Experimental Demonstration of the tomatotopic organization in the soprano *(Cantatrix sopranica L.)*

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Sommaire : Démonstration expérimentale d'une organisation tomatotopique chez la Cantatrice. L'auteur étude les fois que le lancement de la tomate il provoquit la *réaction yellante* chez la Chantatrice et demonstre que divers plusieurs aires de la cervelle elle était implicatées dans le response, en particulier le trajet légumier, les nuclei thalameux et le fiçure musicien de l'hémisphère nord.

As observed at the turn of the century by Marks & Spencer (1899), who first named the « yelling reaction »(YR), the sticking effects of tomato throwing on Sopranoes have been extensively described. Although numerous behavorial (Zeeg & Puss, 1973 ; Roux & Combaluzier, 1932 ; Sinon *et al.*, 1948), pathological (Hun & Deu, 1960), comparative (Karybb & Szÿla, 1973) and follow-up (Else & Vire, 1974) studies have permitted a valuable description of theses typical responses, neuro-anatomical, as well as neurophysiological data, are, in spite of their number, surprisingly confusing. In their henceforth late twenties'classical demonstrations Chou & Lai (1927 *a, b, c*, 1928 *a, b*, 1929 *a*, 1930) have ruled out the hypothesis of a pure faciofacial nociceptive reflex that have been advanced for many years by a number of authors (Mace & Doine, 1912 ; Payre & Tairnelle, 1916 ; Sornette & Billevayzé 1925). Since that time, numerous observations have been made that have tried to decipher the tangling puzzle as well as the puzzling tangle of the afferent and/or efferent sides of the YR and led to the rather chaotic involvement of numberless structures and paths : trigeminal (Lowenstein *et al.*, 1930), bitrigeminal (Von Aitick, 1940), quadritrigeminal (Van der Deder, 1950), supra-, infra-, and intertrigeminal (Mason & Ragoun, 1960) afferents have been likely pointed out as well as macular (Zakouski, 1954), saccular (Bortsch, 1955), utricular (Malosol, 1956), ventricular (Tarama, 1957), monocular (Zubrowska, 1958), binocular (Chachlik, 1959-1960), triocular (Strogonoff, 1960), auditive (Balalaïka, 1515), and digestive (Alka-Seltzer, 1815) inputs. Spinothalamic (Attou & Ratathou, 1974), rubrospinal (Maotz & Toung, 1973), nigro-striatal (Szentagothai, 1972), reticular (Pompeiano *et al.*, 1971), hypothalamic (Hubel & Wiesel, 1970), mesolimbic (Kuffler, 1969), and cerebellar (High & Low, 1968) pathways have been vainly search out for a tentative explanation of the YR organization and almost every part of the somesthic (Pericoloso & Sporgersi, 1973), motor (Ford, 1930), commissural (Gordon & Bogen, 1974), and associative (Einstein *et al.*, 1974) cortices have been found responsible for the progressive building-up of the response although, up-to-now, no decisive demonstration of the both the input and output of the YR programming has been convincely advanced.

Recent observations by Unsofort & Tchetera pointed out that « *The more you throw tomatoes on Sopranoes, the more they yell* » and comparative studies dealing with the gasp-

reaction (Otis & Pifre, 1964), hiccup (Carpentier & Fialip, 1964), cat purring (remmers & Gaautier, 1972), HM reflex (Vincent *et al.*, 1976), ventriloquy (McCulloch *et al.*, 1964), shriek, scream, shrill and other hysterical reactions (Sturm & Drang, 1973) provoked by tomato as well as cabbages, apples, cream tarts, shoes, buts and anvil throwing (Harvar & Mercy, 1973) have led to the steady assumption of a positive feedback organization of the YR based upon a semilinear quadristable multi-switching interdigitation of neuronal sub-networks functioning *en désordre* (Beulott *et al.*, 1974). Although this hypothesis seems rather seductive, it lacks anatomical and physiological foundations and we therefore decide to explore systematically the internal incremental or decremental organization of the YR, allowing a tentative anatomic model.

Material and methods

Preparation

Experiments were carried out on 107 femal healthy Soprano *(Cantatrix sopranica L.)* furnished by the Conservatoire national de Musique, and weighing 94-124 kg (mean weight : 101 kg). Halothane anesthesia was utilized during the course of tracheotomy, fixation in the Horsley-Clarke, and major operative procedures. 5% procaine was injectetd into skin margins and pressure points. Animals were then immobilized with gallamine triethyiodide (40 mg/kg/hr) and normocapnia was maintained by appropriate artificial ventilation. Spinal cord transections were performed at L^3/T^2 levels, thus eliminating blood pressure variations and adrenaline secretion induced by tomato throwing (Giscard d'Estaing, 1974). The fact that animals were not suffering from pain was shown by their constant smiling throughout the experiments. Internal temperature was maintained at 38°C ± 4°F by means of three electrically drived boiled kettles.

Simulation

Tomatoes *(Tomato rungisia vulgaris)* were thrown by an automatic tomatothrower (Wait & See, 1972) monitored by an all-purpose laboratory computer (DID/92/85/P/331) operated on-line. Repetitive throwing allowed 9 projections per sec, thus mimicking the physiological conditions encountered by Sopranoes and others Singers on stage (Tebaldi, 1953). Care was taked to avoid missed projections on upper and/or lower limbs, trunks & buttocks. Only tomatoes affecting faces and necks were taken into account.

Control experiments were made with other projectiles, as apple cores, cabbage runts, hats, roses, pumpkins, bullets and ketchup (Heinz, 1952).

Recording

Unit activity was recorded through glass-tungsten semimacroelectrodes located *au-petit-bonheur*, according the methods of Zyszytrakyczywsz-Sekrawszkiwcz (1974). Spike recognition was performed by audio-monitoring : every time a unit discharge was heard, it was carefully photographed, tapped, displayed on a monograph and, after integration, on a polygraph. Statistical evaluation of the results was made using a tennis algorithm (Wimbledon, 1974), that is, every time a structure reponds up to win the game, it was recognized as YR-related.

Histology

At the end of the experiments, Sopranoes were perfused with olive oil and 10% Glennfiddish, and incubated at 421°C in 15% orange juice during 47 hours. Frozen 2 cm unstained sections were mounted into δ-strawberry sherbet and observed under light and heavy microscopy. Histological verifications confirmed that all the electrodes were located in the brain except four that were found in cauda equina and filum terminale and disclosed from statistical analysis.

Results

Sterotaxic explorations of brains during tomato throwing showed that most the areas respond differently to the tomesthetic simulation. As can be seen from Tab. 1, where the results are summarized, three (3) distinct areas gave definite, unambiguous and constant responses : the nucleus anterior reticularis thalami pars lateralis (NART pl), or nucleus of Pesch (Pesch, 1876 ; Poissy, 1880 ; Jeanpace & Desmeyeurs, 1932), the anterior portion of the tractus leguminous (aplL), lying 3.5 mm above the obex and 4 mm

Regions						
	1/s	2/s	3/s	4/s	5/s	6/s
whole brain	0.0	0.0	4.2	0.6	0.7	000.1
raphe area	3.1	4.1	5.9	5.9	5.9	000.2
septum	±1	67	875	121	000	π3517
thalamus	2.2	$\sqrt{3}$	456	±7	8.9	0.0001
NARTpl	456	+2	-4	§§	« 2 »	±0.001
hypothalamus	±"3	1&2	41	S.G.	121	many
hypocampus	1/2	3%	$\sqrt{\int 7}$	?	<16	0,± ±7
cereb.cortex	yes	<55	nsp		$\pm\infty$	71±70
scMS	∼31	∼65	>87	00+	$\frac{345}{\{4\{}$	a few
apTL	0.0	3.1	6.7	$\sqrt{4}$	−	56%
amygdala	+3	±3	3.3	333	3	$\int 3.33$
N.Poissy	→8	0.0	→1	12←	M/5	$1 + 1 = 2$
N.Pesch	3§4	781	↑2	↓34	!	!!!!!
N.ruber	Λ51	???	$\sum_4^3$	$\int_0^7$	415	maybe

TAB. 1 – *Differential responding of tomatics stimulation in the brain at different frequencies.*

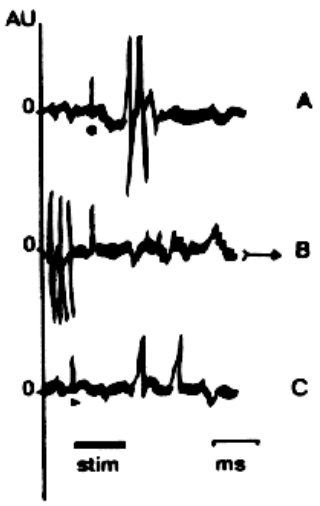

FIG. 1 – *Unit activity in structures respondings to tomatic stimulation. Bar indicates stimulus onset & cessation. Calibration : 3.1416 ms. Each trace is made of superimposition of 33.57 successive recordings. Note the point in A, the arrow in B and the black triangle in C.*

right on the tentorium and the dorsal part of the so-called « musical sulcus »(scMS) of the left hemisphere (Donen & Kelly, 1956). it is of interest to notice that, if the left hemispere was kept for analysis, the right hemisphere was left.

Examples of responses obtained from these structures can be seen on FIG. where temporal analysis of the spike distribution based on their Responsive-Area-Temporal-Programming (RATP) properties allowed to distinguish 3 unit subtypes :

1. units responding before the simulation ;
2. units responding during the simulation and
3. units responding after the simulation.

Cross-examination of responses driven by other projectiles and Ketchup stimulation are shown on FIG. and argue unquestionably in favor of a tomatotopic organization of the YR along, between and across the NARTpl, apTL and scMS. Temporal relationships of the responses, as examplified in FIG. , showed that the hypothesis of a clustering interdigitation of neuronal subnets is highly probable, although no experimental evidence can be given due to the relative difficulty of entering those damned structures without destroying a lot of things (Timeo *et al.*, 1971).

Discussion

It has been shown above that tomato throwing provokes, along with a few other motor, visual, vegetative and behavioral reactions, neuronal responses in 3 distinctive brain area : the nucleus anterior reticularis thalami pars lateralis (NART pl), the anterior portion of the tractus leguminous (apTL), and the dorsal part of the so-called musical sulcus (scMS). As pointed out by Chou & Lai (1929 *b*), Lai & Chou (1931 *a* ,*b*) and Unsofort & Tchetera (1972), The YR organization cannot be simply reduced to an oligosynapic facio-facial nociceptive reflex which would have relayed over in the fascia leguminosa of the VIth laminations of the ventral quadrants of the paleospinorubro-yello-tectocerebello-nigrostriatal tomatonergic ascending pathways. For the fact that horseradish peroxidase injected into the Sopranoes'vocal cords is retrogradually transported from the vagus nerves to the tomato-tomatics synapses of the contralateral pseudo-gasserain afferents (McHulott *et al.*, 1975) prooves with some likehood the leguminous nature of the mediator responsible for the transmission of the message from the receptive tomato fields to the YR circuitry (Colle *et al.*, 1973). thus 3,5 (M-tri) argyril-$\beta - L-$tomatase which is selectively trisynthetized in the NARTpl-apTL bundle and whose destruction block up drastically the YR (Others *et al.*, 1974) stands out as the major candidate for the transmitter involved in the YR retroacting loop, although an alternate hypothesis based upon latency calculations, and co-cross

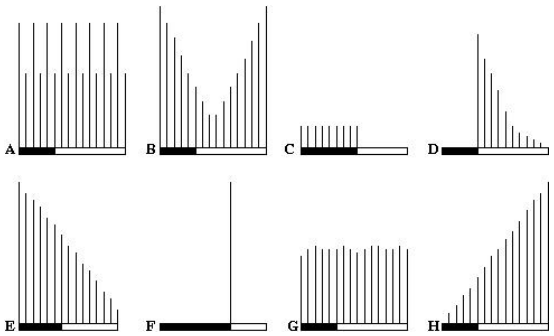

FIG. 2 – *Examples of responses in the apTL provoked by tomato and other throwings. Explanations in text. A =tomato ; B =apple ; C = cabbage ; D = hats ; E = roses ; F = ketchup* ; G = pumpkin ; H = bullet.*
* *Kindly provided by Laroche-Ciba, Inc.*

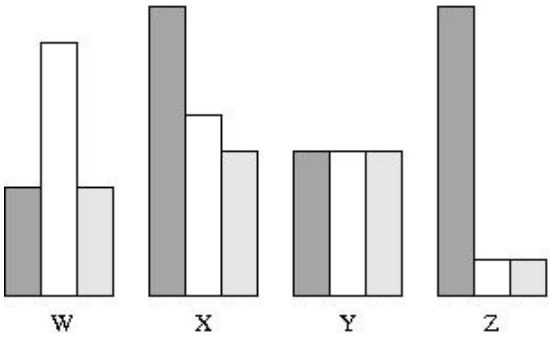

FIG. 3 – *Temporal relationships of the responses recorded in the YR area. Abscissae : arbitrary units ; ordinates : international units. Explanations in text.*

frequency correlations, puts forward the feasibility on a tomatotomic synapse (see Dendritt & Haxon, 1975). Although decisive experimental evidences are still lacking and further series of experiments are needed before the complete elucidation of the YR can be achieved, it seems logical to advance that above combined arguments along with experimental results described in our work are likely to support hypothesis of a semi-linear multi-stable multi-switching netlack feed-work organization of the YR whose a tentative anatomical model can therefore be proposed (FIG. 4).

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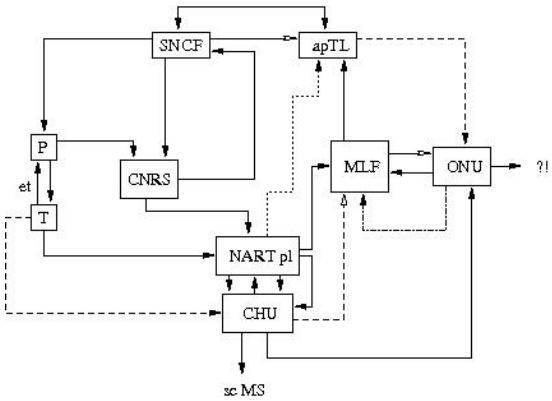

FIG. 4 – *Tentative anatomical model of the YR organization. Explanation in text or elsewhere. Black line = inhibitory ; broken lines = interrogatory ; dashed lines = redhibitory ; stellate lines = whig-and-tory.*

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