WHY DO CHILLIES CREATE A BURNING SENSATION,

WHILE PEPPERMENT IS KNOWN TO COOL?

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Both 'hot' and 'cold 'are sensations and about both of them a lot of questions can be raised. The interesting fact here is that the science of these sensations is hidden in the cells of the body which feel and detect these sensations. One of the most important questions regarding this theme can be found in the very title of this article, why do chilies create a burning sensation and why does peppermint have a cooling effect? There are multiple experiences related to this, many people have said that when they put their hands in hot water the first sensation that they feel in their hands is that of coldness and then gradually the sensation of heat takes over. This has also been experienced by many people that when we soak our hands in completely boiling water, instead of feeling any heat we begin to experience pain.

You must have also experienced that when you hold an object that is freezing cold then after sometime your hands will begin to experience a kind of numbness. Let me add to this anotherextremely interesting fact, it was found in the year 1840 by a scientist working on the functioning of the human body called Ernest Heinrich Weber that whenever we pick up something in our hands the weight of the object depends on the temperature of it. So if the object is cool it tends to feel heavierwhere as if it is hot it tends to feel lighter. This is known as 'silver Thaler illusion'. If we conduct a small experiment, then we can discover some new things about hotness and coldness. Take three glasses; fill one with hot water, one with cold after and the last one with luke warm water. Now put the fingers of one hand in the hot water and the fingers of the other hand in the cold water. After some time, take out both the fingers from their respective glasses and dip them together in the glass that as containing the Luke water. Now try saying, whether the water in that glass is hot or cold? These questions were always there, but there was yet another question that was lurking in my mind. It was perhaps because of this particular question that I began to study about the sensations related to heat. There was a time when there were much estimation about the sensation of heat but a clear and logical understanding of the phenomenon had not yet been arrived at. A lot of theoretical formulations were being charted out during this time. One of the prominent ideas circulating around this time was that heat and cold are completely different substances. Heat was named 'caloric' while some people had argued that there was also another substance that was associated with the sensation of coldness and they called it 'Frigoric'. The second category was not much talked about, but what was said is that the higher presence of caloric would make the substance hotter. Gradually, it became established that far from being two distinct substances 'heat' and 'cold' were not even two distinctive ideas. These were only two sides of a single coin and went on to show how the temperature of one object could be seen in opposition to the temperature of another object.

The purpose of sharing with my readers the above information was simple. The idea that I wanted to put across was that today in Physics it is argued that the temperature of any object is the result of the heat produced in its cells by the kinetic energy running through it. The more the amount of kinetic energy running through the molecules of the object, the greater will be its temperature. Thus heat or cold are

not different categories, all they reflect is the amount of kinetic energy in the molecules with respect to each other. I have studies in biology that we can record the extent of heat and cold through different instruments only. But how can this be possible, one discipline argues that heat and cold are nothing but reflections of the presence of kinetic energy present in the molecules of the object whereas biology seems to say that hot and cold are two distinct phenomenons. The measurement of heat-cold in a combined way is called heat-conduction mechanism.

I assume that by now I have been able to explain my problem and from here I shall move ahead in the discussion. Before being able to understand the above questions it is fundamental for us to begin by understanding the properties of heat conduction.

The first thing to understand is that these cells by which we are able to feel the sensations of heat and cold are found all over the skin of the body. It has been found through research that these receptors of heat and cold are found all over the skin in such a way that their presence can be understood in terms of small points in the body. This means that these points enable you to have the sensation of hot and cold. If we try to compare the number of these spots then it would be seen that the spots for the sensation of coldness are far more than the spots for detecting heat. These receptors of coldness are found in an even greater number on your ears, nose and eyes and this is also perhaps the reason why in these portions you feel the maximum cold.

Now let us understand ho these to receptors help us to have the sensations of hot and cold. It has been seen that under normal circumstances, these points for sensation constantly send messages to the brain for detection.

If the body temperature is above 40 degrees then the cold receptors become ineffective. But as the temperature of the body goes down, these receptors become activated again. These sensation centers become excessively active fewer than two circumstances, one is when they are constantly exposed to a similar temperature pattern and the other is when this temperature pattern suddenly changes. The representation clearly shows that the moment the temperature begins to go below 35 degrees they become immediately active. Close to 27 degrees their sensitivity is at its peak. Reaching close to about 18 degrees they stop sending messages to the brain.

Now let us understand something about the heat receptors. These receptors become activated when the temperature of the body becomes 30 degrees. Now, with the increase in temperature their activities also get increased. At about 45 degrees their sensitivity rates is atits highest. When the temperature exceeds this limit they quit sending signals to the brain about the heat but instead send signals regarding pain. This is the reason why at an extremely high temperature we begin to experience pain.

Through intense research and study it has been found that whether we are talking of heat or coldness, for the sensation of each kind more than one type of receptor is found in the body. It is worth pointing out that, apart from feeling heat or cold there are also many receptors which are sensitive to things like pain, taste, touch etc.

By the explanation given above, there is one thing that becomes quite clear, that at a particular range the sensations of both heat and cold can be felt effectively. This range is between 30-35 degrees. It is is in this range that receptors of both heat and cold work effectively and send sensations to the brain.

It has been said that it is through the messages that are received by the brain from these receptors that the brain forms judgments regarding bodily comfort/discomfort.

There is yet another interesting fact that can be noted from the above argument that between 18-45 degrees whateverthe temperature of your body be, these receptors send steady messages to the brain. As soon as there is a change in the temperature, the quality of sensitivity of the receptors also undergoes change. This change depends on two factors, firstly what was the temperature in the beginning and secondly on what was the rate at which the temperature has changed.

It is believed that we are able to detect even a 0.15 degree decrease in the bodily temperature but when it comes to detecting the atmospheric temperature we are not as efficient. The difference needs to be at least 1 degree for us to be able to measure adequately.

Now let us discuss about the receptors of heat and cold in the human body. These receptors can be classified in two distinctive ways. Firstly, on the basis of the kind of sensation that they produce in our bodies in a conscious state. And secondly, according to biological sciences which are the sensations that they are known to detect. This fact can be understood better with the help of peppermint/menthol and a substance found in chilies called capeskin.

When peppermint is applied on the body it activates the same receptors which are meant to detect the presence of coldness. The fact is that when the body comes in contact itpeppermint, cold receptors send the message of cold to the brain. The brain thus perceives that the body is indeed feeling cold. The same thing happens when the body comes in contact with capeskin. We feel heat when in contact with it as it activates the heat receptors which in turn inform the brain. The brain thus perceives we are feeling hot.

With regard to menthol it is thought that it increases the temperature of the cold receptors as a result of which, these cold receptors begin to send messages to the brain at a higher temperature.

I have mentioned above that these receptors are of multiple kinds. These get activated at a wide range of temperatures. This means that even for one particular type of sensation there are more than one type of receptor. The receptors of cold have something peculiar about them. These receptors of course do send signals upon the decrease of temperature but when the temperature becomes higher (45 degrees and above) even then they continue to send signals. Because of a fundamental difference between the receptors of heat and cold, the brain first receives the signals from the receptors of cold. The reason for this is that, the receptors of cold transmit signals faster when compared to the receptors of heat. This is the reason why when we put our hands in extremely cold water, the first sensation is that of cold.

The amazing fact is that a single receptor can be sensitive to a variety of sensations. Through numerous experiments it has been found that apart from a select few receptors most other receptors are

performing a variety of sensational functions. These are called polyamide receptors. And most of the receptors in our body are polyamide.

In case of touch and pressure, this thing is felt even more clearly. There are certain receptors that are sensitive even to the sensations of cramping or twitching. That is perhaps the reason why when we pick up something that is cold it seems heavier because the receptors for the sensation of pressure are also activated during that process and that is why the object feels heavy.

The problem with chilly is quite unique and interesting too. When we put it on the top of our tongues, it creates a burning sensation and we think that this is the taste of the chilly. But factually, what is happening is that it is only activating the heat receptors. Similarly, these receptors are to be found all over the body and thus in all parts of the body when a chilly is touched, the same burning sensation can be felt.

It is extremely fascinating to note that the sensations produced by both menthol and capsaicin are illusions of the brain. Actually, the sensation produced by capsaicin is that of danger but we assume it to be its flavor!

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ILLUSTRATIONS (refer original article in Hindi)

PAGE 12- experimenting with hot and cold water.

PAGE 13- Feeling the weight: A coin cooled down by ice appears heavier when placed on the forehead. When the same coin is placed on the forehead at a normal temparature, it seems lighter.

PAGE 14- graph depicting temperature and signals sent per unit time

Unit time

Temperature

PAGE 16- PEPPERMENT CRYSTALS