

EXPERIMENTS IN DEAF COGNITION

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Abstract

The deaf cannot hear – sounds pretty justified but researchers are of the opinion that they do have a phonological representation of the words. Our experiments aim at verifying this hypothesis. Apart from this we study the effect on Theory of Mind (ToM) in deaf children who are being taught how to speak by lip-reading and hand-gestures but don't have any standard sign language teaching.

Background

1. Phonological Representation

Phonology is the use of sound to encode meaning in a spoken language. Phonological representations in the hearing impaired are explained by "*The Functional Equivalence Hypothesis*" which states that *deaf children's phonological development is qualitatively similar, albeit quantitatively delayed, in comparison to hearing children*. The central claim of the functional equivalence hypothesis posits that visible speech information (seen articulatory gesture) extracted from the speech signal by the deaf learner is interpreted as a phonologically plausible signal by the brain. Basically, it implies that phonetic information derived from both auditory and visual inputs map into the same motor representation of vocal tract gestures.

It has been suggested that with the help of the visual information acquired through speech-reading (Campbell, 1987; Dodd, 1976; Dodd & Hermelin, 1977) and the articulatory feel of words that comes through intensive speech training (Marschark & Harris, 1996), deaf children can develop phonological representations of words.

2. Theory of Mind (ToM)

ToM reasoning involves the ability to understand mental states—the beliefs, desires and intentions of others—and to appreciate how these differ from our own.

A key issue for how children come to express ToM reasoning in terms of an understanding of others' false beliefs concerns the effect of language input. Specifically, to what extent is an expression of ToM dependent on the sense of hearing? This is an important aspect in analysing the development of cognition in the deaf. The ability to form beliefs, desires and an interpretation of the emotions of others is very much dependent on the input from the environment. This input gets limited in the case of deaf and hence, the ToM is expected to be less developed but since they have completely normal brains, they are expected to have fully developed

ToM after a certain age which is expected to be greater than that of the normal children.

Experiments

We sampled our subjects from 'Jyoti Badhir Vidhyalaya, Bithor' from a varying age-group. The test group consisted of 11 subjects (6 females, 5 males) from an age group 8-14(1:8yr, 1:10yr, 2: 11yr, 3: 12yr,1:13 yr, 3:14 yr).

We conducted 5 experiments in total – 1 for assessing the phonological representation and 4 ToM experiments. The subjects were

1. Experiment 1: Rhyme Test

This experiment is to test the subject's ability to identify a rhyming word with varying distracters. In the experiment, we showed the subjects a PowerPoint slide containing 4 images of simple day to day things. The first image was the cue and among the other 3, one was the target picture i.e. the thing to which it referred to rhymed with the thing shown in the cue picture, while the other two were distracters. The subjects were asked to identify the target picture given the cue. For example- one of the slides was



Figure 1: In this, the "Taala" is the cue and the second one "Maala" is the target while the third ("Patta") and fourth ("Heera") are the distracters.

The complete test consisted of 8 such slides and is presented as **Appendix 1**.

Initially, we had to prime the subjects to the test. So, we took the help of the teachers who made the subjects understand the task by writing some sample rhyming words on a piece of paper. Then, they were shown the slides one by one and asked to identify the target. They were marked correctly if they accurately identified the target.

2. Experiment 2: Unexpected Location Task

The experiment is designed to assess the children's ability to mistake the flow of story by wrongly interpreting the thoughts of the subject. The experiment was performed in two versions:-

2.a.

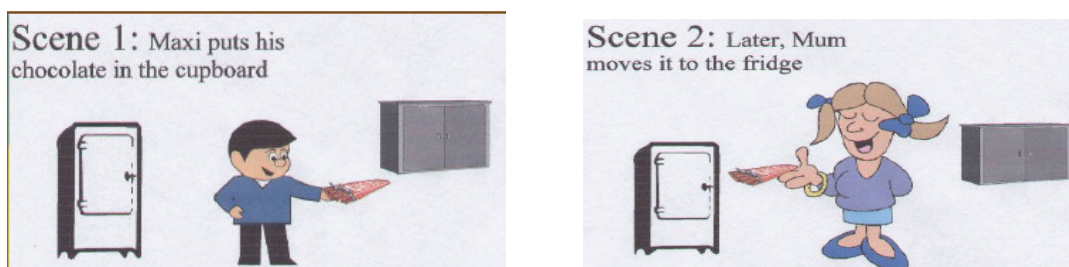


Figure2: Experiment 2

The narrative told to the subjects was –

“A boy (say Maxi) puts his chocolate in the cupboard on the right and goes away to play. His mother then takes out the chocolate from the right cupboard and places it in the left one. She leaves then. The boy, feeling hungry, comes back home to eat the chocolate.”

The question asked was –

“Where will the boy look for his chocolate – left or the right cupboard?”

Two additional questions were asked to check if the students understood the story and retained the facts of the story –

1. “Where did the boy keep the chocolate?”
2. “Where did his mother keep the chocolate?”

The subject was marked successful only if he answered all the three questions correctly.

2.b. Another version of this test was –

“Manu places her football in her casket and leaves. Tanu saw her doing so. After Manu went, she moved the ball into her bag and leaves both the bags there. Manu comes back.”

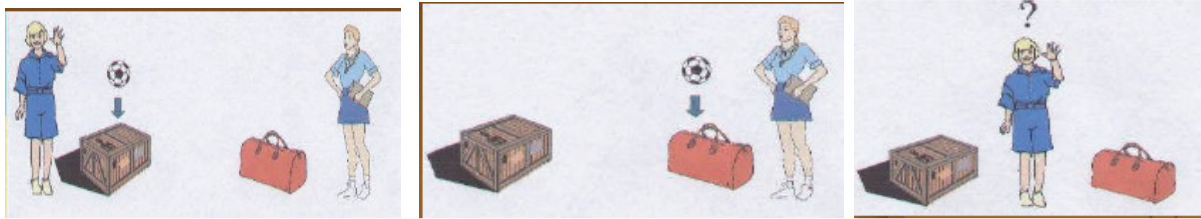


Figure3: Experiment 2(alternate version)

The question asked was –

“Where will Manu look for her football – her bag or Tanu’s?”

The two additional questions were asked to check if the students understood the story and retained the facts of the story –

1. “Where did Manu keep her football?”
2. “Where did Tanu keep the football?”

The subject was marked successful only if he answered all the three questions correctly.

3. Experiment 3: False- belief test

This experiment was to test the subject’s ability to separate his own belief from that of other subject’s.

The subjects were shown a soap cover with something in it. They were then asked of what they thought was in the soap-cover. Then it was shown to them that the soap cover actually had a lock inside instead of the usual soap.

The subject was asked –

“If your friend who is not present here right now is shown the soap cover and is asked what is inside it, what would his answer be?”

The subject was marked successful only if –

- a. he answered soap when asked what was inside the cover before lock was revealed.
- b. he answered lock when asked about what his friend would say is in the cover.

4. Experiment 4: Emotion Recognition Test

This experiment was aimed at testing the subject’s ability to predict the emotion of a story character in a given situation.

The narrative told to the subject was –

“A boy has been informed by his parents that they will be taking him to a movie in the evening. Later his friends tell him of the cinema hall being closed that evening for repairs.”

The subject was asked –

- a. “What would be the boy’s emotion after knowing that the hall is closed – happy or sad?”
- b. “What was his emotion before he knew that hall was closed – happy or sad?”

The subjects were marked correct only if they answered both the questions correctly.

5. Experiment 5: A strange story

This is a tougher version of the experiment 4. It tests the subjects for complex emotional interpretation.

The narrative told to the subject was –

“An old woman is walking home alone late at night. A man suddenly appears and comes toward her, wanting to ask what time it is. The old woman, seeing the man, starts to tremble and says, “Take my purse, just don’t hurt me please!””

The subject was asked –

- a. “Was the man surprised to hear what the old lady said?”
- b. “Why did she say that, when the man only wanted to ask what time it is?”

The subjects were marked correct only if they answered both the questions correctly.

Results and Discussions

One of the teachers was told the story and he narrated it to the subjects using pictorial representations and hand gestures. This led to a communication gap and the teacher was often giving away information more than necessary thereby compromising the experiment. Another problem was of the teachers taking it personally and forcing the children to come up with the right answer.

1. Experiment 1: Rhyme Test

The results for the rhyme test are summarized in the following table

S.No.	1	2	3	4	5	6	7	8	9	10	11
Age	10	8	12	12	11	11	12	13	14	14	14
Correct/Total	2/3	4/4	3/3	5/5	2/7	1/8	3/8	8/8	3/8	8/8	8/8
% Correct	66.7	100	100	100	28.6	12.5	37.5	100	37.5	100	100

For the first 5 subjects, if a word that corresponded to the image was out of the subject's vocabulary or if there was another word that the subject thought for that image, we discarded that slide and did not include it in our results. However, for the subsequent tests, we wrote the word that the subject didn't know.

The average accuracy of the test came out to be **71.2%** which points to a fairly high indication of phonological representation of words. A possible reason for such a high accuracy could be that since a comprehensive teaching methodology is employed at the school with emphasis on picking up word sounds through lip movements, a phonological representation is created in the subject's brain. Also, since we did not have a choice of choosing random students, it may be possible that the teachers sent only those students which had a high aptitude.

It was observed that when the elder teacher described the test to the students, they performed much better than if one of the younger teachers described it. This may be because the elder teacher was very patient with the students and made sure they understood the task through sample rhyming words before we showed them the slides.

2. Experiment 2: Unexpected Location Test

Most of the subjects could not understand the story in the first go perhaps because of the communication gap. Then the entire story was acted out with a mobile phone in the place of the chocolate to illustrate what was going on. This proved successful but subjects were often trying to point out to the experimenter where the phone really was rather being interested in answering the actual question being asked.

S.No.	1	2	3	4	5	6	7	8	9	10	11
Age	10	8	12	12	11	11	12	13	14	14	14
√ or x	x	x	x	x	x	x	x	√	x	√	√

3/11 answered correctly. This is, however, only after the teachers tried to explain the act very thoroughly and poured a few details not in the original experiment like 'the other girl stole the football and hid it in her bag'.

We selected only those cases as positive in which the subject answered correctly and the give-away information was minimal.

This test, however compromised, hints at a possibility of ToM development at a later age perhaps above 13.

3. Experiment 3: False-belief test

The subjects rarely had any problem understanding the experiment.

S.No.	1	2	3	4	5	6	7	8	9	10	11
Age	10	8	12	12	11	11	12	13	14	14	14
√ or x	√	√	√	√	x	x	√	√	x	√	√

8/11 answered correctly. Apart from a few cases, the experiment was not compromised. In those few cases, the teacher explicitly told the subject that their friend ‘doesn’t know what’s actually in the soap cover’.

This shows a considerable capability among the subjects of separating their beliefs from those of others.

4. Experiment 4: Emotion Recognition test

The teachers changed the true version of the story to their own parents taking them to the movies. This made it obvious for them to nod for happy and unhappy respectively in the two conditions thus compromising the test.

S.No.	1	2	3	4	5	6	7	8	9	10	11
Age	10	8	12	12	11	11	12	13	14	14	14
√ or x	√	x	√	√	√	√	√	√	√	√	√

10/11 answered correctly. This experiment cannot be used to conclude anything as it deviated heavily from the original statement as explained earlier.

5. Experiment 5: A Strange story

The experiment proved too tough for the teachers to act or narrate and the subjects were unable to comprehend anything so it was dropped after being performed on first two subjects. So it remains un-conclusive.

Discussions and Future Work

McQuarrie and Parrila, 2008 conducted a non verbal IQ test on the subjects to test their aptitude and the subjects which scored two standard deviations below the mean were excluded from the study. Similarly, it may also be a good idea to have a measure of the candidate’s aptitude before they are subject to Phonological and Theory of Mind tests. We had prepared a Raven’s mental ability test but due to the paucity of time and on the insistence of the teachers that the students were of the same aptitude, we did not conduct it.

There is also a need to standardise the tests. Since we were unable to interact properly with the students, we sought the help of the teachers. But there was no control over the amount of information given by the teachers and in some cases it even led the students towards the answers. In the rhyme test, we tried to put pictures that would have only one word for it and that word should easily come out but still we observed that some

students had difficulty. For ex- the word “*Heera*” was not in their vocabulary and they had a different word for “*Matka*” (“*Ghada*”) in their lexicon.

Conducting the experiments in a group instead of individually be certainly be a very good idea as it would be same for the students and would save a lot of time. We would certainly be interested in doing in future work on this subject.

Acknowledgment

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