



## **EFFECT OF CHANGE IN SKIN TEMPERATURE ON TWO POINT DISCRIMINATION SENSITIVITY**

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### **ABSTRACT**

Sensation is a perception associated with stimulation of a sense organ or with a specific body condition, located not in specific parts but is found all over the body and originates in the bottom layer of skin called the dermis. Two-point discrimination is the ability to discern that two nearby objects touching the skin are truly two distinct points, often tested with two sharp points during a neurological examination. Besides touch, skin contains thermoreceptors endings that are highly sensitive to temperature. Some thermosensory fibers specifically respond to warmth (warm receptors); others respond to cold (cold receptors), located just beneath the skin surface. Hence the different sensations may interact to effect each other complexly. 45 subjects were included in the study with mean age 21.48 years, mean height 166.03 cm & mean weight 59.80 kilogram & were selected. The experiment was divided into 3 groups with Group-A (normal room temperature), Group-B (cold application) and Group-C (heat application) and two point discrimination sensitivity testing was done on dermatome T1. After application of cold pack, two point discrimination sensitivity was found to be increased. The magnitude of increase in heat application group was 5.13 mm, however for cold was 8.25 mm. This shows that greater change in two point discrimination sensitivity occur with cold application as compared to heat application. Therefore the study concluded that greater change in two point discrimination sensitivity occur with cold application as compared to hot application.

**Keywords:** Sensation, heat therapy, Cold therapy, Two point discrimination.

### **INTRODUCTION**

Cutaneous sensory, assessment is an integral part of general physical as well as neurological examination. Evaluation of sensitivity is required both for accurate diagnosis & for measurement of postoperative results in patient with chronic nerve compare and acute nerve injury [1].

Sensation is a subjective experience resulting from the stimulation of sensory receptors & sensory receptors are specialized modified sensory nerve ending which under goes depolarization in response to specific stimulus. Sensation is presumed to arise as a result of nerve activity in certain areas of cerebral cortex, which receive incoming signals from the sensory receptors [2].

Once a touch stimulus is detected by receptor

endings in the skin, the neuron responds by initiating electrical impulses (action potentials) that are carried into the spinal cord. Impulses are then relayed to other neurons in the spinal cord and to the thalamus of the brain. From there, the impulses are transmitted to neurons in the somatosensory cortex of the cerebrum [3].

The actual process of perception (that is, conscious realization or awareness) of the stimulus occurs only when certain neurons in the somatosensory cortex of the brain receive the incoming sensory impulses from that part of the body.

In the patient sustaining injury to peripheral nerves like ulnar palsy, carpal tunnel syndrome etc., the ability to perceive temperature, pressure, light touch &

vibration is commonly tested. With respect to light touch, the examination consists of an assessment of patients two point discrimination sensitivity.

Two point discrimination test is a reasonably easy clinical procedure, although two point discrimination is a routine component of the neurological examination, its most frequent and perhaps most effective use has been in patient with hand injuries. Regarding the test instrument, researcher have emphasized that the points making contact with the skin must be blunt [4].

Two point discrimination sensitivity is the ability to assess distance how close together two points non noxious & light touch stimuli can be before felt as one when touched the skin. In order for touch at two separated points on the skin to be perceived and discriminated by the brain as two distinct stimuli, the following prerequisites must be met [5].

- In the skin, stimulation of at least two spatially separated touch sensitive nerve endings must occur. This is a more likely to happen if the touch stimuli are widely spaced and if the two stimuli occur in sensitive areas of the skin innervated by many touch-sensory endings per unit area. Perception of two stimuli is less likely if the two stimuli are closely spaced or if stimuli are in insensitive areas of skin innervated by few touch-sensory endings.

- In the spinal cord and brain, nerve impulses triggered by the two stimuli must be carried in two separate pathways, resulting in activity in two separate locations in the somatosensory cortex. Such spatial separation of sensory structure and function in the spinal cord and brain is a key feature underlying our ability to discriminate or resolve separate points of touch.

The value of two point discrimination sensitivity varies in different skin regions because the distribution of sensory receptors in different regions of body varies. Moving two point discrimination give a measure offhand ability to feel objects, provided hand motion is possible & the level of sensitivity can be increased with training [6].

Specially the two point discrimination testing has been used to assess hand or arm function following skin grafting [7], peripheral nerve suture [8] & digital replantation [9].

More recently two point discrimination testing has been used to evaluate the effectiveness of various procedure used in surgical management of peripheral nerve injuries [10].

Fine touch perception occurs through the dorsal (posterior) column pathway. Mainly fasciculus gracilis & fasciculus cuneatus. Fasciculus gracilis receive afferent from lower half (lumbar & sacral segment) of body while fasciculus cuneatus receive afferents from upper half (cervical and thoracic segments)

When touch stimulus is applied on the forearm, sensory receptors are stimulated & send the signals (information) upto the dorsal root ganglia via the sensory

nerves. From the dorsal root ganglia signals (information) is carried out through the dorsal column tracts (fasciculus gracilis & cuneatus) upto the somatosensory cortex where the information is perceived [11].

Besides touch sensory nerve fibers, skin contains thermosensory fibers with receptor endings that are highly sensitive to temperature [12]. Some thermosensory fibers specifically respond to warmth (warm receptors); others respond to cold (cold receptors). Endings for cold-sensitive or warm-sensitive nerve fibers are located just beneath the skin surface [13].

The density of these thermo-sensitive points varies greatly in different body regions. For example, there are up to 15-25 cold points per square centimeter in the lips, 3-5 cold points per square centimeter in the finger, and less than 1 cold point per square centimeter in some broad areas of the trunk [14].

In most areas of the body there are three to ten times as many cold-sensitive points as warm-sensitive points. It is well established from physiological and psychological testing that warm-sensitive nerve fibers and cold-sensitive fibers are distinctively different from one another in both structure and function. Both kinds of fibers seem to terminate as free nerve endings [15].

## METHODOLOGY

### Design of study

Study was experimental in nature with same subject design. A randomized sample selection with data collection was performed.

### Sample

45 subjects were included in the study with mean age 21.48 years, mean height 166.03 centimeters & mean weight 59.80 kilogram & were selected from region of Delhi & NCR.

### Inclusion criteria:

- Healthy adult individuals willing to participate voluntarily in the study.
- Individuals within the age group of 18-25 years.

### Exclusion criteria

- Diabetic individuals
- Skin hypersensitivity
- Neurological condition ( involving sensory or motor nerves)
- Dermatological conditions like scar, burn & dermatitis
- Psychological disorders
- Any systemic illness
- Individuals taking treatment for any skin condition
- Any recent injury over the selected part
- Cardio vascular disease with any complication related to central nervous system

- Persons not willing to participate
- Individuals with any cosmetic alterations like tattoos

#### **Instrumentation**

- Compass type instrument
- Hot pack
- Cold pack
- Stop watch
- Distance measuring scale
- Towels

#### **Dependent variables**

- Two point discrimination sensitivity

#### **Independent variables**

Skin temperature

- Hot
- Cold

#### **Procedure**

45 individuals meeting the inclusive & exclusive criteria who gave their consent for participation were selected. Procedure and purpose of testing was explained to each subject. This experiment was divided into 3 groups with same subject design as follows

**Group-A:** At normal room temperature two point discrimination sensitivity testing was done on dermatome T1.

Subject was made in comfortable sitting position on chair with eyes closed & forearm was resting on the table; then cleans the area of dermatome T1.

Start with the tips of compass type instrument about 80 mm apart the examiner should lightly touch the two tips of instrument on the T1 dermatome, with keep in mind that both points bear equal pressure. Then gradually decrease the distance with each application between the two points (with 2 sec gap between each application). The subject should state whether he or she perceived the touch as a single point or as two separate points. Occasionally, and without the subject's knowledge, examiner should touch the subject with single tip. This will help prevent the subject from knowing whether or not a double point stimulus was always delivered.

Inter point distance was increased or decreased until the subject was consistently able to correctly indicate whether they had been touched by 1 point or two point simultaneously.

To reduce the possibility of accommodation to the test stimuli examiner avoided touching the same point on the skin more than one, during testing & when hair was present in the test area care was taken to avoid touching or moving the hair as the points of the testing instrument were being applied to the skin [16].

Smallest distance, at which the subject reliably differentiates the application of two points, was recorded.

**Group-B:** After applying cold pack for 10 min two point discrimination sensitivity testing was done on same dermatome T1.

After 30 min. completion of stage I, Subject was again made in comfortable sitting position on chair with eyes closed & forearm resting on the table; then cleans the area of dermatome T1. Hot pack is applied for 10 min, after that it was removed.

Now again start with the tips of compass type instrument about 80 mm apart the examiner should lightly touch the two tips of instrument on the T1 dermatome, with keep in mind that both points bear equal pressure. Then gradually decrease the distance with each application b/w the two points ( with 2 sec gap between each application). The subject should state whether he or she perceived the touch as a single point or as two separate points. Occasionally, and without the subject's knowledge, examiner should touch the subject with single tip. This will help prevent the subject from knowing whether or not a double point stimulus was always delivered.

Interpoint distance was increased or decreased until the subject was consistently able to correctly indicate whether they had been touched by 1 point or two point simultaneously.

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Smallest distance, at which the subject reliably differentiates the application of two points, is recorded.

**Group-C:** After applying hot pack for 10 min two point discrimination sensitivity testing was done on the same dermatome T1.

Subject was made in comfortable sitting position on chair with eyes closed & forearm was resting on the table; then cleans the area of dermatome T1.

Cold pack was applied for 10 min, after that it was removed.

Start with the tips of compass type instrument about 80 mm apart .the examiner should lightly touch the two tips of instrument on the T1 dermatome, with keep in mind that both points bear equal pressure. Then gradually decrease the distance with each application between the two points (with 2 sec gap between each application). The subject should state whether he or she perceived the touch as a single point or as two separate points. Occasionally, and without the subject's knowledge, examiner should touch the subject with single tip. This will help prevent the subject from knowing whether or not a double point stimulus was always delivered.

Interpoint distance was increased or decreased until the subject was consistently able to correctly indicate

whether they had been touched by I point or two point simultaneously.

To reduce the possibility of accommodation to the test stimuli examiner avoided touching the same point on the skin more than one, during testing & when hair was present in the test area care was taken to avoid touching or moving the hair as the points of the testing instrument were being applied to the skin [17].

Smallest distance at which the subject reliably differentiates the application of two point, was recorded.

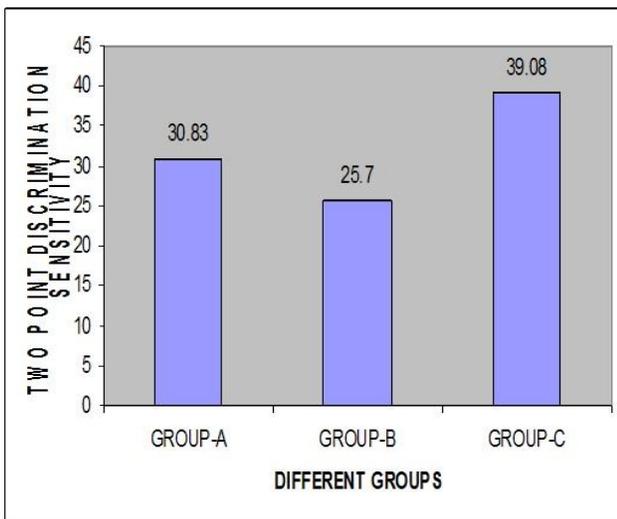
**RESULT**

On the basis of below results it can be observed that after application of hot pack, two point discrimination sensitivity decreases and after application of cold pack, two point discrimination sensitivity increases. The magnitude of increase in two point discrimination sensitivity for GROUP-B (after application of hot pack) is 5.13 mm, however for GROUP-C (after application of cold pack) is 8.25 mm. This shows that greater change in two point discrimination sensitivity occur with cold application as compared to hot application.

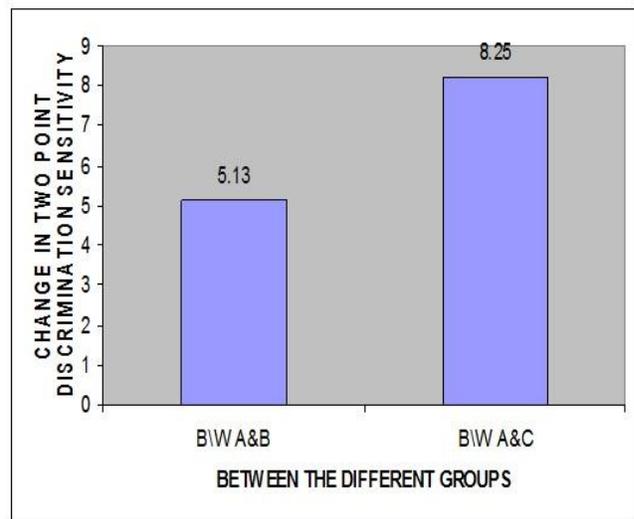
**Fig 1. Instruments used during the methodology**



**Graph 1. Comparison of two point discrimination values between the different groups**



**Graph 2. Change in two point discrimination sensitivity between group, A&B and A&C**



**Table 1. Mean and Standard deviation of Age,Weight and Height of subjects**

No of subjects		GroupA	GroupB	GroupC
		45	45	45
Age (in years)	Mean	21.48	21.48	21.48
	Standard deviation	1.54	1.54	1.54
Wight (in kg)	Mean	59.8	59.8	59.8
	Standard deviation	10.67	10.67	10.67
Hight(in c.m)	Mean	166.03	166.03	166.03
	Standard deviation	9.43	9.43	9.43

**Table 2. Comparison of Mean and Standard deviation of two point discrimination sensitivity of different groups**

Two point discrimination sensitivity	GroupA	GroupB	GroupC
Average Mean(in mm)	30.83	25.7	39.08
Average Standard deviation(in mm)	4.86	4.34	4.77

**Table 3. Comparison of change in two point discrimination sensitivity values between the different groups**

	Between Group A& B	Between Group A& C
Change in Two Point Discrimination Sensitivity (in mm)	5.13	8.25

**DISCUSSION**

The main finding of this study was that the two point discrimination sensitivity decreases after hot application and increases after cold application. Also, the magnitude of change in two point discrimination sensitivity was greater with cold application as compared to hot application.

Mean two point discrimination sensitivity value at normal room temperature (for Group-A) was 30.83 mm.

Mean two point discrimination sensitivity value after application of hot pack for 10 minutes (Group-B) was 25.7 mm.

Mean two point discrimination sensitivity value after application of hot pack 10 minutes (Group-A) was 39.08mm

The change in magnitude of average two point discrimination threshold after application of hot pack for 10 minutes was 5.13mm & The change in magnitude of average two point discrimination threshold after application of cold pack for 10 minutes was 8.25mm.

Age of the test subject has also been reported to influence two-point discrimination ability. Sohn and Simons found that two-point discrimination values increase with age. The age range of the sample in this study was 20 to 24 years old, and, therefore, provided information on a restricted subset. In view of the findings of Sohn and Simons, therapists should be cautious in using the results reported here as standards for determining normalcy in two-point discrimination ability in either younger or older individuals. Replication of the study using subjects in other restricted age groups might be very useful to therapists who evaluate and treat patients with sensory dysfunction in these age groups.

However no relevant data about the effect of skin temperature on two point discrimination threshold was available the result of this study explain that change of

two point discrimination threshold may occur with change in temperature.

When we compare two point discrimination threshold of Group-B and Group-C, we found that magnitude of change in two point discrimination threshold was greater in group-c (after application of cold pack) as compared to group-b (after application of hot pack).It may be due to that, in most areas of body there are three to ten times as many cold points as warm sensitive points. The density of these thermo-sensitive points (hot and cold points) varies greatly in different body regions, it is well established from physiological and psychological testing that warm-sensitive nerve fibers and cold-sensitive fibers are distinctively different from one another in both structure and function. Both kinds of fibers seem to terminate as free nerve ending.

The importance of this study is that it may be helpful in management of neurological conditions like in patient with hand injuries, peripheral nerve injuries and other neurological disease

**CONCLUSION**

On the basis of this study it was concluded that change in two points discrimination sensitivity occurs with increase or decrease in temperature. With the application of cold pack change in ‘two point discrimination sensitivity’ was greater as compared to hot pack application.

The averages change in two point discrimination sensitivity, after cold pack application was 8.25 mm and after hot pack application was 5.13 mm

**ACKNOWLEDGEMENT**

None

**CONFLICT OF INTEREST**

The authors declare that they have no conflicts of interest.

**REFERENCES**

1. Michael FN. Two-point discrimination assessment in the upper limb in young adult men and women. *PhysTher*, 62, 1982, 965-969.
2. Sinclair D. Psychophysiology of cutaneous sensation. *Physiology and Pathophysiology of the Skin*. London, England, Academic Press, 1973, 429-473.
3. Charlie D. Touch and temperature senses, *Ecology, evolution and organismal biology*, Iowa university, Ames, IA 50011, 2004.

4. Michael FN. Two point discrimination value for face and trunk, Department of anatomy, University of south florida, 65, 1985, 33612.
5. Hutchisson J, Trough JS, Wyburm GM. Comparison of cutaneous sensory pattern of different region of body. *Br J PlastSurg*, 1, 1948, 131-144.
6. Mannerfelt L. Evaluation of functional sensation of skin grafts in the hand area. *Br J Plast Surg*, 15, 1962, 136-154.
7. Almquist E, Eeg-Olofsson O. Sensory nerve conduction velocity and two-point discrimination in sutured nerves. *J Bone Joint Surg*, 52, 1970, 791-796.
8. Gelberman RH, Urbaniak JR, Bright DS, et al. Digital sensibility following replantation. *J Hand Surg*, 3, 1978, 313-319.
9. Stromberg WB, McFarlane RM, Bell JL, et al. Injury of the median and ulnar nerves. *J Bone Joint Surg*, 43, 1961, 717-730.
10. Jain SK. Human physiology and biochemistry for Physical therapy and Occupational therapy, 2002, 354-355.
11. Niels B, Gerd T, Gillian M, David A. Age changes in the two-point discrimination threshold in skin innervated by the trigeminal nerve. *Journal of oral rehabilitation*, 1, 1994, 323-333.
12. Periyasamy R, Manivannan M and Vengesa B. Changes in Two Point Discrimination and the law of mobility in Diabetes Mellitus patients, Biomedical Engineering Group, Department of Applied Mechanics, Indian Institute of Technology Madras, Chennai, 600036, India, 2008.
13. Ivan L. Disturbance of Two-point Discrimination Sensitivity in different forms of cerebral Palsy, Neurological Clinic, Faculty of Paediatrics, Charles University, Prague, Czechoslovakia, 1967.
14. Tobias K, Patrick R, Peter S, Hubert R and Martin T. Impaired Tactile Acuity in Old Age Is Accompanied by Enlarged Hand Representations in Somatosensory Cortex, 2008.
15. Jean L, Johanna D, Edith R, Jean P and Christine P. Changes in Tactile Spatial Discrimination and Cutaneous Coding Properties by Skin Hydration in the Elderly. *Journal of Investigative Dermatology*, 115, 2001, 454-458.
16. Novak C, Christine B, Mackinnon S. Correlation of Two-Point Discrimination and Hand Function Following Median Nerve Injury. *Annual of plastic surgery*, 31(6), 1993, 495-498.
17. Srikantan S, Nagarajan DT et al., Practice-Related Improvements in Somatosensory Interval Discrimination Are Temporally Specific But Generalize across Skin Location. *The Journal of Neuroscience*, 18(4), 1998, 1559-1570.