an increase of the atrial muscle refractoriness, may explaine the rarety of atrial arrhythmias in hypothyroidism comparatively with hyperthyroidism, and provides clues to understand the underground of the rhythm disturbances[1,4].

Table II. The MAP caracteristics in 2 patients with hyperthyroidism

No.	Name	Sex	Age	P-P	A	D_1	D_2	D_3	dV/dt 3
1	SE	♀	53	580	4.5	230	170	110	1150
2	GT	♀	60	620	4	240	200	140	820

Résumé. L'enregistrement du potentiel monophasique d'action de l'auricule droite a été effectué à l'aide des électrodes de succion, chez 9 patients. On constate un allongement notable du potentiel monophasique chez les hypothyroïdiens, il se raccourcit après traitement thyroïdien, tandis que chez les hyperthyroïdiens sa durée est diminuée.

S. Cotoi, L. Constantinescu and S. Gavrilescu

Ist Internal Clinic, Institute of Medicine, Timisoara (Romania), 5 November 1971.

Identification of Temperature Increases and Decreases: A Difficult Task for Monkey and Human[1]

Many authors have subdivided somatosensation into 4 sub-modalities of sensory experience-tactile, cool, warm and pain[2-4]. Based on this consensus, attempts were made to train 2 monkeys to discriminate tactile, cool and painfully hot stimuli delivered separately in time to the same area on the shaved dorsal surface of the rigidly held forearm (Figure). The monkeys were required to make discriminations by pressing the appropriate one of 3 available levers when the stimulus came on (Figure 1A).

Although the monkeys learned to discriminate the tactile and thermal stimuli, they did not learn to discriminate the 2 thermal stimuli. Numerous changes in training procedures made over a 2 years period were inadequate in establishing the discrimination. There are several possible explanations for this failure: 1. the correct training contingencies were not used. 2. The triple discrimination task was beyond the monkey's 'intellectual' capacity. 3. The rates of change of the thermal stimuli were too slow. 4. Monkeys do not have the sensory capacity to discriminate temperature increase from decreases as they were applied in this experiment.

When an auditory stimulus was substituted for the cool stimulus, the monkeys learned to discriminate the auditory from the hot and tactile stimuli, thereby eliminating both the first and second explanations. When the rate of change of the thermal stimuli was increased (Figure 1C), the monkey was still unable to learn the discrimination, thereby making the 3rd explanation less likely. To test the 4th explanation further, 12 naive humans were tested with the same apparatus. Although all subjects were able to detect the presence of a thermal stimulus, they also reported difficulty in identifying the 'quality' (i.e. direction of change) of that thermal stimulus. The human subjects, therefore, made errors in lever press responses much like the monkey subjects. Most human subjects developed these difficulties after the testing began, usually within 5 to 20 min, but 3 subjects reported confusion on the first trial (Table, compare first and last 4 trials).

Although these discrimination difficulties appear to be related to the phenomenon of paradoxical cold, this phenomenon occurs rarely and only with pinpoint stimuli which are normally easy to identify[5,6]. Furthermore, most of the errors made by the human subject in this experiment were identifying the cool stimuli as 'hot', thereby suggesting the errors be described as 'paradoxical hot', a phenomenon even more rarely reported. It seems reasonable to conclude, therefore, that it was difficult to train monkeys to discriminate the hot and cool stimuli because, like humans, the monkey does not have the sensory capacity for such discrimination under these conditions. This conclusion is surprising because, phenomenologically, hot and cool seem easy to identify. It remains to be determined what characteristics of this experimental situation make the identifications so difficult.

There are several possibilities. It is possible that the stimulus parameters were not changed appropriately to effect the identification of hot and cool. Kenshalo et al.[7] have found that it takes a larger temperature change to produce identification of cool or warm than it does to produce a simple detection of change, especially at the adapting temperature used in this experiment (37.7°C). A possibly immoderate adapting temperature is not the complete explanation, however, because the amounts of change required for identification of cool and warm at 37–38°C in the Kenshalo et al. experiment[7] (1–1.5°) were much smaller than those used in this experiment (Figure 1C).

Another possibility is the occurrence of both hot and cool stimuli within the same testing session. The fact that some of the human subjects made identification errors on the first trial, however, tends to negate this possibility.

Other possibilities include the size and locus of the stimuli. Stimulus size is not probable because the stimulator used here was larger than the range over which areal summation occurs[8-10]. Locus, however, may be important,

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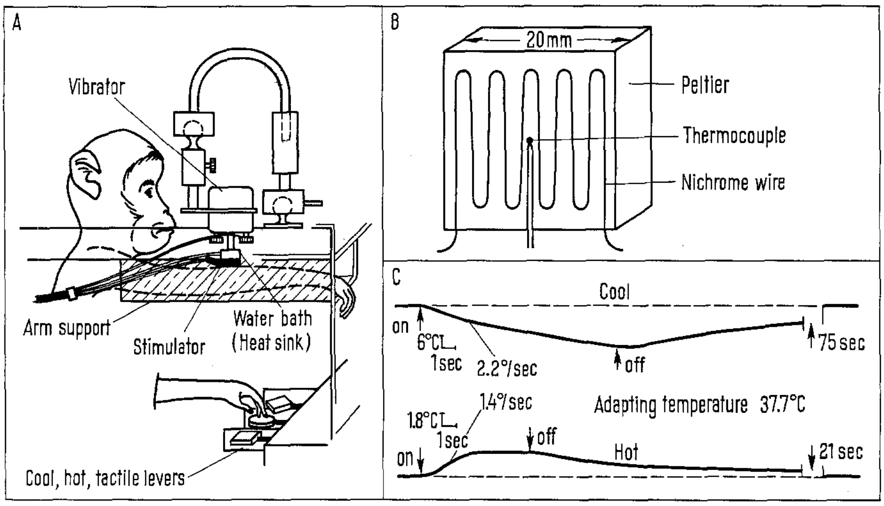

Diagram of A) training situation; B) bottom surface of stimulator; and C) thermal stimuli. (Note the change in amplitude scale for the 2 stimuli.) The subjects were required to make the discriminations by pressing the appropriate lever when the stimulus came on. 'Correct' cool and tactile lever press responses resulted in the delivery of a 75 mg banana pellet (not shown); 'correct' hot lever presses resulted in the rapid termination of this noxious stimulus. Note that the subjects ususally responded to the stimuli within 1 to 2 sec, so that they actually received only a small portion of the thermal stimuli shown in C). The tactile stimulus was produced by a vibrator at 4 pulses per sec. The hot stimulus was produced by passing current through the nichrome coil shown in B). The cool stimulus was produced by passing current through a Peltier device modified from KENSHALO[19].

because the forearm is probably less sensitive than other parts of the body surface to thermal changes[8,11–13]. Another possibly relevant characteristic is the constant, firm pressure (about 100 gm) exerted by the stimulator apparatus on the skin surface (Figure A). Although vibratory pressure stimuli do not interfere with the identification of warming[14], and warm thresholds are the same when measured by radiant or conducted heat[8], 'innominate' (unidentifiable) thermal sensations involving large stimuli are often reported under conditions of constant pressure or ischemia[15–18].

Percent correct identification of temperature increases and decreases by humans during the first and last 4 trials of the testing session[a]

	% Correct					
	Cool		Hot		Tactile	
Subject	First 4	Last 4	First 4	Last 4	First 4	Last 4
MB	25	0	100	100	100	100
OF	50	50	100	75	100	100
KB	50	25	100	75	100	100
JT	75	0	100	100	100	100
WS	100	25	75	75	100	100
RD	100	75	100	50	100	100
SH	100	75	100	25	100	100
MR	100	100	100	100	100	100
Mean %	75	44	97	75	100	100

[a] The total testing session included 12–25 trials and took 30–50 min to complete.

In summary, there are 3 experimental factors which most likely contribute to the difficulty in identifying cool and hot. These factors are 1. the original adapting temperature of the skin, 2. the pressure of the stimulator, and 3. the location of the stimuli. But whatever the conditions of stimulation that produce errors in identifying increases and decreases in temperature, the fact remains that such errors occur. These difficulties emphasize the artificiality inherent in subdividing 'touch' into sub-modalities, especially when attempting to study these sensations in animals.

Résumé. Les singes n'apprennent pas à distinguer l'élévation et l'abaissement de la température quand les stimulis sont donnés à l'avant bras. Ils ne peuvent pas reconnaître le sens du changement quoique l'homme y soit sensible. Il est possible qu'ils sont influencés par le poids et l'emplacement de l'appareil stimulant ainsi que par la température de l'adaptation originelle.

K. J. BERKLEY and S. S. HUGHES

Department of Psychology, Florida State University, Tallahassee (Florida 32306, USA), 22 December 1971.

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