INFLUENCE OF WEATHER AND CLIMATE ON THE HYPOTHALAMIC THERMOREGULATION EFFICIENCY AND THE EFFECT ON ASTHMA, BRONCHITIS AND RHINITIS *

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Introduction

If one studies the vast medical literature on the possible causes of diseases of the respiratory tract in general and of rhinological diseases in particular one is always struck by the fact that, apart from obvious anatomical causes of an inefficient airflow through the respiratory tract and nose, usually only four causal factors are taken into consideration: allergic, infectious, endocrinological and psycho-somatic factors. The influence of weather and climate (both micro- and macro-) is usually entirely neglected or is considered to be of only minor importance and this despite the fact that a vast literature exists on such weather induced phenomena, which are briefly indicated in biometeorology by the term "meteorotropic effects".

Particularly climatic chamber studies in the British, American and Canadian armies made it possible in recent years to understand the deeper physiological mechanisms which are involved. It was found that the key centre in the body, both of animals and man, responsible for registering the majority of meteorological stresses, is located in the hypothalamus, the principal thermoregulation centre. The hypothalamus in turn affects the hormonal functions of the pituitary which is reflected in a number of weather controlled changes in the functioning of the thyroid, adrenal gland, pancreas etc. Through the hypothalamus various meteorological factors, in particular thermal and radiation stresses, seriously affect also the functioning and activity of the autonomic nervous system.

The restricted time prevents me from discussing in detail the many studies on each of these meteorotropic mechanisms, which seem to be of great importance for several rhinological problems. However, I should like to refer very briefly to a four years study in our Biometeorological Research Centre at Leiden.

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Examples of hypothalamically controlled meteorotropic effects.

It was found that in cooling resistant subjects, in other words subjects with an efficiently working, well balanced, thermoregulation mechanism, a very characteristic, meteorologically induced, physiological pattern can be observed. For example during atmospheric cooling, which is the combined effect of temperature, humidity and air movement, as a result of the influx of polar airmasses, cold front passages etc., the urinary output is increased, affecting the extra cellular fluid balance, the blood volume and haemoglobin content of the blood. The electrolyte balance is considerably affected (decreased excretion of chloride and sodium), the excretion of urea, hexosamines (important metabolic products of the connective tissues) decreases; the production and excretion of 17-ketosteroids and other hormones of the adrenal cortex is activated; the permeability of the various body membranes decreases; the peripheral capillary bloodflow is considerably reduced; the blood sugar level increases, the γ-globulin level of our blood usually decreases, etc. It is also known from other studies (Tromp, 1962b) that, at least in animals, temporary but profound changes in the structure and functioning of the thyroid occur after a sudden cold stress. The orthosympathetic nervous system as a whole is activated but only to a certain maximum (known as "habituation" in environmental physiology) which is usually followed by an increased parasympathetic activity and of the bodily functions controlled by this nervous system.

All these processes vary during the different seasons, partly as a result of different degrees of adaptation of the body to meteorological stresses in the cold and warm seasons, but also short term changes in the amplitude of meteorotropic effects occur as a result of the endogenous biological rhythm. The same meteorological stress (e.g. cold front passage) could have entirely different effects if it reaches the body during the day or during the night.

Thermoregulation efficiency test

It is evident that the various physiological changes, as a result of meteorological stimulation of the hypothalamus, either through the thermoreceptors in the skin or due to temperature changes in the peripheral blood flow, may have a profound influence on the body as a whole but also on the respiratory tract and the general resistance against infections. This explains our efforts to find a simple test to determine the degree of efficiency of the thermoregulation mechanism as a whole. In 1961 a simple water bath test was developed (Tromp, 1964 c). The left hand of the subject is cooled for two minutes in water of 10 °C and with a thermo-couple every 15 seconds the rewarming of the centre of the handpalm is recorded. In well thermoregulated subjects within six minutes the initial temperature is reached (fig. 1).

One may object that the test is only an indication of changes in peripheral bloodflow and not of improved hypothalamic thermoregulation. However, several observations point to the latter:

1. The improvement of the rewarming curve after repeated exposure to hypoxic stress, in a low pressure chamber, suggesting the influence of the respiratory centre in the brain.

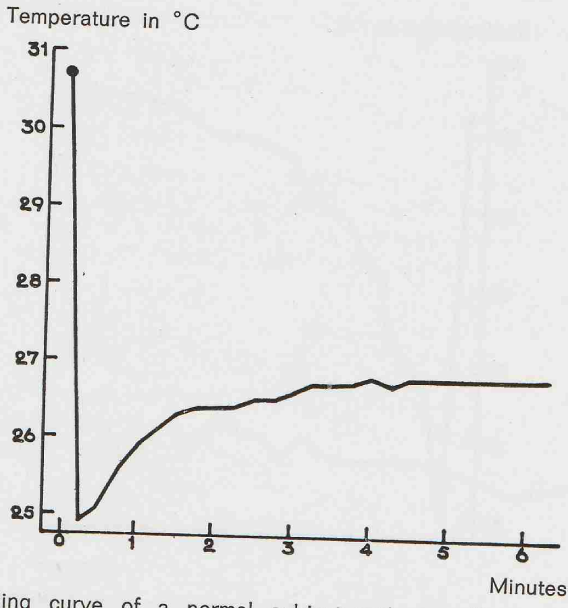

Fig. 1. Rewarming curve of a normal subject with an efficient thermoregulation mechanism.

2. The temporary change of an efficient rewarming curve of women during menstruation suggesting hormonal influences of the pituitary.
3. The observation that only in subjects with an efficient rewarming curve, the specific pattern of the hypothalamically controlled electrolyte balance, hormonal excretion of the adrenal gland etc., characteristic for cooling resistant subjects, is observed.
4. The similarity between the rewarming curve of the left and right hand of female subjects shortly after being operated for mammary carcinoma on the left or right breast.

These various considerations and the known close interrelationship between hypothalamus, pituitary, respiration and vasomotor centre suggest that the hypothalamus is the major factor in the causation of the peripheral changes as observed in our water bath tests.

During the last three years various groups of patients have been studied: mental patients, cancer patients, and in particular large groups of patients suffering from bronchial asthma, asthmatic bronchitis, bronchitis and rhinitis. It was found that asthmatic, bronchitic and rhinitic patients, according to our test, have a poor thermoregulation mechanism and that artificial improvement of this mechanism reduces their complaints considerably.

Influence of the hypothalamus on asthma, bronchitis and rhinitis

In the case of BRONCHIAL ASTHMA it may take 15 minutes or more during a water bath test before the initial temperature is reached (fig. 2, 3 and 4). This observation seems to explain, at least partly, the biometeorological

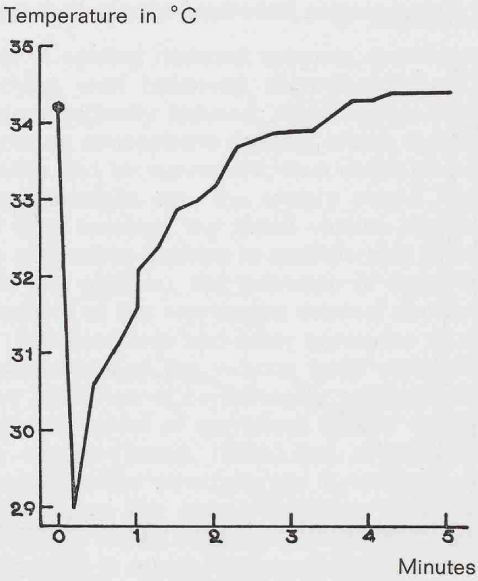

Fig. 2. Rewarming curve of a male subject suffering from bronchial asthma.

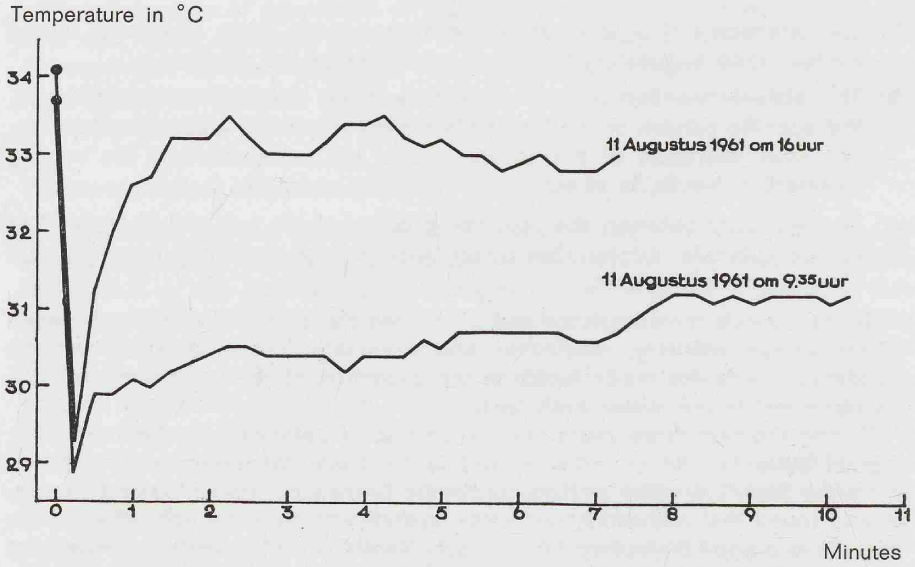

Fig. 3. Difference in rewarming curves of the same female asthmatic subject, recorded on the same day during the morning and afternoon.

observations (Tromp, 1962 a) of our research centre during the last ten years (1953—1963), that in a group of subjects suffering from non-infectious bronchial asthma a sharp increase in complaints is observed either as a result of

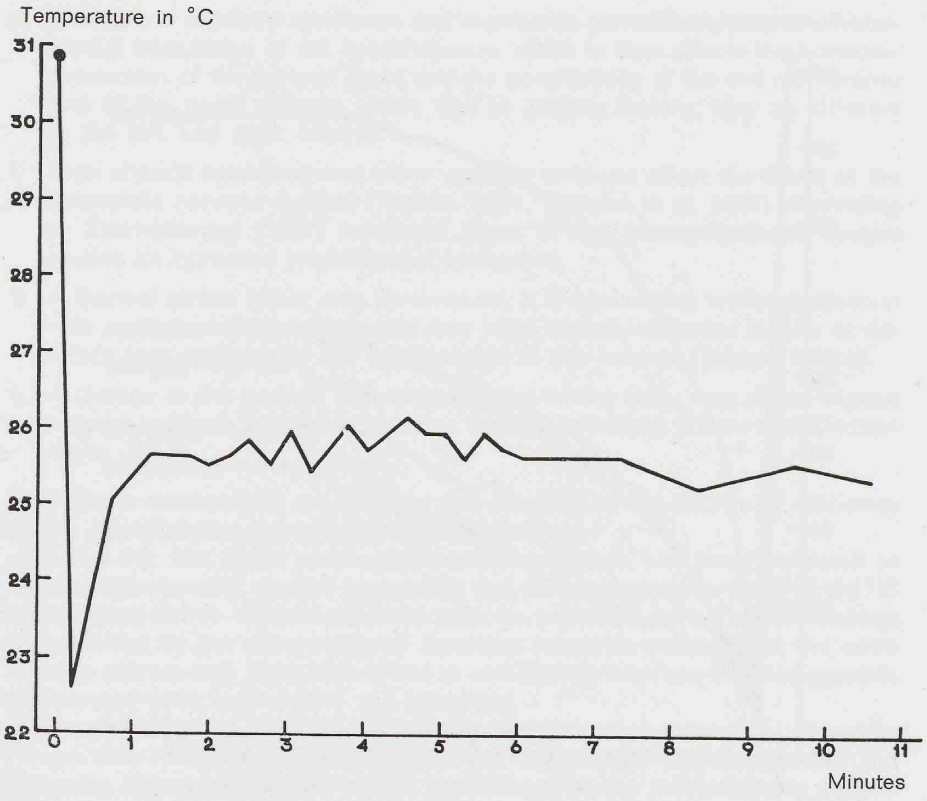

Fig. 4. Typical rewarming curve of a female subject suffering from bronchial asthma.

a sudden and strong atmospheric cooling or after great heat stress. Fog seems to have little or no effect on this type of bronchial asthma (Tromp, 1962 b).

As the warm weather conditions are very rare in Western Europe the cooling condition is the most dangerous one, particularly if it is accompanied by great air turbulence during an approaching depression or by active cold fronts. It was found that regular treatment of asthmatic patients in a low-pressure climatic chamber, above a simulated altitude of 1500 m, improves their thermoregulation efficiency and therefore their resistance against cooling which coincides with a decrease in their asthmatic complaints (fig. 5; Tromp, 1964 a).

It is believed that the meteorotropic effect of the hypothalamus both on the hormonal production of the adrenal gland (e.g. 17-Ketosteroids) and on the increased cholinergic processes in the respiratory tract, following a long lasting cold stress, with initially dominating adrenergic processes, is mainly responsible for these meteorotropic phenomena observed in asthmatics.

BRONCHITIC PATIENTS, contrary to subjects suffering from non-infectious bronchical asthma, are extremely sensitive to fog, in particular in air polluted areas. Also bronchitic patients; have an inefficient thermoregulation mechanism

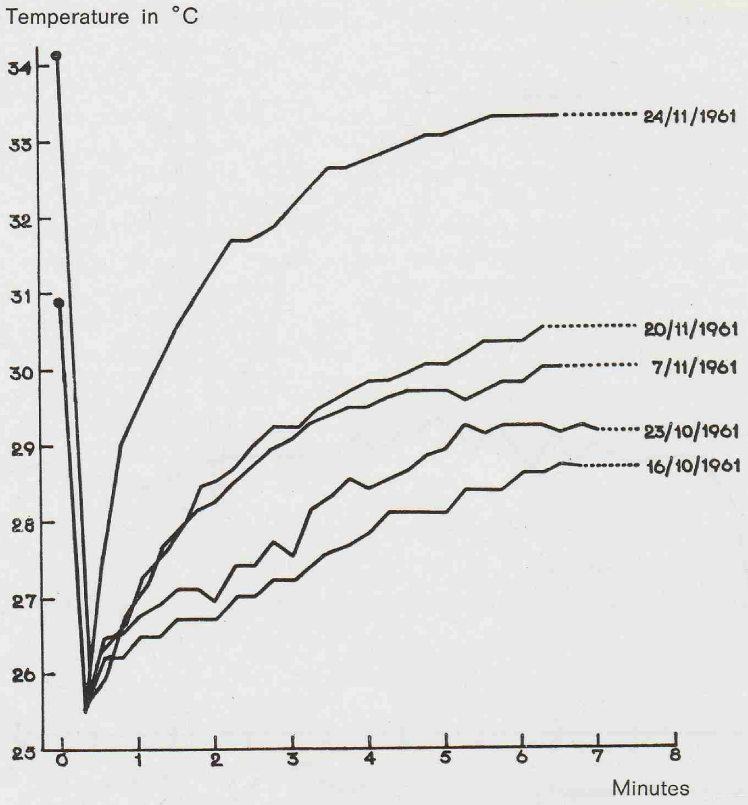

Fig. 5. Gradual improvement of the rewarming curve (thermoregulation efficiency) of a female asthmatic subject after a series of simulated high altitude treatments.

(see fig. 5, lowest curve). Various factors are involved in the weather sensitivity of bronchitic patients: changes in mucus flow, in bacterial development and in general resistance of the body against infections. The mucus flow seems to be affected by the acidity of the air (Tiefensee, 1929), a surplus cf positive or negative ions (Krueger, 1958 and 1963), by the automatic nervous system and probably also by hormonal stimulation, both latter mechanisms being influenced by meteorotropic stimuli of the hypothalamus. The growth of bacteria and viruses is considerably affected by temperature, humidity and air-movement (Hemmes, 1959; Schulman, 1964). The general resistance of the body against infections seems to depend at least partly on the thermoregulation efficiency of the body. It was found during our climatic chamber studies that, apart from a thermoregulation improvement after high altitude treatments, also an increased resistance against infections developed. Various hypothalamically controlled processes seem to be involved in the change in bodily resistance against infections as a result of weather effects:

1. Changes in capillary resistance and membrane permeability due to environmental stimulation of the hypothalamus, which in turn affects the hormonal production of the adrenal gland and the permeability of the cell membranes and of the nasal mucosa which, due to genetic factors, may be different in the left and right nostrils.
2. High altitude treatment and other weather stresses affect the tonus of the autonomic nervous system (Timiras, 1964; Straube et al, 1951). According to Zakrividoroga (1961) increased tonus of the parasympathetic system causes an increased production of antibodies.
3. A thermal stress effect may be involved. It is known that artificial infection with various viruses or bacteria may have entirely different results at different temperatures of the environment of the subject (Tromp, 1962 b).
4. A change in the general hormonal balance of the body may affect various enzyme systems and the resistance against infections (Uters and Zimmermann, 1951).

All these mechanisms are considerably affected by the degree of efficiency of the hypothalamic thermoregulation mechanism.

During the last three years considerable evidence has been collected in our climatic chamber studies suggesting that also in various forms of RHINITIS a thermoregulation disturbance may play an important part. This assumption is supported by the observation of Japanese research workers that the same allergen extract may have little effect in one season whereas in other seasons pronounced skin test results are observed.

Time prevents me from discussing this problem more extensivily. However I hope that I have been able to draw the attention of the members of the European Rhinologic Society to the significance of the meteorotropic activity of the hypothalamus for various respiratory and rhinological diseases.

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