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Role of speech associated gestures of the teacher in Medical education - a comparative study

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Abstract

Background and aim: Gestures are generally hand or body movements that express the feelings and intentions. It's a universal feature of communication and is tightly timed with speech. Gesture and Speech combine to reveal meaning that is not fully captured in one modality alone, as they share a common neural relationship. Many earlier studies have revealed the importance of gestures in improving learning in school children. Studies on the role of gestures in improving the learning skill in medicine are scarce. This study was carried out to find out whether gesturing improved the learning outcome of medical students. Materials and methods: Ninety four students from first MBBS batch were recruited and randomized in to four groups A,B,C and D. Group A and B (Topic I (n=46)) consists of 23 students each, whereas group C and D (Topic II (n=48)) consists of 24 students each. Group A and C who were taught with gestures formed the study group; Group B and D taught without gestures acted as control. Two lectures on two different topics were taken for both the study and the control groups without any audiovisual aids for 20 minutes during tutorial time in the department of Physiology and the results were analyzed statistically using Wilcoxon Ranksum test. Result: Results of the study on two lecture topics showed that the scores of the students taught with gestures was higher with a p value of 0.005 and 0.0248 than those taught without gestures both immediately as well as a week after the lecture. Conclusion: Gestures do have a definite role in improving learning in medical students. Along with other teaching aids, gestures should also become an integral part of teaching.

Key words: teacher, co-speech gestures, medicine, learning.

Introduction

A person's mental state can be modified by both linguistic and gestural modalities. Gestures are a form of non-verbal communication in which bodily actions, face expression and hand movements are used to convey thoughts that at times the subject may not express in speech. "Gestures are windows into the thought process". Systems activating gestures and speech arise from a common cognitive process. Neurofindings demonstrate a fundamental connection between speech and gestures. Both the classes of stimuli operate a common left lateralized network of inferior frontal and posterior parietal regions which are functionally coupled to each other as well as to the homologues of these regions in the right hemisphere. When the portion of the brain associated with speech production is activated, activity spreads to the neighbouring sites associated with movements of the hand form and vice versa. Studies have shown that motor areas including premotor area, cerebellum become active in language tasks eg. when adults are asked to read words silently from a video screen their hand areas get activated. Language areas become active with hand movements which happen even when individuals think about moving their hands also. Hanlon et al proved that some language functions in aphasic patients may be improved by gesture production and training. Gestures influence how information is exchanged between teachers and students during learning sessions. During counting numbers, not only hand gestures used by the students themselves but also the gestures used by
the teacher improve the student’s mathematical score. Singer & Goldin Meadow observed that when teachers used gestures during maths instruction e.g. using fingers for counting, children learnt the concepts better than when teachers use speech alone. Hand gestures provided additional clarifying input for students in explaining concepts in biology classes. Even small changes like vocal pitch variability and the extent of hand gestures dramatically improved the students’ score. Based on these evidences, it is clearly understood that gestures play an important role in delivering the concepts with clarity than speech alone. These findings suggest that gesturing can promote learning, if these gestures become an integral part of conversation in a teaching situation. The role of co-speech gestures in improving learning in school children was substantiated in many earlier studies. The present study aims to find out the impact of speech associated gestures in medical learning and its influence on the student’s score.

Materials and Methods

Ninety four first year medical students were recruited for this study after obtaining permission from the Institute Research and Ethical committee. The students were randomly selected into four groups A, B, C and D.

Inclusion criteria

1. 1 MBBS medical students
2. Willing to participate in the study
3. Age between 17-19 yrs
4. Those who have joined MBBS directly after 12th standard.

Exclusion criteria

1. Unwilling to participate
2. Those who have prior knowledge of the topic to be taught

Group A and B were allotted for Topic 1 and consist of 23 students each, whereas group C and D allotted for Topic II consisting of 24 students each. Group A and C formed the study group; Group B and D acted as control group. All the groups are equally distributed based on achievements in previous tests conducted in the Department of Physiology.

Two lectures on two different topics were taken. Lecture Topic I was Parkinson’s disease and Topic II was surfactant. The study was conducted in the Department of Physiology during tutorial time between 2 to 3 pm for all the four groups of students without any audiovisual aids for twenty minutes. The lecture was taken by the same teacher for both the study and the control groups. During control group teaching, steps were taken to prevent hand movements specifically by instructing the lecturer to keep the hands folded.

Study group A had lecture with twenty meaningful gestures and study group C with five meaningful gestures elaborating the key points of the lecture. These gestures were validated by group of professors, peers and psychologist for their correctness for the situation. The two control groups had the same lectures (B-Parkinson’s disease and D-surfactant) but without gestures.

At the end of the lecture on Topic I and Topic II, both the study and control groups were evaluated with a written test consisting of 20 + 5 questions from the same lecture. Out of 25 questions, most of the questions were based on points which were taught with the gestures and few questions from the same topic on points which were taught without gestures. Twenty minutes time was given for the students to answer the questions. The questions given to the students were also validated and approved by the peers for their correctness in study. Each questions from topic I carried 0.5 marks to the total of 10 marks. And in topic II each question carried 2 marks to the total of 10 marks.

After one week time, one more test with the same questions was conducted to all the students without previous announcement to evaluate their retaining capacity. The answer sheets of both the study and the control group were shuffled to avoid the correction bias.
and then evaluated by professors who were not involved in the study with the help of printed answer keys for the questions. Both the study and the control groups were compared with the help of scores achieved.

The results were analyzed with the help of Wilcoxon Ranksum test using STATA 11 analysis software. Since the distribution of marks shows non normal distribution, this non parametric test was used to assess the statistical significance.

Results

Results of the study immediately after the lecture for ninety four students showed that the scores of the students taught with gestures were significantly higher than those taught without gestures. The study group which was taught with gestures scored the average of 6.02 (± 2.09) out of 10 compared to the control group (taught without gestures) which scored an average of 4.73 (± 2.31) out of 10. The mean value (5.5) of the study group for Topic I (A&B) was found to be higher than the mean value (4.3) of the control group, though statistically not significant. The results of topic II (C&D) was highly significant with a p value of 0.01.

Results of the study after a week on two lecture topics for ninety four students showed a higher score for the study group ie 3.43±1.88 out of 10 than for the control group which was 2.65±1.90. The results of Topic I (A&B) was highly significant with a p value of 0.001. For topic II (C&D) the mean score of the study group was 4.25 which was higher than the mean score of the control group (3.52).

Discussion

Our ancestors communicated through meaningful gestures and over time the brain regions that processed gesture became adapted for using words. Systems activating mouth and arms mutually influence one another and ultimately settle on a compromise frequency. Children often produce their first gestures several weeks before they say the first word ‘I’\(^\text{11}\). Communicative gestures like pointing gestures develop at around 10-11 months of age. Butterworth and Hopkins\(^\text{12}\) have found that newborns react to pressure applied to their palms by opening their mouths. Either vocalization or mouthing movements co-occur with extension of index finger in children between 9-15 weeks.
Gestures help in improving spatial thinking which is central to success in science, technology, mathematics and engineering. Gestures were by far the most frequent non spoken form of communication for all the teachers apart from pictures, objects and writing. It is a known fact that teachers would repeat their own speech while clarifying the meaning of their utterance with gestures. Meaningful gestures are more frequent when speakers are spontaneously constructing sentences than when they are reciting rehearsed sentences.

The neural relationship between gesture and speech was first seen with the discovery of "mirror neurons" in monkeys in an area homologous to human Broca's area. Similar mirror neurons are identified in Broca's area in humans. Several studies also have shown that brain regions that process speech also process actions made with the hand. Gestures are processed in the same region as speech. These regions include Inferior frontal gyrus (Broca's area) and posterior middle temporal gyrus (Wernicke's area). When the portion of the brain associated with speech production is activated, activity spreads to the neighboring sites associated with movements of hand. Connectivity analyses also showed that left inferior frontal gyrus & posterior middle temporal gyrus were coupled to the superior temporal gyrus only for speech and to fusiform gyrus and inferior temporal gyrus only for symbolic gestures. Floel et al. found that when there is damage to parts of the brain that control hand movements, speech comprehension also differs. Willems et al. used functional MRI to show that Broca's area integrates gestural and spoken information during sentence comprehension, suggesting a common neural mechanism. Wu & Coulson showed that gesture may have combined with speech to build stronger and vivid expectations of the picture than just speech alone. These findings suggest that understanding and learning will be better with co speech gestures as larger areas of the motor cortex are activated simultaneously.

Many earlier studies have shown the importance of gestures in improving learning in school children. Pozzer-ardenghi and Roth have studied teacher-student interactions during high school biology lessons and found that for many concepts, hand gestures provided additional clarifying input for the students. Even gesture mismatches help in learning.

These speech associated gestures are totally different from sign languages, where the sign language is comprised of established or codified hand shapes, hand movements and grammar. Gesture is an arbitrary way of transmitting information by random hand and body movements.

Speech associated gestures have variously been called "representational gestures," "illustrations" & "Gesticulations". Mc Neil classified co-speech gestures into 4 types:

1. Deictic gestures are pointing gestures. E.g. You, there etc.
2. Iconic gestures express images. E.g. To convey the sentence "Priya chased the cat with an umbrella", you poke about with an imaginary umbrella.
3. Metaphoric gestures convey an abstract idea into a concrete form. E.g. Wiping imaginary sweat from ones brows.
4. Beat gestures are hand movements that help the rhythm of speech. E.g. Political speeches.

All are symbolic, in that hand and arm stand for something other than themselves, and all are closely related to the semantic and pragmatic aspects of the speech they accompany. The study was devised in such a way that all these four types of gestures are used. As a whole 25 standardized meaningful gestures were used in this study. Two topics were selected as, the bias created by the topic 1 (clinical topic) with more number of meaningful gestures can be compensated by the topic 2 (preclinical topic) which has minimal number of meaningful gestures.
The result that the overall score of the students taught with gestures is higher (p=0.005) than the scores of students taught without gestures confirms the effect of gestures on medical learning. On analyzing the results it is found that immediately after lecture, the scores of the topic with minimal meaningful gestures (Topic II) were found to be higher than the topic with maximum number of gestures (Topic I). Though the overall effect of speech associated gestures had increased the learning outcome, for immediate memory topic with minimal gestures can be preferred.

As the Study and the control groups are selected in such a way that the number of students in all the groups is less than 25, results suggest that these speech associated gestures have a definite value in small group teaching like tutorials where black boards or Power Points are not used. Gestures not only elaborate a topic that has already been introduced in speech but also introduce new information that is not mentioned in the speech. It also improved the spatial thinking. Williams and Ceci [10] illustrated the substantial connection between a professor’s non-verbal behaviors and student evaluation of teaching. Even small stylistic changes dramatically improved the score from 3.08/5.0 to 3.92/5.0. Though he used identical syllabus, lecture content, audio visual materials for both the groups he only altered his voice pitch variability and the extent of his hand gestures between the two versions of his course. The present study which again included mainly hand gestures confirms the findings of the earlier studies. The flaws which could have been avoided in this study are: 1. The number of questions for both the topics is not equally distributed. 2. Interchange of the study and the control group of topic I with the control and the study group of topic II to prevent the performance bias on part of the students.

Words learnt with gestures produced deeper and stronger neural memory traces [18, 27]. It was also analyzed in this study whether these significant differences between the study and the control group persisted even after a week. When the same questions were given after a week and evaluated, it was interesting to find that:

1. The overall score was high in the study group than the control group even after a week. This concludes that the retaining and recalling capacity is more in subjects taught with gestures than without.

2. Scores of topic I was extraordinarily high as this topic consisted of maximum number of meaningful gestures. This shows that usage of maximum number of meaningful gestures improves short and long term memory. Scores of topic II was statistically not significant (though the mean score is high) as the number of meaningful gestures used was minimal.

This suggests that the gesture-speech relationship is preserved in lasting memories as a result of learning.

Conclusion

Co-speech Gestures: 1. Help in spatial thinking 2. Elaborate the contents of the speech 3. Breaks the monotony of the lecture 4. Overcome the language barrier to an extent 5. Reduces inhibition, increases the reciprocation and improves the interaction between the teacher and the students. Gestures definitely do play a role in educational outcomes involving teaching and learning. Along with black boards, PowerPoint, pictures, objects etc gestures should also become an integral part of teaching. The present study has brought out the importance of speech associated standardized gestures only in small group teaching. The role of the beneficial effects of these gestures has to be further evaluated on a larger scale.

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Annexure:

Topic 1. Parkinsonism

**Gestures used:**

1. Gesture to show tremor (Shaker's palsy).
2. Gesture to describe basal ganglia as a group of subcortical neurons.
3. Gesture to describe the location of basal ganglia.
4. Gesture to denote the connection between cerebral cortex, corpus striatum and substantia nigra.
5. Gesture to show the normal balance between Ach and dopamine.
6. Pill rolling tremor.
7. Gesture to demonstrate Cog wheel rigidity.
8. Lead pipe rigidity.
9. Gesture to show bradykinesia.
10. Expressionless face.
11. Excessive salivation.
12. Scanning speech.
13. Gesture to show timing and scaling of movements.
15. Gesture to show absence of swinging of arms while walking.
17. Festinant gait - stooped posture with short shuffling steps.
18. Gesture showing imbalance in levels of Ach & dopamine in Parkinsonism.
19. Gesture showing how L- Dopa reaches brain crossing blood brain barrier.
20. Gesture to show how nerve growth factor administered along with lenti virus reaches substantia nigra.

**Questions on Parkinson's disease (with answers)**

Number of questions : 20  
Total marks=10

1. What is the other name for Parkinson's disease? (1/2)  
   Shaker's palsy or paralysis agitans.
2. Where is basal ganglia and why is it known as basal ganglia? (1/4+1/4)  
   In brain. Because it is a collection of sub cortical neurons present in basal region of brain.
3. Name the neurotransmitter secreted by substantia nigra and mention whether it is excitatory or inhibitory in nature. (1/4+1/4)  
   Dopamine. Inhibitory.
4. Name the pathway in basal ganglia where degeneration of neurons results in Parkinson's disease. (1/2)  
   Nigrostriatal pathway.
5. Give 2 causes for Parkinsonism. (1/4+1/4)  
   Old age, viral infection, drugs
6. Mention 2 important clinical features of Parkinsonism. (1/4+1/4)  
   Resting tremor, bradykinesia or rigidity.
7. Which is the important feature of Parkinsonism & explain the physiological basis behind it? (1/4+1/4)  
   Resting tremor. Normally basal ganglia masks the physiological tremor. This tremor manifests itself when there is lesion in basal ganglia.
8. Name the type of gait seen in Parkinson's disease. And describe how it is? (1/4+1/4)  
   Festinant gait. Short shuffling steps in stooped posture.
9. What is micrographia & why is it seen in Parkinson's disease? (1/4+1/4)  
   Tiny handwriting or hand writing that decreases in size from normal to minute. Timing & scaling of movements are lost in Parkinsonism.
10. Define bradykinesia. Give one example. (1/4+1/4)  
    Slowness in initiating voluntary movements, e.g.: turning the whole body slowly in response to a stimulus, than turning the head alone.
11. Define rigidity. (1/2)  
    Stiffness or increase in tone of muscle due to contraction of both agonistic and antagonistic muscles.
12. Name the 2 types of rigidity seen in Parkinson's disease. (1/4+1/4)  
    Cog wheel, & lead pipe rigidity.
13. Describe the cog wheel rigidity. (1/2)  
    Is a type of rigidity where muscle gives way in jerks when the muscle is passively stretched.
14. Name the type of tremor seen in Parkinsonism and describe it. (1/4+1/4)  
    Pill rolling tremor or resting tremor. Is the tremor seen in tips of thumb and the index finger or middle fingers are brought together, like rolling a pill.
15. Name 2 famous personalities who suffered from Parkinsonism. (1/4+1/4)  
   Hitler, Mohammed Ali.
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16) What type of face is seen Parkinson’s disease? (1/2)
   Expression less or mask like face.

17) Describe the speech in Parkinson’s disease. (1/2)
   Hypophonia, monotonous, slurred speech.

18) Suggest the medical treatment for Parkinsonism. (1/4+1/4)
   Dopaminergic & anticholinergic drugs.

19) Why L-dopa is given to treat Parkinson’s disease and
    why not dopamine directly? (1/2)
   Because only L-Dopa can cross the Blood-brain Barrier
   and not dopamine.

20) Explain how growth of dopaminergic neurons in
    substantia nigra can be promoted? (1/2)
   By injection of nerve growth factor along with
   lentivirus.

Questions on surfactant (with answers)
Number of questions: 5 Total marks: 10

1. Which cells in the lung secrete surfactant? 1+1=2 marks
   Type II alveolar epithelial cells.

2. Explain how surfactant reduces surface tension. 1+1=2 marks
   Surface tension is due to unequal attraction between
   the water molecules. Surfactant, being made of lipids
   mainly, reduces surface tension by preventing the
   attraction between the water molecules.

3. Mention two roles of surfactant in the lung. 1+1=2 marks
   1. Prevents the collapse of the lungs.
   2. Prevents edema of the lungs or keep the lungs dry.

4. Name a condition where surfactant production
   increases and why? 1+1=2 marks
   Sighing. To open up the closing alveoli or to prevent
   the collapse of the alveoli.

5. What is respiratory distress syndrome? 1+1=2
   It is a clinical condition seen in preterm babies due to
   lack of functional surfactant.

Topic 2. Surfactant

Gestures used:

1. Gesture to show alveoli with lining cells
2. Gesture to show the crowding of water molecules
   during expiration
3. Gesture to show the elastic nature of the lung
4. Gesture for Sighing
5. Gesture to show tumour in the bronchi

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