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Katholieke Universiteit Leuven
Laboratorium voor Neuro- en Psychofysiologie

EFFECTS OF LOCAL ANAESTHESIA AND CHEMICAL STIMULATION OF THE LATERAL AND VENTROMEDIAL HYPOTHALAMUS ON EATING BEHAVIOUR IN THE WHITE RAT

HUGO MAES[1] & MARK CALLENS

Through permanently implanted cannulas, the ventromedial (VMH) or lateral (LH) hypothalamus of the white albino rat was chemically blocked or stimulated in an effort both to manipulate eating behaviour, and to mimic hyperphagia and aphagia after lesions of VMH and LH. — Observation A (Table 1) showed that sodium pentobarbital (SPB) (100γ), injected into the LH at the onset of a meal delayed the continuation of that meal. The adrenergic stimulant *l*-nor-epinephrine (NE) (0.2γ), injected in similar circumstances, did not enhance eating. Observation B (Table 2) showed that LH-injection of SPB (doses 50γ and 100γ) yielded no differences as to meal size and intake, but that the 100γ dose lowered the mean length of eating bouts and destroyed the normal decrease of successive eating bouts in the course of a meal (Fig. 2). Observation C (Table 3) showed that SPB 60γ and NE 0.2γ, when injected into the VMH of satiated rats, elicited eating while the cholinergic stimulant acetylcholine chloride (5γ) yielded no effects. Eating seemed to become conditioned to the observation procedure (Table 4), but this could not be replicated. The SPB-results mimic the hyperphagia and aphagia, seen after destructive VMH- and LH-lesions. — Two findings are discussed. 1. Eating as elicited by injection of SPB and NE (unexpected) into the VMH reflects two local-VMH mechanisms to activate the feeding system. 2. LH-anaesthesia by SPB interferes with local-LH positive feedbacks on the eating tendency, not with the eating tendency itself.

PROBLEM

The regulation of food intake in the rat is classically attributed to the interaction between the lateral (LH, "hunger"-center) and ventromedial (VMH, "satiety"-center) hypothalamic regions of the brain. The synaptic transmission of the neurons of this so-called "eating system" in the hypothalamus should be adrenergic, in contrast to the cholinergic transmission of the "drinking system" (6). Electrolytic lesions of the LH lead to a long lasting abolishment of eating behaviour, those of the VMH to over-eating and obesitas. Both electrical and (adrenergic) chemical stimulation of the LH can trigger eating; it has to be noted that the LH is also the main focus for electrical self-stimulation. In the satiated animal, the VMH is considered to inhibit the LH by measuring short- and long-term satiety signals like blood glucose level

[1] Aspirant of the "Nationaal Fonds voor Wetenschappelijk Onderzoek" (N.F.W.O.).

and tissue energy supplies. As satiety decays over time, the VMH should initiate metabolical (body temperature) as well as behavioural compensations (searching for food, eating), the latter type by releasing the LH in as far as it controls eating.

LH and VMH elimination were mostly performed by electrolytic lesions, which may produce a permanent irritative stimulation of the surrounding tissue (2), but even more, may interfere with forebrain dopamine levels (23) (interrupting the ascending nigrostriatal bundle that funnels through the LH), as well as disrupt hormonal balance (8) (lesioning VMH-connections with the hypophyse). As each of this side-effects can change eating habits by its own, here an attempt was made to block the presumed LH-VMH feeding system by a purely functional and transient disabling of these structures by local micro-injections of sodium pentobarbital. As adrenergic stimulation of the LH has been reported by Grossman (6) and many others to elicit eating, noradrenaline was injected at the same sites.

Evidence has been accumulated that the LH not merely energizes feeding ("hunger-center") but is involved in the organization of eating behaviour in time. From the finding that eating bouts increase during the opening phase of a mouse meal, but only when non-feeding bouts do not exceed a critical length, Wiepkema (24) concluded that the feeding tendency at the start of a meal is strengthened by some positive feedbacks, arising from the eating activity itself, probably taste and odor. Olfactory bulb removal (9), as well as LH-destruction (7) disorganize the circadian meal pattern, generating "nibbling" (a lasting chain of short eating bouts), and there is ample evidence that sensory input of food quality reaches the LH. Hypothesizing therefore that these positive feedbacks operate in the LH, an attempt was made to promptly and transiently destroy the within-meal progressive increase of feeding bouts by local LH-anaesthesia.

CHEMICALLY BLOCKING AND STIMULATING THE LH [2]

COMMON PROCEDURE

Subjects: In twenty-one male Wistar albino rats (weighing 229-298 gm at time of operation) two cannulas were stereotaxically implanted under ether anaesthesia, fixed to the skull with screws and dental cement, and shielded from the outer air by plastic caps. They were aimed bilaterally to various LH sites. Sixteen animals (7 from observation A and 9 from observation B) recovered well and gained 28 gm (median) body weight during the first 30 postoperative days. They were kept individually in perspex cages (floor 25 × 25 cm) on a

[2] Performed while a 1973 trainee of the "European Training Programme in Brain and Behaviour Research".

24 hr dark-light period, dark starting at 12.00 a.m. and lasting for 12 hrs.

Cannulas and injections: Injectors (o.d. .3 mm, 27 gauge), connected to thin plastic tubing (length ± 50 cm) and a microsyringe could be inserted in and fixed to the implanted cannulas (o.d. .3 mm, 23 gauge), their tips protruding just as far as to reach the brain tissue. Once filled with a solution, connected to the rat, suspended over the cage and balanced by a counterweight, the whole system could remain in place for several hours and injections could be made as accurate as 1 µl without disturbing the freely moving animal.

Histology: At the end of the observations, the rats were perfused transcardially with 10% formalin. The heads were removed and stored for minimal 3 days in 10% formalin. Then the brain was removed, and frozen 40µ sections (vertical cutting angle according to the De Groot atlas (3)) were prepared and stained with cresyl violet. After examination, 12 rats showed to have had accurate LH-localizations (cannula tips lateral to the fornix). According to De Groot's coordinates, cannula tips ranged in the sagittal plane from 4.2 to 6.8 (mean 5.2), in the vertical plane from 2.0 to 3.5 (mean 2.9), and in the lateral plane from 1.2 to 3.5 (mean 1.8) mm.

Intake measurement and deprivation: A metal tube with access opening at the lower end was fixed to a cage wall. This way, solid food cylinders could be retracted from the cage, weighed and easily slided back into the cage without disturbing the animal. Avoiding both gastric lesions (17) and hormonal balance disruption (22) associated with the common food-deprivation schedules, food was withdrawn only for the first 3 hours of the active (dark) period. In this period rats have normally their largest food intake. A meal criterion of 4 min was used: the non-eating or non-drinking interval between two successive eating bouts had to exceed 4 min, to consider these eating bouts as belonging to separate "meals". Thirteen preliminary observations showed that naive rats on this food access schedule took 2 (median) meals in the 1 hr 40 min period following food restoring. Mean intake per meal was 3.0 gm (0.57-7.48), mean meal duration was 9.2 min (1.0-18.5) and median latency of first meal after food restoring was 85 sec (0-1080 sec). Hence, it was assumed that this schedule was quite acceptable to control meal occurrence, without "depriving" the animal, just postponing for 3 hours the first spontaneous night meal. No distinction was made between "low eaters" and "high eaters", for this and previous observations showed that inter-day meal-size variability in the same animal exceeded largely inter-animal variability.

Statistical testing: The animals passed through all conditions and thus served as their own controls. Since conditions were assigned at random to each animal and some observations failed for technical reasons

(yielding different values for N), statistical testing was always performed on independent samples (Mann-Whitney U test) (20). As most distributions turned out to be rather skew, medians are often mentioned along with the means.

OBSERVATION A

Hypothesis: If the aphagia resulting from electrolytic LH-lesions is due to local elemination of the supposed LH eating system, then local aneasthesia of the LH should interrupt an on-going meal, while adrenergic LH-stimulation should enhance the eating activity during this meal.

Method: Seven naive rats (all with accurate LH-cannula localizations) were habituated during 20 postoperative days to the 3 hr deprivation schedule. Observations lasted for 10 consecutive days. On each of those days, the food was removed at 12.00 a.m. and the rats were connected to the injector system, filled with one of the three solutions: (1) sterile saline as placebo, (2) sodium pentobarbital[3] (SPB) 100γ/μl, and (3) *l*-nor-epinephrine[4] (NE) 0.2γ/μl[5], both soluted in sterile saline. From 15.00 p.m. to 15.06 p.m. each minute food was restored in a next cage from left to right and 45 sec later 1 μl was injected bilaterally in the corresponding rat. In 52 out of 70 observations, the animal started eating within this 45 sec delay. In all but 4 of the remaining observations, eating started during the first 30 min post-injection period. At injection, on-going behaviour was never noticed stopping or even faltering. For 90 min, cages were then scanned from left to right. Per rat, food intake was measured for each 10 min period by weighing the remaining food cylinder, and, for each 30 sec period, behaviour was scored manually in 4 categories: (1) eating, (2) drinking, (3) active, and (4) sleeping or resting. Cage positions were switched at random each day, and solutions injected assigned random to animals.

Results: Food intake and time spent on eating for the whole observation period of 90 min and for the first "meal" (defined in common procedure) were calculated separately. To be considered as "first meal", a meal had to start anywhere in the 7 min period after injection (presumed active period of chemicals injected). Results are summarized in Table 1. Confirming the hypothesis, the time spent on eating as well as the quantity of food ingested were markedly reduced for the first meal after SPB-injection into the LH, compared to the placebo control condition. The reverse was noted for these parameters when calculated over the whole 90 min observation period. This suggests that animals do not skip but merely delay a meal after SPB-injection, in fact, there may even be a rebound. It also confirms the transient effect of

[3] Nembutal®, Abbott S.A., France.
[4] Levophed®, Winthrop S.A., Brussels.
[5] All NE doses refer to the free base.

LH-anaesthesia. NE has abundantly been reported to elicit eating when injected into the LH (adrenergic eating). In this experiment, when calculated for the whole 90 min observation period, only a minor and statistically not significant rise in quantity ingested and feeding

		PLAC	SPB	NE
	N	28	21	21
first meal duration in sec	mean	6.4	4.6	6.7
	median	6.0	1.0	5.5
	p	—	0.020*	0.794
first meal intake in gm	mean	2.27	1.76	2.64
	p	—	0.043*	0.368
total period duration in sec	mean	8.3	10.4	10.3
	median	7.0	11.0	10.0
	p	—	0.101*	0.246
total period intake in gm	mean	2.96	3.96	3.79
	p	—	0.051*	0.308

TAB. 1. OBSERVATION A : TIME SPENT ON EATING AND FOOD INTAKE FOR FIRST MEAL AND TOTAL 90 MIN OBSERVATION PERIOD, AFTER LH-INJECTION OF SALINE (PLAC) SODIUM PENTOBARBITAL (SPB) AND *l*-NOR-EPINEPHRINE (NE). p values obtained by 2-tailed Mann-Whitney U test between PLAC and NE or SPB; N: number of observations; *: significant.

activity duration was observed. Supposing that the NE had any effect, the intake in the normal (placebo) first meal was probably already near ceiling performance so the NE could not add much to it.

OBSERVATION B

Hypothesis: Light local LH-anaesthesia should cancel the presumed progressive increase of feeding bout lengths in the course of the meal. It should make animals nibble, i.e. lower the mean duration of feeding bouts without affecting quantity ingested or total time spent on eating.

Method: Eight naive rats were used, from which 5 had accurate LH-cannula localizations. They were trained to the 3 hr deprivation schedule for the first 18 postoperative days, after which observations started. Three substances were injected in 1 µl bilaterally: (1) sterile saline as placebo, (2) SPB 50γ/µl, and (3) SPB 100γ/µl, both soluted in sterile saline. SPB was also used in this light dose (50γ) to account for the possibility of a complete eating activity suspension in the 100γ condition. Behaviour was manually recorded through a 10-channel keyboard, connected to an Angus Esterline 10-pen recorder. Each key represented one of ten distinct behaviours from which only eating behaviour will be considered. While removing food at 12.00 a.m.,

animals were connected with a loaded injection system. An observation started with restoring food and injection, and lasted for 20 min. At the end, the quantity eaten was measured. Contrary to observation A, one single rat was observed at the same time. As each rat took about 30 min to handle this way, and the series was started at 3.00 p.m.,

		PLAC	SPB-50	SPB-100
intake in gm	N	11	11	14
	mean	4.00	3.08	3.59
	p	—	>.20	>.20
eating time in sec	mean	612.2	540.1	493.9
	median	665.0	491.0	488.0
	p	—	>.20	>.20
eating bout length in sec	N	98	114	181
	mean	68.4	50.7	38.0
	median	23.0	23.0	10.0
	p	—	0.271	0.004 *

TAB. 2. OBSERVATION B: FOOD INTAKE, TIME SPENT ON EATING AND DURATION OF EATING BOUTS AFTER LH-INJECTION OF SALINE (PLAC), SODIUM PENTOBARBITAL (SPB) 50γ (SPB-50) AND SPB 100γ (SPB-100). p values obtained by 2-tailed Mann-Whitney U test between PLAC and other conditions; N: number of observations; *: significant.

deprivation actually ranged for each rat from 3 to 6 hours. Cage position, sequence of animals treated and chemicals applied were randomly switched from day to day.

Results: Results from the rats with valid cannula localizations are summarized in Table 2. Confirming the hypothesis and the results of observation A, neither a significant difference was noted as to quantity of food ingested nor as to total time spent on eating during the 20 min post-injection period. However, the mean length of the different eating bouts was significantly shorter in the SPB 100γ condition, as compared to the saline control condition. SPB 50γ and placebo did not yield significant differences among them. To look for a systematic change of the eating bout lengths in the course of the meal, the means of all eating bouts in the same ordinal position were calculated for each condition. Since total frequency of eating bouts per observation was not constant, the higher the ordinal position, the smaller the number of eating bouts that were actually observed in that position. Therefore, means were calculated for as long as this number exceeded two. Results are shown in Fig. 1. In both normal (placebo) and SPB 50γ rats, a trend toward lower eating bout lengths is visible. To test this trend, Spearman rank correlation coefficients were calculated for each condition, between mean eating bout length and corresponding ordinal position in the meal. They were $-.39$ ($p<0.2$, 2-tailed, $df=11$) for placebo, $-.76$ ($p<0.01$, 2-tailed, $df=10$) for SPB 50γ, and $-.02$ (not significant, $df=15$) for

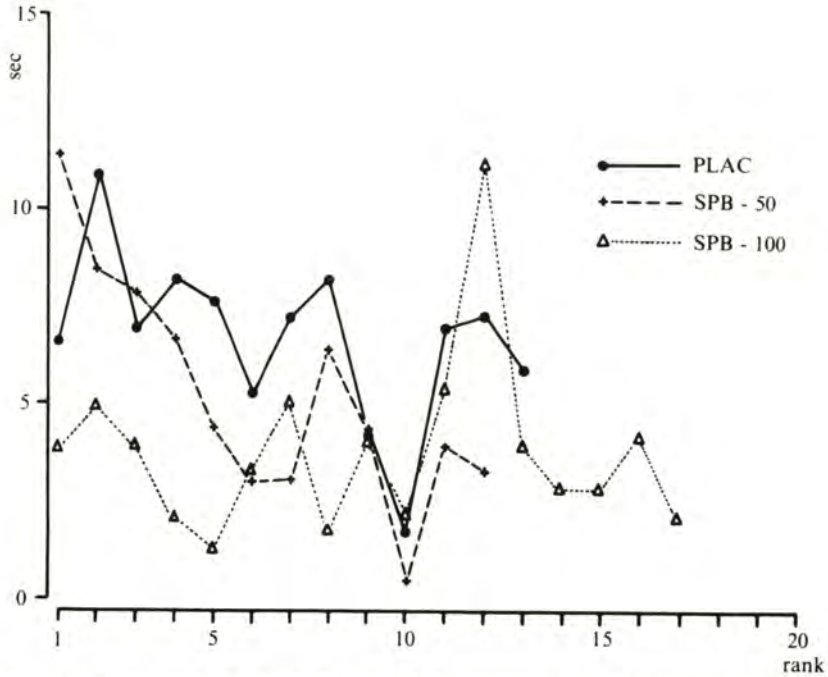

FIG. 1. OBSERVATION B: MEAN EATING BOUT LENGTH AS A FUNCTION OF POSITION (RANK) OF THAT EATING BOUT IN A MEAL, AFTER LH-INJECTION OF SALINE (PLAC), SODIUM PENTOBARBITAL (SPB) 50γ (SPB-50), AND SPB 100γ (SPB-100). Observation length: 20 min. Number of observations: PLAC, N=11; SPB-50, N=11; SPB-100, N=14.

SPB 100γ. Confirming the hypothesis, LH-anaesthesia (with at least 100γ SPB) made the animals nibble. It also cancelled the trend of eating bouts to decrease in the course of a normal control meal, not to increase as previously reported (24).

CHEMICALLY BLOCKING AND STIMULATING THE VMH: OBSERVATION C [6]

Hypothesis: If the hyperhagia resulting from electrolytic VMH-lesions is due to purely local removal of the VMH-inhibition on the eating tendency, then local anaesthesia of the VMH of a satiated rat should result in prompt eating, while adrenergic VMH-stimulation should enhance this inhibition and hence yield no effect.

METHOD

Subjects: Sixteen male Wistar rats, weighing 325-385 gm at time of operation, were cannulated as described above. Twelve animals

[6] Supported by grant n° 3.0003.75 of the F.G.W.O. ("Fonds voor Geneeskundig Wetenschappelijk Onderzoek").

recovered well, and, at histological examination 10 of them showed to have had accurate localizations in or slightly above the VMH (Fig. 2), and were analyzed. The animals were kept individually in plastic buckets (floor diameter 16 cm, covered with wood shavings), solid food pellets and water being available ad libitum. The day-night period was 24 hrs, night (12 hrs) starting at 11.00 a.m.

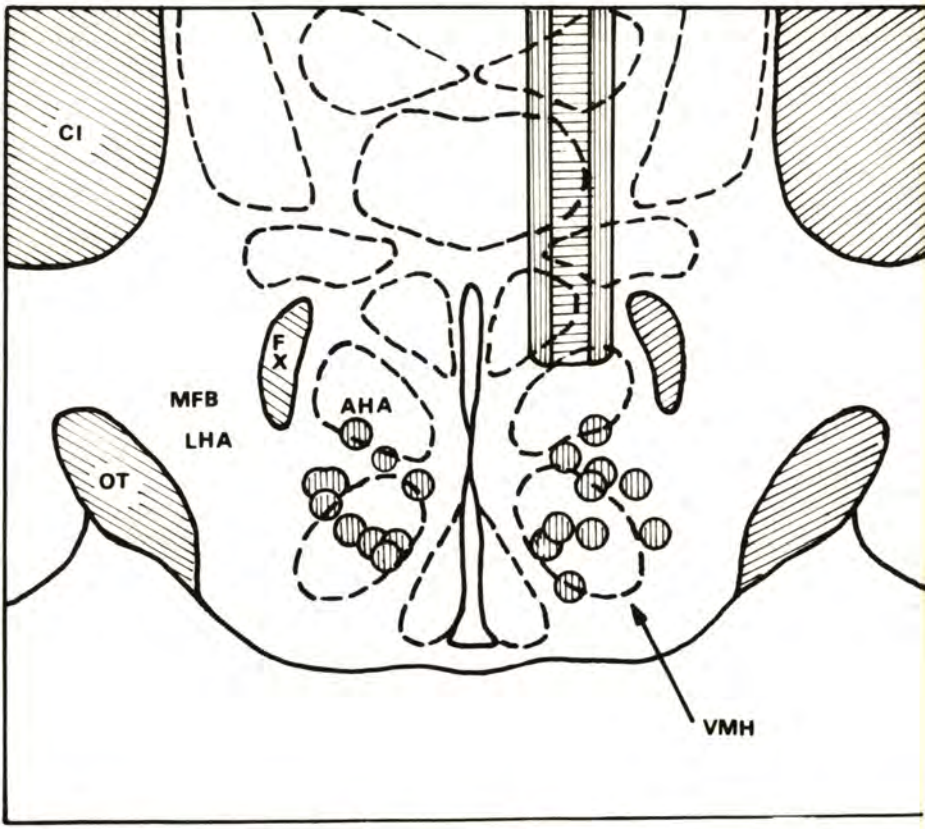

FIG. 2. OBSERVATION C: BILATERAL CANNULA TIP LOCALIZATIONS OF 10 RATS THAT WERE INCLUDED IN THE RESULTS. Vertical section plane according to De Groot (3). For reference purposes, a permanently implanted outer cannula (o.d. .3 mm) is drawn on the section.

Procedure: After postoperative recovery of at least 18 days, tests were run during 17 days in a 27-day period, non-test days serving for completion of observations that were interrupted the previous days for various reasons. Five substances were bilaterally injected in a volume of 1 µl: (1) sterile saline alone as placebo (PLAC), (2) sodium pentobarbital

(SPB) 60γ/μl, (3) acetylcholine cloride[7] 5γ/μl as cholinergic stimulant (ACH), (4) *l*-nor-epinephrine 0.2γ/μl (NE) as adrenergic stimulant, (5) *l*-nor-epinephrine 0.2γ + glucose 50γ/μl (NE+GLUC), all substances soluted in sterile saline. Solution (5) was used to account for a possible oxidation of the NE. On each test day, the same solution (unknown to the observer) was injected once in all rats. The sequence of solutions over test days and the sequence of animals each test day were at random. The test cage (94 × 48, height 39 cm) was dimly illuminated and separate from the observation room. Eventual external sounds were masked by a noise generator. A drinking tube could be accessed by the animals, and about 300 gm of food pellets were scattered over the 3 cm layer of wood shavings that covered the floor. Immediately after injection, the (satiated) rat was placed in this (strange) test cage for 14 minutes and its behaviour manually recorded through a keyboard, connected to cumulative duration and frequency counters. Measures obtained were: (A) frequency and duration of eating and drinking, (B) latency after injection of the first eating and drinking bout, (C) a score for general motor impairment and agitation. Sessions started at 1.00 p.m. and lasted till 7.00 p.m. depending on the number of animals run. Food and water were always available ad libitum in the home cage. Unfortunately, 7 of the 12 animals did not complete the entire test series dying suddenly at different days without any previous weight lose, food refusal or detectable sign of illness. However, as all rats randomly went through all conditions, serving as their own controls, this did not impair the design, and results separately calculated for animals which did and did not complete the whole series showed no difference.

RESULTS

As cholinergic stimulation of the LH has been reported to elicit drinking, the (non-significant) increase of drinking noted after ACH-injection might have been induced by diffusion to the LH. Occasionally, some motor impairment in the SPB condition was noted.

Eating performance in a 20 min session under various conditions is summarized in Table 3. Confirming the hypothesis, SPB injection induced significantly more eating than placebo, while ACH yielded no significant results. Unexpected was the finding that NE and NE+GLUC elicited also feeding activity in the same amount as SPB. The mean eating bout length was even considerably longer in the NE and NE+GLUC conditions than in the SPB condition. As SPB injections into the LH yielded similar results (observations A and B), diffusion of chemicals from VMH to LH can account for these differences.

It is hard to conceive why the satiated rats should engage in eating activity (maybe for a short time and with long latencies) after placebo and ACH injection. The medians being zero in these conditions indicates

[7] Acetylcholine, N.V. Roche, Brussels.

that this is due to only a limited part of the observations, and as shows part 1 of Table 4, indeed to the later replications: animals ate significantly more during the third than during the first replication of ACH and placebo. This was not the case for the remaining three

		PLAC	SPB	ACH	NE	NE+GLUC
eating time in sec	N	21	22	18	35	33
	mean	27.8	158.8	46.4	153.2	184.7
	median	0.0	122.5	0.0	124.0	130.0
	p[2]	—	0.00006 *	0.39	0.0005 *	0.00006 *
eating bout length in sec	N[1]	7	20	8	26	30
	mean	23.2	23.3	28.2	51.6	44.9
	median	18.2	13.8	18.4	23.0	19.5
	p[3]	0.79	—	0.73	0.05 *	0.09 *

TAB. 3. OBSERVATION C: TOTAL EATING TIME DURING ONE OBSERVATION AND EATING BOUT LENGTH AFTER VMH-ADMINISTRATION OF SALINE (PLAC), SODIUM PENTOBARBITAL (SPB), ACETYLCHOLINE (ACH), *l*-NOR-EPINEPHRINE (NE), AND NE+GLUCOSE (NE+GLUC). N: number of observations; [1] only those observations in which animals eated actually; [2] Mann-Whitney U test (2-tailed) between PLAC and other conditions; [3] same test between SPB and other conditions; *: significant.

eating-eliciting conditions (part 2 of Table 4). As each rat went through all conditions (from which 3/5 in fact induced eating) several times, and conditions were offered at random, it was unavoidable that the animal had longer experienced stimulus-bound eating at the later

	replication	1	2	3
part 1: eating time in sec pooled for PLAC, ACH	N	18/3	14/6	7/6
	mean	2.0	48.4	100.9
	median	0.0	0.0	98.0
	p	—	>0.2	<0.004 *
part 2: eating time in sec pooled for SPB, NE, NE+GLUC	N	28/4	26/23	20/16
	mean	158.6	161.7	183.0
	median	125.5	126.2	129.5
	p	—	0.99	0.93

TAB. 4. OBSERVATION C: TOTAL EATING TIME DURING ONE OBSERVATION FOR THREE SUBSEQUENT REPLICATIONS. Part 1: pooled non-eating conditions: saline (PLAC) and acetylcholine (ACH); Part 2: pooled eating conditions: sodium pentobarbital (SPB), *l*-nor-epinephrine (NE), and NE+Glucose (NE+GLUC); N: total number of observations/ number of observations in which animals eated actually; p: Mann-Whitney U test (2-tailed) between first and next replications; *: significant.

replications of ACH and placebo than at the first one. Eating could thus be "conditioned" to the injection and observation procedure. To ascertain whether this was a real transfer effect or merely sensitization or habituation, two subsequent replications of the experiments were run.

The five experimental conditions were split up in two groups with (A) always and (B) never food present in the test cage. After completion, it was planned to test the (satiated) animals for eating in the observation cage with only placebo injected. Surprisingly enough, this supposed transfer effect could even in the A-group (which duplicated this experiment) not be replicated, although it was subsequently observed by M. Beyra (personal communication).

DISCUSSION

Food intake increase after intercranial administration of aspecific neural blockers as sodium pentobarbital or procaine (1, 4, 5, 12, 21) has scarcely been reported, as compared to VMH lesion-induced hyperphagia. All but one (4) report deal with intraventricular, rather than local-VMH injections. Consequently doses and volumes had to be larger than those used in our experiments, facilitating both generalized anaesthetic effects and interference with other paraventricular structures. From the observations reported here, it may however safely be concluded that local VMH-anaesthesia releases feeding quite reliably. The results do not invalidate electrolytic VMH lesion-induced hyperphagia as being secondary to humoral changes.

Unexpectedly, *l*-nor-epinephrine (an α-adrenergic agonist), was found to elicit even more organized eating through the same cannula in the same animal. Leibowitz (10) recently reported similar effects, and established them as being typical for α-, not β-adrenergic agonists. Eliciting eating by blocking, as well as by α-adrenergic stimulation of the VMH suggests that this area is not a simple "brake" on LH-activity as it was in the classical view. At first sight, it fits Panksepp's (16) model of the dual output (excitatory and inhibitory) from VMH to LH. However, these key connections VMH-LH have been shown to be a myth (reviewed by Rabin (19)). In addition, too many premises have to be made as to why adrenergic stimulation should only affect the first (excitatory) type, anaesthesia should block only the second (inhibitory) type and cholinergic stimulation should favour neither. As it seems now, the LH itself can meter many energy balance parameters as blood levels of glucose, insulin (14), free fatty acids (15), and amino acids (16) and has access to sensory food quality information. It therefore seems not to depend on the VMH for inhibiting its won eating-bound activity. Adrenergic and anaesthesia-induced eating found in observation C may well represent proper VMH functions, bypassing the LH. In fact, both types of feeding may reflect two different VMH-mechanisms to generate eating, as they have distinct characteristics. Adrenergic eating was more structured : animals searched for food, carried and eated a whole food pellet, regularly interrupting feeding for systematic scanning of the environment. Under VMH-anaesthesia, they rarely scanned or carried food and frequently dropped pellets (personal observations). A test of this assumption of a dual VMH-mechanism is in progress.

LH-anaesthesia did partly interrupt an on-going meal in observations A and B. It is however not probable that this effect was a transient parallel of the lesion-induced aphagia. This aphagia may in fact be secondary to hypodipsia, or caused by sensory neglect, by interrupting the pallidofugal pathways (13), or by primary gastric lesions through autonomic imbalance (11), – not by elimination of the scanty LH neurons themselves. Without substantially decreasing intake or eating time, LH-anaesthesia destroyed entirely the decrease of feeding bout lengths as the meal went by in observation B. That feeding bouts in the control (placebo) meal decreased instead of increased as reported by Wiepkema (24), can be attributed to the fact that the animals were slightly deprived and that the observation extended beyond the opening phase of the meal. When this time pattern destruction is due to disabling the LH as reinforcing the on-going (eating) behaviour by positive feedbacks from eating itself (24), the paradox between self-stimulation ("rewarding, hence drive reducing") and stimulus-bound eating ("hunger, hence drive inducing") as elicited by the same LH-electrode, can be resolved. The LH can then be considered, not as a "go"- (18), but as a "go-on"-structure, both for eating and intracranial reward.

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Laboratorium voor Neuro- en Psychofysiologie
Dekenstraat 6
3000 Leuven

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