 inch 33.3° C.; at two inches 33.7° C.; at three inches 34.5° C.; and at the bull 36.1° C. In general, superficial are less warm than deeper parts. According to Bernard, the deeper lying tissues are as a rule warmer than the blood which leaves them. The sole of the foot is according to Davy 1.15° cooler than the axilla.

Roger (in children) finds a difference of 4.2° 6°C between the axilla and the hand or foot. Edwards gave the following temperature taken from a healthy man at rest: Mouth 36.1° C.; in the hand, 37.3°C; on the foot 35.6°C; thus making a difference of 0.5° 3.13°C between the mouth or axilla of the foot. He also found in the axilla:

1. De la température des sujets à l'état physiologique et pathologique. Archivio Sizial., de Medicina e Sier. 1823, T IX p 266.
2. Experiences et Observations sur la peau à l'état normal, journal de la circulation. Chques T IV p 212.
3. Études sur les propriétés physiologiques et les altérations pathologiques des liquides de l'organisme 1837, T I p 77 et suiv.
& grow a lower temperature than in the head—a result which, of course, does not, as a result of the imperfections of the method. Collard de Marigny made the following thermometric observations in the rabbit: 1. Throat 17.5°. 2. Abdomen (inside skin) 26.3°. 3. Abdomen (outside) 21.3°. 4. Head 26.5°. 5. Throat (inside skin) 20.3°. 6. Head 27°. 7. Throat (outside) 30.5°. 8. Throat (inside skin) 30.3°.

This singular result regarding the lower变为an internal abdominal temperature is no doubt due to the imperfections of the method employed. For the introduction of a thermometer into the abdominal cavity is a process calculated to alter very considerably the normal circulatory temperature relations of the part, especially in an animal like the rabbit with an abdominal vascular system at once very capacious and highly sensitive. Even the finer thermo-electric method is not free from objection in this particular. But the lower internal temperature of the abdomen might also be due to the situations in which the two temperatures were taken. If, for example, the internal temperature was taken in the front part of the abdomen, the abdominal temperature more laterally or higher up, the difference would be readily explicable; for the one thermometer would come in contact with the comparatively cool large intestine, while the other would lie over the heated stomach, liver, or small intestine. And this brings us to what is perhaps the subject of this section of my paper: The Temperature-hypotrophy of the Abdomen in the Rabbit. In the following experiments, an attempt was made to determine the vascular condition of the splanchnic area by means of the thermométre. And the method adopted was as follows. The rabbit was bled in its usual way, the four paws, it had been
left free. To prevent excessive heat loss it was lightly covered with a sheet of cotton wool. The bulb of a straight, very accurate thermometer, she was inserted into a small incision in the skin of fascia of the flank & passed through the subcutaneous connective tissue into any desired position. Now, according to Pitirimovitch, the body temperature falls very slightly from within outward as far as the muscular layer (inner zone). Fluctuations of temperature in the surrounding medium affect only the outer zone but not the muscular layer or much the less as muscle is an excellent heat conductor of heat (thus as bad as water). Thus the bulb of the thermometer lay between the two zones, protected from the effect of external fluctuation & cotton wool, only separated from the abdominal veina by a thin muscular partition. It was soon found that the temperature fell on a very slow and steady, according as the bulb of the thermometer was forced in towards the abdominal cavity, or withdrawn towards the skin, so in order to regulate & keep constant the amount of pressure exerted upon the bulb, retained it in the most favorable position for registering variation in the vascularity of the abdomen. Local contents, a small pad of cotton wool was placed over it secured of a piece of tape, which was passed round the abdomen tied with a small pair of forceps. Threads of elastic band which, passing from the other end of the thermometer to various fixed points, serve to maintain the instrument at the same level to return the bulb to its original position if it
placed of the animal's struggles. A second thermometer was introduced into the rectum to a constant depth of 2½ inches, i.e. the bulb lay near the base of the pelvis just below the sacral promontory. At the rectal & abdominal temperatures were obtained continuously, recorded every 5 minutes, or oftener if necessary. Taken in this way I have just described the abdominal temp.
is found to vary greatly according to the position occupied by the abdomen. The temperature of the abdomen, and these variations, have distinct reference to the position of the contained viscera. From a large number of observations taken in the way described, it appears that while the absolute temperature of the abdomen varies a good deal, yet the relation between the temperatures of the different regions (organs) remains fairly constant. The temperature of the
1. Hepatic region was found to be 1°-2°C higher than the rectal temperature
2. Rectal region
3. Rectum - very constant - Standard

Small ileocecal region found to be 8°-9°C lower than rectal temperature
Large ileocecal region - 7°-12°C lower

For example to take one of very many observations
Directly over liver 39.2°C
Directly over Stomach 39.1°C
1st below point of liver on left side 38.6°-7°C (Small Intestine)
Anterior wall just below umbilicus 37.6°-7°C (Large Intestine)
Rectum 38.8°-39°C.

The rectum being remote from cooling influences, shows a very constant temperature provided the bulb of the thermometer is always intro-duced to the same depth. The liver and Stomach are also very constant. The Small and large bowel are the most variable.

A few words are necessary here with regard to the relative position of the abdominal viscera in the rabbit.

Almost the whole of the anterior part of the abdomen is occupied by the large intestine, as it turns from side to side a few coils of the small bowel may reach the anterior wall, but this is not by any means constant. The case is, for the small bowel lies in great part behind the large, and reaches the abdominal wall...
lateral, at a point about 1" below the carina punctus and of the last rib. This holds good of both right and left sides. By careful palpation, the surrounding viscera may generally be distinctly made out; the distended stomach on the lower superior, the intestines inferior, the posterior, the tail of the large intestine anterior. So that an arbitrary rule for finding the position of the small intestine is to say that for the usual rabbit it is always superficial, the perfectly pliable abdominal wall admitting of the most exact palpation. We will next consider the effect of fasting on temperature in the rabbit.

When a rabbit is first found its temperature falls rapidly for about half an hour or rather more; this initial fall may amount to considerably over 1°C. Then a level is reached which is maintained with comparatively slight variations, if the animal be protected from exposure to heat or cold. The rectal temperature remains remarkably constant; but the bowel becomes dry after a time to feel slowly, in two or three hours the small intestine may commence the peristalsis by as much as 0.5°C (Fig. 1). This is perhaps an exceptional state but as a rule within an hour from the time of fasting, the temperature curve of the small bowel exceeds that of the rectum, and this lead slight and to diverge. But they may converge or meet again after some hours (Fig. 4). The surface of the small or large intestine may gradually become parallel, chiefly owing to the original considerable difference—the large bowel rarely rises above the rectum under normal conditions. In slight fever the relations of the temperature are not altered, all are about equally raised. And in such cases considerable fluctuations are apt to occur some hours after fasting especially in the bowel curves. (Büttner, Schwanhaupt lernt Anatomie, Städcher, Preussische Wärme II Abhandl. Archiv f. Anatomie Physiologie 1876. 3, 268-302.)
Thus, simply binding a rabbit would cause, from the crossing of the curvatures to abut the balance of the circulation in abdominal vessels, producing apparently a determination of blood to the splanchic area.

In the observations on temperature topography, in which the bulb of the thermometer was pushed about from one position to another through the subcutaneous cellular tissue, the crossing of the abdominal or rectal curvatures described above did not occur, although some of the experiments lasted three or four hours. This was probably due to reflex contraction of the abdominal vessels caused by the stimulus of stimulation (forcing thermometer through cellular tissue).

In one case in which a rabbit was bound for several hours at a time on three successive days, severe diarrhoea came on after the first day's experiment. It persisted. The diarrhoea was not violent, but the animal died on the 6th day, apparently from exhaustion. At necropsy, no decided hyperemia of the intestines was found. The arterioles appear radially to be chiefly affected, but there were no capillary injection or loss of cellular fluid. New areas of diarrhoea occurred as is well known after division of the mesenteric nerves. Have seen a fatal case where diarrhoea followed & extema pulmonorum came on concluding of a more rapid fatal in a case of spreading disease of the spinal cord which had begun in the cerebral region & extended upwards. In both these cases the diarrhoea was somewhat paralytic. More or less its usually followed by muscular and secretory nerves, but in one case to disease of the cord & in the other to repeated binding. Simple binding a rabbit causes as we have just seen, a determination of blood to the splanchic area, a condition of shock in fact -- repeated short-continued binding of course intensifies this effect. Though a pure dogmatism may be allowed to mention as a fact of some interest that in the above mentioned case of spinal disease the first sign of the central cord being implicated was exteme rapidly of pulse (50-60) which was at least not a fact due to stimulation of the cardiac accelerator nerves. The pulmonary and motor nerves are also known to run in the central cord, hence the exteme pulmonorum.
The action of Chloral.

My attention was first directed to the action of Chloral on the rectum of the laboratory animal, by observing the marked abdominal congestion found after death in rabbits which had been anesthetized by means of that drug. In the strong healthy rabbit which had 15 cubic centimeters of chloral injected on three occasions (the first two times on one occasion, the third time on the 4th day), no other operation having been performed, death occurred on the 5th day. Post mortem, the most intense engorgement of the abdominal vessels was found. The other vessels were almost empty. The heart was tympanitic, without the exception of the right auricle, which with the two car. jux was greatly dilated. Shortly before death the temperature of the abdomen, taken in the way I have described, was 27.9°, while the rectal temperature could not be measured as the thermometer only registered down to 26°. Thus the abdomen was at least 1° warmer than the rectum. The tremendous abdominal congestion found post mortem readily explains this difference.

The exact course of the rectal (pelvic) and abdominal temperatures after a fatal and fatal dose of chloral is shown in the accompanying curves, Fig. 8. 6:7. The temperature of the small or large intestine, it will be seen, follows essentially the same course, only differing considerably from that taken of the rectum. Thus, as soon as the chloral takes effect the bowel become rigid, it may be a very slow 3.5° decline within five minutes from the time of injection. This rise may continue for 10-15 minutes, but it is always succeeded by a prompt fall, the curve of general cooling. The rectal temperature falls from the first, falls as a rule a good deal more quickly than the abdominal temperature. Thus the two curves first cross then diverge. The divergence continues for 2-3 hours when they gradually converge again from the reheat.
after ceasing to fall or beginning to rise. After a variable time they then parallel, finally of course they return each other to their original relation. The next day after complete receding, the temperatures are found to be normal. Fig. 5 shows all these changes except the retracing of the curves. At the point where the curves stop, the section is gradually bending to resume its normal position above the small intestine. Fig. 6 shows the recovered normal relation of the temperatures. Next morning, their course after a repetition of the chloral. As I show the third day's experiment with a similar dose. In the morning of the 4th day the rabbit died, the post mortem which was made at once disclosed the usual condition of marked abdominal hyperemia. Heart in charnel. In another rabbit which survived four experiments with similar results, the post mortem condition was exactly the same. Ateria of the subcutaneous tissue of the abdominal wall was also present in both. It lends the interpretation of the above results.

Considering what has been already said under the head of temperature topography, there can I think be little doubt that the temperature of any small part of the abdominal wall taken in the way with the precautions I have already described affords at least an approximate measure of the temperature vascular condition of that organ or part of an organ which is elevated immediately subjacent to the bulb of the thermometer. That the thermometers were really correctly placed was in every case ascertained by post mortem examination; but the temperature alone fails to indicate this very accurately. In those experiments which were performed with regard to the situation of the various abdominal organs could be made out with the greatest exactness, owing to
the complete relaxation of the abdominal muscles produced by this drug. Admitted that, that the recorded temperatures are really approximately those of the small- and large intestine, the interpretation of the curves becomes a comparatively easy task. When the uniform results of post-mortem examination are taken into account, the curves of the small- and large intestine follow essentially the same course, as one would expect, the small bowel being considerably more vascular, sometimes showing more marked changes. The rapid rise of the bowel curves following the administration of chloral is presumably due to dilatation of the vessels of the intestines; this view is confirmed by the exploration of the intestines found after death, which were more distended than in the control series. The fact, that the same condition may be readily observed, if the abdomen be opened before death, during the chloral narcosis, and this too, only after the primary rise of temperature is over. The short duration of the rise of temperature is the subsequent rapid fall is apparently due to general cooling of the animal. The sudden fall of the rectal core indicates that this is so, for there are few parts of the body more sheltered from the effects of heat-loss than the deeper parts of the rectum. If then the temperature falls in a part so remote from cooling influences as the rectum, a posteriority how much more subject is it to fall in the abdomen, which is only separated from the outer air by a thin layer of muscle tissue. Other things being equal this would hold good, but in the case we are considering other things are not equal, for the intestines are congested, whilst the rectum is probably more or less anemic, being drained of its blood to supply the dilated abdominal vessels. Thus the abdominal temperature instead of falling more rapidly than the rectal
at first rise, & when it does fall, it does so a rule decided more slowly than the others, owing to the pressure of the general cooling. The primary crossing of the curves then indicate intestinal hyperaemia, & their subsequent divergence indicate the same condition persisting, or, in other words, increased resistance to general cooling. It return to the course of the temperatures. The divergence of the rectal & abdominal curves may be well marked as in Fig. 5 or almost absent as in Fig. 6 of. It cannot be more pronounced when the general cooling is less rapid. It is very acute poisoning, as we shall see, it is acting about in 2-3 hours after the injection, of the capral (1-1/2 gr.) the rectal & abdominal curves begin to approach each other. This convergence is brought about by the continued sinking of the abdominal temperature, while the rectal temper. erature either falls more slowly, or remains stationary, or an. tually begins to rise. All these stages are seen in Fig. 5. That the rectal temperature should be the first to show signs of recovery is not surprising when one considers the extremely sheltered position of the part. The dilated abdominal vessels, so to speak, have their advantage, whereas the increased volume of blood they contain is cooled down to the general level. The rectum we may suppose begins to rise as soon as the heat-loss begins to diminish. The bowel, being much more exposed to cooling influences, does not respond with a rise of temperature to a slight diminution of heat-loss, though it must fall more slowly. But after a time the abdominal temperature too begins to rise, the curves reach a slight recovery, then their normal relation, the rectal & abdominal curves again crossing. In summary we have roughly speaking, 1. Crossing & divergence. 2. Convergence. 3. Crossing & divergence to original position.
In the example given above the curves converge just as recovery begins. There is no necessary connection however between convergence & recovery, for the curves may converge quite almost parallel for a considerable time in fatal cases. In the example of sub-acid chlorate poisoning cited above, recovery from the first dose seemed to be complete, but on the third day the temperature was somewhat low at first, probably from depression & want of food during the prolonged narcosis. But in another similar series of four experiments - the temperature was normal on the fourth morning. Let us now see what happens in acute & rapid fatal poisoning by chlorate. Figs 8 & 9 show the temperature curves of such a case. The abdominal curves, it will be observed, record a rapid uniform fall of temperature, presenting no special features whatever. The rectal curve on the other hand is peculiar. After the injection it falls almost vertically (792 in a few minutes) turning both the other curves in its descent, which during the first 5 min. is exactly 3½ times as rapid as that of the abdominal curves. For the next 15 minutes it falls more slowly than the others, (at exactly half the rate), during the next 15 minutes it again falls more quickly than they. After which all three curves run parallel. The only obvious way of explaining such an extremely rapid descent of the temperature of the rectum is to suppose that the part is budding drained of blood, while the splanchnic area apparently does not suffer at all, for the abdominal curves fall at a uniform rate to the end, & marked abdominal local congestion is formed before after death. That the cutaneous vessels are dilated, in parts at least, is evident from the splanchnic congestion of the ears, the bleaching of the tongue, caused by the suicide of the phrenic nerve. The congestion of the ears precedes & in about an hour the cutaneous vessels of the limbs close up.
seen to be affected in chloral narcosis. In Fig. 2 the temperature
curve of the skin of the thigh is seen to fall rapidly after chloral
administration, while the curves which represent the skin of the
trunk, the chest and the intestine, fall more slowly. But we shall return to this again.

In the intermediate case of acute chloral poisoning, that is to
day, rather rapidly fatal nor quite as acute (in which the
patient either lives for many hours, or-as in one case eventually
recovers) the course of the temperature is somewhat different.

In such cases, in addition to observing the rectal and abdominal
temperatures I applied two skin thermometers (Bly thermometers),
one to the skin of the back close to the upper dorsal spine, the
other to the skin of the thigh. The skin thermometers were simply
bounced on to the skin (the part having been first carefully shaved),
the upper surface of the special bulb covered with a thin layer
of cotton wool. The general results are as follows. At first with
regard to the skin temperatures, the thigh curve falls as a rule
at once more rapidly, but the trunk curve may present an initial
rise (2 cases) of from 1°-1.5°C, after of course it falls, but does so
much more slowly than the other, especially at first. In Fig. 9 the
thigh curve falls about 3½ hours as fast as the trunk curve
during the first half hour. Injection of the cars also occurs.

In this case, of course, the abdominal curve generally lags the
primary rise. The hyperemia which occurs later is only indicated by the abdominal temperature remaining constant for
some time (5-15 mm.), after the others have begun to fall.

When it does fall, it takes much the same course as the skin of
the trunk. The rectum falls more rapidly than the abdomen
or skin of the trunk, but less rapidly than the thigh. The fall
of the abdominal curve was delayed for 10 minutes or the back.

Thus the abdominal meals the cutaneous nerves of the trunk.
Head seem to be chiefly affected & cerebral in the rabbit.
To summarize briefly. We have considered three sets of cases of chloral poisoning.

1. Sub-acute, in which the process lasted 3-6 days the tail on each day varied from 1-15 min. Result: Marked primary rise of the abdominal temperature followed by a fall slower than that of the rectum. Rectum falls uniformly upon the whole.

2. Acute poisoning fatal in 1-2 hours with a dose single or divided of 2.5-6.5 gm according to size & sensibility of animal. Result: Rectum falls immediately & almost instantaneously, crossing abdomen in the descent; then falling more slowly. Abdomen as a rule from no primary rise, (it did in one case 1.05), but falls uniformly after a time both fall parallel till death.

3. Intermediate cases intermediate i.e. as regard time the animal dying after many hours or as in the case recovering slowly (2 days) Result: no primary rise of abdominal temperature but it remains constant for some time (5-15 min) after all the others have begun to fall. Rectum falls uniformly & more rapidly than abdomen.
Skin of trunk (cheek & dorsal spine) slight primary rise (10-15°C) followed by a fall slower than that of rectum & about equal to that of abdomen. Skin of thigh. Generally rapid immediate fall, at first, much more rapid than the others afterward about equal to that of rectum. Consequently quicker than abdomen or skin of trunk. In the two last sets of cases congestion of the ears occurs starts for about an hour.

Interpretation: We have tried to show in the three sets of cases considered alone, that the primary rise, the uniform fall, the re.

Maintaining constant of the abdominal temperature all indicate the same (adiabatic) condition of the abdominal results. This we have been confirmed by acute post mortem examination.
The rectum falls more rapidly than the abdomen in state of the greaty more sheltered position. It must, therefore, be in a condition of (relative) anaemia.

The temperature of the skin of the flank (head) may first rise, then falls with the general cooling, but more slowly than the rectum. It must, therefore, be in a condition of (relative) hyperaemia as it is very much more exposed to heat-loss than the rectum.

The high curve falls rapidly & diverges, which probably indicates anaemia of the limbs.

The fatal dose of chloral in rabbits varies greatly according to the conditions of the experiment & the precautions taken to prevent heat-loss. Whether the animal is covered with cotton-wadding or exposed, whether the room is warm or cold &c. According to these the term are borne in summer than in winter. In one case 1/8th proved fatal in 1 hour 35 min., the rectal temperature falling 4°C, the abdominal 3.1°C. In another case the animal recovered from a dose of 3gram, but the depression of temperature was very great.

The recovery very slow. Fig 9 shows the course of the temperature.

The chief points here as follow:

<table>
<thead>
<tr>
<th>2nd day</th>
<th>4th hour later</th>
<th>2nd hour later</th>
<th>4th day</th>
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<tbody>
<tr>
<td>shun</td>
<td>38.7°C</td>
<td>34.1°C</td>
<td>28.2°C</td>
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<tr>
<td>tomm</td>
<td>38.7°C</td>
<td>34.7°C</td>
<td>29.2°C</td>
</tr>
<tr>
<td>right</td>
<td>36.4°C</td>
<td>33.4°C</td>
<td>29.2°C</td>
</tr>
<tr>
<td>left</td>
<td>33.9°C</td>
<td>31.1°C</td>
<td>26.9°C</td>
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</table>

This experiment was performed in summer (6th June 79) & the rabbit was lightly covered with cotton wadding. The temperature of the room was 15°C.

The rectum fell 10.5°C, the abdomen 9.5°C, the skin of the back 7.1°C, the skin of the thigh 9.05°C. But the greatest depression was fast.

Brunton quoted & Fothergill in his lectures on Department of the circulation.
concentrally greater than is recorded alone for the temperature and rising itself rapidly when the lowest measurement was taken. Recovery had certainly begun some time before. The high temperature of the skin of the back on the second day is noteworthy in this experiment.

Death in chloral poisoning results either from stoppage of the heart (generally in the sole) or from stoppage of the respiration. In the latter class of cases the heart frequently continues to stand or to stand for long after death. It may even continue to beat spontaneously for some time after the thorax is opened.

As regards the Modus Operandi of chloral on the nervous system there is still some doubt. Most experimental on kidney removed from the body seem to show conclusively that it affects the peripheral nerve motor mechanisms. Cerebral tracts reach from ready to told of electric during the delirium of chloral narcosis, but this may be due to direct cortical muscular plant cells. It is perhaps worth mentioning that on one occasion after injecting chloral into the arista of a rabbit, I observed the ear of the same side to become rough, marked, congested some time before the other ear was at all affected. This would tend to show peripheral paralysis. But what the medullary motor centre is also (chiefly) affected there is little doubt.

Thus chloral is primarily a nerve motor poison, though secondary in large doses a cardiac or respiratory poison. The great fall of temperature is chiefly (or entirely) due to increased heat loss from dilated cutaneous arterial vessels in the rabbit.

The action of Morphia

is very uniform whether the dose be large or small. Thus

With a small dose (1–1/2 grains) there is a moderate fall of all
three temperatures; but the rectal falls rather more than the
buccal curves, which as usual run nearly parallel (Fig. 11)

With a dose of 0.02 gm. the fall of temperature is somewhat greater,
but the relation of the curves is similar. The rectum falls
more decidedly next (Fig. 12).

With a dose of 0.03 gm (Fig. 13) the divergence of the curves becomes
more marked, as much so as in an almost deep case of cholera
poisoning. In 2 hours +10 mm. Hg. (Fig. 13.) the rectum fell 2.8°C; the
small intestine 1.4°C, the large intestine 1.5°C. The parallelism
of the intestinal curves — their divergence from the rectal curve
are well shown in this example.

With a dose of 0.08 gm (Fig. 15) no essential alteration occurred in the
course of the temperature. In 21/2 hours the rectum fell 3.8°C; the
small large intestine 2.9°C each. Note again the parallelism
of the abdominal, the divergence of the rectal curve. At this
point 21/2 hours after the injection of the Morphia, the animal
began to recover; all three temperatures began to rise at the
rate of 1°C in 1.5 hours. At the close of the experiment, they were
still running parallel.

Fig. 14 presents another feature of the Morphia curve. Immediately
after the injection of 0.02 gm, a sudden and considerable fall of
the abdominal curves occurred, followed, after about half an
hour of constant temperature, by a slight rise. This rapid
primary fall of the abdominal temperature I have only ob
noted twice, the secondary rise once (in the example cited above)
if it should prove to be a constant occurrence after a certain
dose it might be reasonably interpreted as indicating a con
traction.
of the results of the splancnic area during the stage of chloral.
Ment. precipitated blood-pressure.
As regard the interpretation of the above results: The main facts are
1. Both rectal & abdominal temperature fell.
2. The abdominal temperatures fall parallel.
3. The rectal temperature always falls distinctly more than the abdominal.

How is this fall of temperature brought about? There is no obvious
viiivo motor action as in the case of chloral: neither abdominal
nor cutaneous vessels appear contracted. The former indeed
are contracted, for I have invariably found the intestines
anemic when the animal was killed during the phase of arexia.
And the blood-pressure is generally raised. It seems probable then
foil that the fall of temperature is due in great part at least
to diminished heat-production, instead of, as in the case of
chloral - to increased heat-loss. That the body-temperature may
be greatly depressed or greatly elevated is influences which act
upon the central nervous system, upon that part of it which
regulates the heat arrangements (oxidation processes), if the body-
we know from various facts both clinical and experimental.

Plumalte hyperpyrexia is probably to be attributed to some
cause acting in this way, the extreme depression of temperta-
ure which sometimes occurs after the injection of chloroform
matter into animals, may be cited as an example in the
opposite direction. Dobjansky & Hanzy in their experiments on
dogs, rabbits, rats, & guinea-pigs, found that besides causing
fever or collapse according to circumstances, injection of chloro-

1. Dobjansky, Hanzy: Beiträge zur Lehre von den Fälschungen (durch
Pyrogene Stoffe bewirkten) Temperaturerhöhung. Archiv für experimant,
Patholog. und Pharmakolog. Band 1 Heft 3 S 181-182.
Matter destroyed the heat-regulatory power, i.e. the power of main-
aining a tolerably constant temperature under varying external
conditions. And they attribute this result to the action of the ether
upon the central nervous mechanism.

Manassei observed that after diurging a rabbit for 1/2 hour its
temperature fell, sometimes as much as 12° C., remained so for
1/2 - 2 hours, the animal being at the same time drowsy.
The cooling did not depend on loss of heat from the current of
air, for it occurred also when the animal was wrapped in
cotton wool. Manassei believes that the diurging acts upon the
central nervous system diminishing heat production, just as
it diminishes cerebral activity—causes sleep or torpor.

Blindfolding the animal increased the cooling, but if the
breathing was checked, ether mechanically. Very small doses
of morphia, the cooling was diminished. If the temperature was
first reduced by morphia, then after this action had passed off
the animal was drowsy, its temperature was unaffected;
whereas a rabbit whose temperature had been reduced by al-
cohol might have it still further lowered by diurging.

Finally in rabbits rendered feverish & insensible by sudden
swooning is peculiarly effective, especially during the resolution,
when it may even reduce the temperature to normal.

These facts are of great interest, especially those regarding al-
cohol & morphia. Alcohol like chloral is a peripheral coole,
leaves the central mechanisms practically unaffected, & thus
so to speak open to the action of diurging. Morphia on the other
hand acts upon the central regulator mechanism & apparently
exhausts, for the time being, its similarity to the action of diurging
as both affect it in the same way. Pulverize morphia also affects.
The central mechanism, producing in small doses fever. The fact that sweating reduces such fever offers no difficulty, for the heat regulator is as it were off the balance in the opposite direction to that in which sweating influences it, hence it is only the more likely to react readily to any counteracting force. Just as it is much easier to reduce a feverish temperature than a normal one, so much for the way in which morphine reduces temperature. We now turn to the second fact deducible from the curves.

2. The abdominal temperature, in parallel, falling rising together or maintaining as a rule a tolerably constant distance from each other. This is merely interesting as showing that the abdominal temperatures really are approximately those of the small or large intestine, but not merely subcutaneous temperatures accidentally differing.

3. The rectal temperature always falls decidedly more than the abdominal. Why this should be while the intestines are rather active than hypostatic it is difficult to say. The explanation was easy formerly in the case of liberal use account of the congestion of the intestines, but in the case of morphia no motor changes if they do occur are not evident. The heat-regulating mechanism of which we have spoken is no doubt a multiple centre of a very complex order. The fact of its being of course least the more sensitive to a particular influence than the rest. This however is pure hypothesis, although the prevalence of thermal, nutritive of urine, carbonic acid and other substances for particular vascular districts is in favour of some such view. The influence of the central nervous system upon these changes is compared to Pain and to the action of

motor nerves upon musculæ and secretory nerves upon glands.
As regards the general action of Morphia on the rabbit, a few remarks may not be out of place here.

Sensibility to pain is greatly diminished, but the reflex excitability is much increased, the slightest noise, vibration, thought, or causing reflex movements. A sort of tone rigidity of the muscles occurs, very different from the relaxation produced by chloral. Thus, the head will remain in almost any position in which it may be placed; if raised it moves very slowly to the table, in stead of falling like a stone as it does in chloral narcosis.

Respiration becomes very much slower and deeper, may be reduced as low as 8 per minute. This effect traces off while the temperature is still falling, long before the recovery of consciousness (Fig. 15) which does not occur until the temperature begins to rise, after which the two actions advance hand in hand. The slowing of the respiration is possibly due to temporary paralysis of the vagi of the vagi; this view is supported by the fact that the action of the heart is very rapid. But on the point I have no precise observations, excepting active peristalsis is sometimes observable through the abdominal walls.

To sum up: contrast in a single sentence the actions of chloral and chloral + Morphia in the rabbit.
Both lower the temperature. Chloral acts chiefly upon the splanchines and cutaneous vessels, increasing heat loss. Morphia acts chiefly upon the central nervous mechanisms, limiting heat production. Chloral diminishes or abolishes reflex excitability—causes muscular relaxation. Morphia excites reflex excitability—causes muscular rigidity.
The thermometer was in fact arranged like a mast, with cross-horse stays, which were passed round the animal's body, gently stretched, secured with catch-fores.
In the following experiments on the action of stercory stimulans on temperature, some changes of method were introduced, as these were continued throughout the series, it will be necessary to describe them before proceeding to the experiments themselves. The skin temperature, & indeed all temperatures except the rectal, were taken & means of thermometers constructed, (after various modifications), as follows.

The bulb of the thermometer consists of a thin walled glass tube of about 2.3 mm. diameter, folded up in the form of a flat spiral of three turns. The shell of the thermometer is melted on to the central end of the spiral & is placed vertically, i.e. at right angles to the plane of the spiral. The scale is divided into 100 of a degree, but can be fairly read off & with a good lens 10'. These thermometers take the temperature of their surroundings accurately in 1-2 minutes, but show changes clearly well in a correspondingly shorter time. In order to avoid error in reading off, a delicate thread was bound horizontally round the tube at the level of the mercury, & a lens was used to magnify the scale. The abdominal thermometer was adjusted as follows.

The flat spiral bulb of one of the above-described thin thermometers was introduced through a small opening in the skin or fascia over the small intestine, the lips of the wound here being carefully stitched together on each side of the shell of the instrument. A small circular pad of cotton wool was adjusted over the wound & fixed by a piece of broad tape which was placed round the abdomen & perforated for the thermometer. Strong crocodile threads, suitably disposed, were next fixed to the instrument: removable and at the same time to press the spiral bulb gradually inwards. When necessary it employed one or two additional abdominal bands are advisable in order to...
replace the normal tone of the abdominal muscles. I found the abdomen from flattening out so much as to alter the relations of the contained organs.

In those cases in which it was necessary to employ artificial respiration, I made use as a rule of Pflüger's new apparatus. By means of this apparatus it is possible to blow air or any other gas into the lungs of an animal, under a constant pressure which can be changed at will. Further, the frequency of the respiration can be regulated within wide limits, the time occupied by inspiration and expiration respectively can be adjusted to any required ratio. The accompanying figures represent the entire apparatus and the special mechanism of the interruptor. Fig. 1 gives a general view of the whole apparatus (no line natural size). The several parts are

1. A cylindrical copper vessel C.
2. The water-drum T.
3. The air-drum T.
4. A mercury manometer m. The entrance & exit serve for water & air.

When the cock h is opened water flows from the supply-jug up through the tube a into the water-drum T, and it falls from there through the three equal parallel glass tubes b b b. into the cylinder C. It reaches air down with it from the air-drum T, through the three narrower tubes c c c which pierce T, and then falls into the tubes b b b. Air enters the apparatus either at K, or if the cock h there is closed (placed vertically) then at K, lower drum. Having passed along the tube a and the air reaches the air-drum T, then streaming through the tubes c c c it becomes mixed with water, and water & air together flow down the tubes b b b. Which open into the upper-end of the cylinder C. In C the water falls to the
bottom, the air remains at the top. The water being under a certain pressure, compresses the air collected at the top, force it through the leads and tube d, which arises from the cyliner behind the middle glass tube f, over a mercury manometer or manometer, and drives it to its side. The air passes down the tube e towards the cock h. But the resistance which the air encounters in escaping from the cylinder generates a certain amount of pressure, which acts on the air and compressing it, on the water g, driving it from the lower end of the cylinder upwards into the tube f, where it rises nearly as high as the top of the cylinder before it finds its way downwards to the cock k, through it to the outflow tube l. The tube g, open all the way, descends from the top of f. It prevents it from rising acting as a reservoir, at the same time q serves as a safety valve in case either of manometry, high air pressure, or exposure of water hi e.

By regulating the water supply q, hence of the cock h, one can increase or diminish the amount of air. By means of the escape cock h one can control the pressure of the air (resistance in the air tube being equal). The manometer m registers the air pressure. The glass bulb on the open limb of the manometer is to act as a reservoir channel the mercury from being forced out of the tube f by excessive pressure. The glass tube f the side of the cylinder e shows whether the relation between influx and outflow of air remains constant, so that water may not rise into the air tube, nor air descend into the water tube. The small cock h on the water outflow tube serves in case of need to empty the whole apparatus.

The compressed air leaves from the cylinder e, along the tube e through the cock h, whence it is conducted by means of a piece of India-rubber tubing to a brass air chamber i, the
inferior of which is shown in section in Fig 4. The chamber is shaped like a segment of a flat cylinder and has two tubes or p. soldered into its walls. To the tube r. is attached a sliding valve ss. which, according to the direction in which it is turned around the axis u, closes one or other of the tube o or p. The compressed air enters this chamber through the tube q. or the tube o (when not closed by the sliding valve). conduct it to the chamber of the animal under experiment. While this is taking place the tube p., leading to the other air, is kept closed by the sliding valve, and when the valve closes o the compressed air escapes through p. into the atmosphere, more or less quickly according to the adjustment of the cock or p.

The rhythmic action of the valve, and in consequence the rhythmical interruption of the respiratory stream, is accomplished by means of a double swinging trough (q ou) which is attached to the axis of the sliding valve. This swinging trough is represented in Fig 2 in its three important positions.

1. The position indicated by the blue outline. When the respiratory tube is closed.

2. The position indicated by the black outline. When the air has free access to the respiratory tube, but the other (escape tube) is closed.

3. An intermediate position (red outline), only possible as a temporary transition stage, when half of each end tube is closed and the valve as represented in Fig 4.

The swinging trough is set in motion by a stream of water which comes from the cylinder c., through the tube f., onwards to the cocks r. By adjusting this cock a larger or smaller stream can be made to fall into the swinging trough. When cups of water are placed on the ends of the swinging trough held over its axis, so that as soon as one of the two equal divisions or buckets of the trough
is filled, the weight of the water causes it to swing round on its axis, thus emptying the water through the central partition between the two buckets (as Fig. 3) to the other side of the system of water. The second bucket (2) fills or falls in its turn, keeps going on in regular alternation. A central buffer or prevents the trough from swinging round altogether. The water spills out of the swinging trough is caught in a semi-cylindrical pipe and conveyed away by an escape-pipe.

Finally, fixed to the axis of the trough swinging with it, is a brace rod bearing a sliding weight (as Fig. 1) By means of this sliding weight the eare quicken the swinging of the trough in the one direction & delay it in the other. And thus the relative length of inspiration expiration can be regulated.

In Fig. 3 the front half of the pipe level is represented as partly removed, in order to show the form of the swinging trough distinctly. It is really composed of two troughs or buckets joined at an angle separated & a central partition. The apparatus requires a pressure of water equal to 1-1/4 atmospheres, (if well made). Or uses 1-lb. of water for every 10 lbf. of air.

The experiments were conducted in the following way:

1. The thorax was passed & a canula introduced.
2. The animal was thoroughly saturated (2-2% solution of a large rabbit)
3. The abdominal & rectal thermometers were introduced & fixed, with the precautions already described.
4. The saline solution was allowed to flow on an electrode in the usual way, the edges of the wound were carefully stitched together on each side of the electrode, so as to keep it steady & prevent all dressing on the wound.
5. A lens was adjusted to take thermometers to facilitate rapid readings.

The apparatus is made by Robert Muncelle, 33, Holborn, N.W.
The electric current was obtained from Dr. S. Daniell, after the kind of stimulation employed here.

(1) The interrupted current of varying strength from an ordinary induction apparatus.

(2) Single shocks (1-5 p.s.) applied by means of Prof. Kromer's interrupter.

(3) The uninterrupted current from the same apparatus.

In order to facilitate comparison of the results, Prof. Kromer's interrupter was employed in all but two experiments, as it enables the operator to administer single shocks at any desired interval of time, from 1 sec. to 1/10 sec., or to apply an uninterrupted current of the same strength as the single shocks. The strength was regulated by an induction apparatus, which was included in the circuit. The letters R.A. in the chart ("Rollen-Abstand") denote the distance of the primary from the secondary coil in centimetres.

The results of stimulation with the interrupted current from an ordinary induction machine present no special features and do not require separate discussion. The results of the experiments here very uniform.

Injuries are brief notes of general, typical and otherwise. The separate observations on each experiment are noted in the order in which they were made. (Exper. 2, supra)

Exper. 16.

1. Stimulation of the Striatum nerve with the ordinary interrupted current for 40-50 sec. caused the abdominal temperature to fall 10°C to 12.5°C. After cessation of stimulation the temperature rose again slowly to 37.0° C.

Exper. 17.

2. Two shocks per second for 150 sec. gave a fall of 0.75°C in the abdominal temperature. Four shocks per second for the same time gave 1°C. After two shocks per second had almost ceased to influence the curve (0.025°C) an interrupted current of the same strength caused a fall of 1.0°C.

Exper. 19.

3. One shock per second for 60 seconds produced no effect. 15 shocks per sec. caused the abdominal temperature to fall 1.0°C. Two shocks per sec.
Then caused a fall of first 1 deg. subsequently 0.075 deg. after which 15 shocks per second gave -10 deg. In this experiment as in most of the others the rectal temperature showed changes in the same direction as the abdominal temperature, but less in extent. The temperature of the skin of the thigh was also obtained. It did not actually fall during stimulation, but its fall was almost completely checked for the foot. Instead of continuing its descent it remained stationary or nearly so during the stimulation, as H. H. had already shown. In an experiment in a nearly rabbit one shock per second for 60 sec gave a fall of 0.075 deg but the ordinary reaction was not checked. The abdominal skin, however, fell apparently more slowly during stimulation while the rectal temperature fell more rapidly. Post mortem. Interes abdominal congestion was found. Paralysis from over stimulation (91.

Experiment 5. The Medulla oblongata was divided below the level of the lower edge of the spinal cord stimulated. No effect was produced upon the abdominal temperature. The rectal temperature seemed however to show slight changes, but they were probably accidental. (Fig. 19)

The spinal rami motor nerves no doubt react to the stimulation but the effect may produce but slight apparent. The method not being sufficiently adequate to show anything but trace changes.

Experiment 6. The Medulla is divided as before the lower face of the section stimulated. The abdominal temperature fell 10 deg.

The conclusions deducible from the above experiments are
1. The interrupted current is more powerful than single shocks.
2. The interrupted current is more powerful than single shocks.

Uhr, h. U. (1870) and

3. Other things being equal, the more rapid the single shocks, the more effect do they produce.

4. The fall of temperature is brought about through the agency of the Medulla Oblongata.

The precise extent to which the efficiency of a stimulus depends on the rapidity, as opposed to the intensity, of the shock, I do not know. The temperature of the rectum as a rule presents changes similar in direction to those of the abdominal temperature, but less in extent. This is fairly well-marked in a good many of the cases. The fact that it is less obvious in some may be partly due to defective observation. For having to work single-handed it was impossible for me to watch two or three thermometers quite continuously, the abdominal temperature certainly receiving most attention. That the rectal changes should be less in extent than the abdominal one would suggest from the relative vascularity of the parts.

Interpretation of the Results Described Above.

There can be little doubt that the fall of temperature in the abdomen is due in great part to contraction of the vessels or increased rapidity of the circulation in those parts, caused by reflex action of the stimulus on the medullary vas motor centre. Heidenhain's observations are conclusive on the point. Proof of the same kind is furnished by experiment 3, which shows that when the vas motor centre is cut off, the fall of temperature does not occur. But Heidenhain has proved:

1. That during stimulation of sensory nerves the blood temperature (measured in the fem. imp.) falls.

2. That the influence of sensory stimulation on temperature is due to the action of the Medulla Oblongata. (Compare Fig. 3)

3. That the fall of temperature is accompanied by a rise of blood pressure.
This rise of temperature occupied 1-14 min. The subsequent fall occupied 6 or 7-10 min.
1. & a consequent quickening of the blood current. 

4. That during stimulation of the more remote nerves (afferent), the blood current is quickened, the volume of blood which passes through the vessels in a given time greatly increased (Stirn, Handbuch Physiologie). 

5. That the blood temperature is raised when the circulation is stopped. 

This may be readily demonstrated by applying a Kroeber's skin thermometer to the skin of the face, compressing the arteries of the face. 

The temperature rises immediately and suddenly (25°C. + 3° to 120 min). 

This rise is partly due to increased heat loss, for Livingstone found that when he placed a warm cloth on the skin of the face of a male elastic brown-skin the heat loss was diminished 18.6%. In one case it was less than from bloodless skin. 

This quickening of the circulation produced as described & absence of stimulation, without the accompaniment of increased muscular action, causes the temperature to fall. But this fall of temperature here depends on the fact that the peripheral parts of the body are normally cooler than the central parts. During stimulation the cool peripheral blood passing with increased rapidity and increased volume to the interior, produces necessary a fall of temperature. But if the periphery of the body lie within reach, e.g., (paw) or artificially (warm bath) made warmer than the interior, then nervous stimulation produces either a negative result or causes an actual rise of temperature. There are thus according to Kleiderhain two conditions on which fall of temperature during nervous stimulation depends. 

1. Quickening of the circulation 

2. Difference of temperature between the internal & peripheral parts of the body — the latter being cooler.
That this simple and natural explanation of the phenomena will require modification ere long is very probable, but meanwhile our knowledge of the central nervous mechanisms which undoubtedly help to regulate the heat-economy of the body, which may, perhaps, be affected by sensory stimulation, is too limited to enable us to do more than guess obscurely at their mode of action. That the nerves which convey impressions of heat or cold are capable of influencing this circuit or group of centres, reflexly, may be inferred from the effect of external cold heat in increasing or diminishing the metabolism of the body, but whether or not the sensory fibres have the same power we do not know; probably they have.

Berard confirms Hettenhauzen's results and attributes the fall of temperature to part at least to the action of a central mechanism which checks the chemical changes concerned in the production of heat.

As regards the effect of sensory stimulation on the skin, Hettenhauzen shows that while the internal temperature is falling the skin temperature constantly rises. That after the stimulation is over the circulation tends to recover the balance, the skin temperature not falling, while the internal temperature tends to fall. If the skin temperature is quickly rising at the height of stimulation, its fall is delayed by the stimulation (Fig. 8) or it may even be turned into a rise according to circumstances.

Experiment XX in Hettenhauzen's paper further shows that the temperature of the right paw, (soles between the toes) rises equally whether the sensory nerve (cutaneous end of nerve) be stimulated on the right or left side. This is not exactly as Brown-Léger and Lombard both maintain the opposite.
On the mention under of Striated muscle.

Studies from the Rheed's Laboratory of Cambridge. III, 132-136.

Jacobsen, Wundt, and others also found that irritation of the skin (cutaneous stimulation) caused the arterial temperature to fall, the skin temperature to rise. Wundt even obtained a crossing of the curves. Thus the vessels of the skin must either not contract at all, or, if they do contract to such an extent that the resulting increase of resistance is opposed to the greatly increased blood pressure, be not sufficient to diminish the volume of blood passing through the skin. And as the volume of blood passing through the skin, in a given time, undoubtedly increases during sensory stimulation, the resistance must increase less than the Vz a torso.

While the influence of the skin which is only temporarily removed by sensory stimulation, causes a relative great decrease in temperature at the periphery, if at the same time protects the intestinal parts from an equally great loss of heat. It is possible if frequently repeated vascular stimulation to so quicken the circulation in the skin that the internal temperature rises not insignificantly. Hence the occasional cooling effect of cutaneous irritation, on the muscle temperature. Changes in muscle during sensory stimulation, may according to Helmholz in the same direction as those occurring in the skin, but are also considerable. Jäckel describes dilatation of the vessels of muscle as a result of stimulation of the vascular centre.

So much for the effect of reflex stimulation of the vascular centre on the temperature of the body. Internal & external let us now consider what is the effect of direct stimulation of the vascular centre.

Electrical Stimulation

The medulla was exposed & divided, the electrode introduced into the wound, the cord stimulated with the interrupted current. When the animal was narcotised the phenomena which occur during stimulation is a powerful disturbing influence. The thermometer is apt to get displaced. The result of course complicated the sudden circulatory & other changes caused by general muscular spasms. I performed the experiment several times in this way: I found that the abdominal temperature fell 1° 2° or even 3° C. The rectal curve was not marked by influence of the individual stimulations, but the general effect they produced was apparently to hasten the fall of the abdominal & check the fall of the rectal temperature. In one case at the beginning of the experiment the abdominal thermometer registered 37.6° C, the rectal 34° C. The curves gradually converged, & after 30 min. stood at 32° C. These temperatures are strikingly low, & yet respiration & other acts were strong & regular throughout the whole experiment. 5 or 10 min. after the head vital was punctured the pulmonary circul"
Another example.

<table>
<thead>
<tr>
<th>Roll</th>
<th>Act</th>
<th>Reaction</th>
<th>Temperature</th>
<th>Time</th>
<th>Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>13</td>
<td>sec</td>
<td>↓ 20°C</td>
<td>y</td>
<td></td>
</tr>
<tr>
<td>y</td>
<td>60</td>
<td>sec</td>
<td>↓ 30°C</td>
<td>y</td>
<td></td>
</tr>
<tr>
<td>y</td>
<td>1</td>
<td>sec</td>
<td>↓ 1°C</td>
<td>y</td>
<td></td>
</tr>
<tr>
<td>y</td>
<td>15</td>
<td>sec</td>
<td>↓ 0.5°C</td>
<td>y</td>
<td></td>
</tr>
</tbody>
</table>

Thus, these times out of four, the rectal temperature shows a slight rise simultaneously with the fall of the abdominal temperature.

In a carotid rabbit after division of the medulla, electrical stimulation of the cord (12 shocks per sec) caused the abdominal temperature to fall 1°C, during 60 sec stimulation. After cessation of stimulation the temperature remained constant for another minute or rather more, then it rose again (0.05°C). In this experiment, also, as in the non-carotid rabbit, the fall of the rectal temperature seemed to be checked during stimulation although the changes were slight—the general course of the temperature remained. (By 21)

During reflex stimulation of the vasomotor nerves the fall of the rectal temperature is accelerated, the same holds good as we shall see presently, of direct stimulation of carotid sinus. When direct electrical stimulation of the cord should produce a different effect upon the rectangle, (if indeed it does so), it is difficult to say, unless it be that in the latter case the splanchic fibers are somehow more powerfully influenced than the other vasomotor, the blood is drawn from the splanchic area to other parts, including the rectum. A Bach found an increase of volume in the dog's hind-paw during stimulation of the splanchic nerves. Whenever the blood pressure reached a certain height, but the curves of increased volume of increased pressure did not run parallel, it meant that although there was a general correspondence, so that although there is a relation between the two it is not a simple one.
A few words on the action of curara on the abdominal and rectal temperatures are necessary in this place.

Normally, as we have seen, the rectal temperature is decidedly higher than the intestinal; but after a full dose of curara this relation is completely reversed. I found, taking an average of 12 experiments, that the bowel temperature is usually about 1°C higher than the rectal. Fig. 19, 21, 22 show this reversed relation. The change is instant due chiefly to paralysis of the abdominal muscles. In the experiments on rectory stimulation, in all of which curara was given—Marked abdominal congestion was invariably found after motion. If curara was given, but no rectory stimulation employed, considerable abdominal congestion was still found, but not nearly so marked as in the former case, in which therefore the congestion must have been due partly to the curara, partly to the rectory stimulation, or rather to stimulation. Again, after division of the medulla without curara, the bowel temperature, although generally higher than the rectal, does not amount to 37°C or anything much (20-26°C). But after division of the medulla with curara the bowel temperature is always much higher than the rectal. The difference often amounts to 20°C. The inference is obvious. Curara causes abdominal congestion. It is known to be a vasomotor poison, the splanchnic area in the rabbit is the most sensitive vascular district. The general temperature is considerably lowered by curara. Taking the temperature at the beginning of my experiments (12 in number), the abdomen was found to average 36.6°C, the rectum 33.5°C. This general fall appears to be due to diminished metabolism, for if it is not prevented by wrapping in cotton wool, it occurs in an atmosphere of 30°C. Pflegel's experiments point to this conclusion. Curara, according to him, paralyses the autonomic.
heat-regulating mechanism, makes a warm-blooded animal react to external cold heat in the same way as a cold-blooded animal. That is to say, its temperature, instead of remaining constant under varying external conditions, rises and falls with the temperature of its surroundings. Section of the spinal cord between its cervical and dorsal divisions, he found, produced much the same effect as curara. And this trick we'll consider.

The effect of division of the medulla - as shown in Figs. 19, 20, 21, 22 - in a paralyzed rabbit the temperature of the abdomen (small intestine) is about 1°C higher than the temperature of the rectum. If now the medulla be divided, the rectal curve falls very rapidly, diverging widely from the abdominal curve, until it falls 20-25 mm. The distance between the two is doubled, or nearly 20, and remains constant nearly to about 2°C. After this, the two temperatures run parallel, falling together. Immediately after section - during the first 3 minutes, the rectum falls 3-4 times as fast as the abdomen, during the second 3 minutes, 1-3 times as fast as, or with a leveling difference until the two again run parallel. The abdominal curve, on the other hand, shows no sudden change after the section, but falls steadily and uniformly, although more rapidly than before. Injection of the ears is often visible. Now the three points here mentioned viz. (1) sudden fall of rectum, gradually returning closer (2) steady fall of abdomen at increased rate, and (3) injection of ears, are precisely those which we have already learned to use. With this, we have acute poisoning of cholin. The relation of the curves is of course different to start with (from the curara), but the essential changes are the same, and are doubtless to be explained in the same way. The rapid fall of the rectal temperature must be due to that part being situated around the blood, which flows probably into the splanchnic area, as in the
case of chloral. The skin, in part at least, also becomes hyperemic.

Thus we have abdomen + skin congested. The muscular arteries
must therefore be empty. The we should expect in this ground.

The general fall of temperature which occurs is not entirely due
to increased heat-loss, (it also go on in an atmosphere of 30°C), but also in
part to diminished oxidation (Fégarg, Parinaud, Gérard) (Parinaud
describes a fall of the internal (deep mental) temperature after
division of the spinal cord.)

The abdominal congestion which is found post mortem after cauta
division of the medulla, is not so marked as that found in
chloral poisoning, & differs from it further in this, that it be-
comes less on exposure to the air, while chloral hypnotherapy
under the usual circumstances tends to become more marked
—the paralysis being both central & peripheral.

Some light is shed upon the way in which the fall of the rectal
temperature after division of the medulla is brought about by the
following experiments

oper. 1. In a carassed rabbit the right splanchnic nerve was divided
(both through rapids of a delicate forceps made out it). No obvious effect was
produced upon the temperature. 35 minutes later the medulla
was divided with the usual result—rapid fall of rectal temperature.

oper. 2. In this experiment the left splanchnic nerve was divided. Slight
change of the rectal curve took place, the abdominal tempe-
rate remaining almost constant. The medulla was then divided.

No change of the rectal curve followed as in the former case,
but both temperature fell steadily, parallel, very changing slightly
after a little time (10 minute). In this case the channel through
which the influence producing the rectal fall descends from the
medulla was evidently cut.

oper. 3. Both splanchnic nerves were divided, one after the other.

Very
slight divergence occurred, but the general course was apparently unchanged. The medulla was then divided, causing both tempora
tures to fall more rapidly, the rectal curve to emerge somewhat more. but not much.

The fact that division of one or other, or both, of the splanchnic nerves precludes division of the medulla from affecting the rectal temperature in the usual characteristic way, is in support of the view already advanced regarding the way in which that change is brought about. Thus the influence producing the rectal fall is
tended (as the case cited) the left splanchnic nerve. But the in-
fluence producing the rectal fall is, in this case as in chloral
poisoning, - abdominal hyperaemia, which may or may not be caused
by division of the splanchnic nerves. The sudden fall of the rectal
temperature means, then, acute of the medulla, and (at least) rise of
the hyperaemia of the abdomen, which it must be remembered is
already congested from the curare. The dilatation of uterine ves-
els probably prevents the abdominal congestion from being intense.

The action of Carbonic Acid Stimulation

i.e., suspension of breathing in carbarized rabbit may be diminished
in a few words.

During the period of stimulation, the fall of both abdominal and rectal temperatures was very much accelerated, as will be evident
From Fig. 26. Here is a pure experiment. No sensory stimulation
having been employed.

During 3 minutes suspension abdomen fell 3° C., rectum also 3° C.

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Rectal (° C.)</th>
<th>Abdominal (° C.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>35°</td>
<td>32°</td>
</tr>
<tr>
<td>1</td>
<td>32°</td>
<td>29°</td>
</tr>
<tr>
<td>2</td>
<td>30°</td>
<td>27°</td>
</tr>
<tr>
<td>3</td>
<td>28°</td>
<td>25°</td>
</tr>
</tbody>
</table>

The effect did not pass off at once on resuming respiration, but
continued with slight increase for some minutes - about as
long as the stimulation lasted. Then the fall became very (abnormally)
Now for a little & finally the balance of the circulation having been restored the curves resumed their ordinary course. Next analysing the first part of Fig. 26, he found that,
During suspension of 3 minutes abdomen fell 3°C Rectum also 3°C
next four minutes 2° 130°
next five minutes 050° 050°
next three minutes 050° 125°
next nine minutes (N.B. stimulation) 25° 275°
During stimulation fall = about 1°C per minute
In interval after effect closed 027° 030°C
This +4 four times as rapid during stimulation as in interval.
To take the second stimulation in the same way.
Suspension of 4½ minutes abdomen fell 350°C Rectum 4°C
Exceeding 4½ 3° 125°
3 ° 0° 075°
9 ° 225° 325°
In the first example it will be seen that the parallelogram is more marked than in the second, but the general features of the curves are alike in both.

This result is just what one would expect to be agreement with
Epp's observations on the blood temperature taken directly
*3° Because of a thermometer introduced into the Vena Cava Inferior.
In every case of Carbonic acid stimulation the curves did not follow the precise course described above. The primary fall always occurred, but sometimes it was succeeded by a slight rise instead of a continued rapid fall.
Carbonic acid will cause a fall of temperature after almost 30 minutes, has become temperature to nearly 30; it is therefore the more powerfulminirule of the two. This may be due to the fact that Carbonic acid acts, not only upon the Lastnidor arteries in the medulla,
& spinal cord, but also upon the peripheral vasomotor mechanisms. In one case in which sensory stimulation had failed to cause any reaction at all of the abdominal temperature, carbonic acid stimulation caused the rectal temperature to fall with considerable
creased rapidly, while the abdominal temperature remained almost stationary, or fell only 1/300 or 1/4 as much as the rectum (K.S.D.). This was probably due to the fact that the splanchic area, i.e., the splanchic nuclei, was paralyzed from the stimulation, while the rest of the vascular system remained sensitive. That part of the vasomotor center which governs the splanchic area was exhausted—the rest of the center remaining active. This theory was suggested by the extreme abdominal congestion found post mortem in these cases in which repeated or prolonged stimulation had been employed. That the paralysis of the center was also indicated by the fact that the congestion became less on exposure to air—(stimulation of peripheral centers.)

We have seen that carbonic acid affects the vasomotor system both centrally & peripherally: its preference for particular vascular districts is shown & the dilatation of the cutaneous or muscular vessels found in asphyxia.

The manometric method described in this paper was adopted in order to avoid both the after effects of operative interference, (especially with the peritoneum), & also the departure from normal conditions occurring when a great deal is excited— as necessity happens of the manometric be resorted to.
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Rabbit housed for 2h. to 3h. then baled again. First bale: flaxseed.

Animal lightly baled with a layer of cotton wool to prevent excessive heat loss in cold room.