Perception and Production of Emotive Intonation in Children with Learning Disability with and without Central Auditory Processing Disorder

Honnakore Swapnaja Mantesh

Registration No: 09SLP006

A dissertation submitted in part fulfilment for the degree of
Master of Science (Speech-Language Pathology)
University of Mysore, Mysore

ALL INDIA INSTITUTE OF SPEECH & HEARING,

MANASAGANGOTHRI, MYSORE-570006

JUNE 2011

CERTIFICATE

This is to certify that this dissertation entitled ***'Perception and Production of Emotive Intonation in Children with Learning Disability with and Without Central Auditory Processing Disorder'*** is the bonafide work submitted in part fulfillment for the degree of Master of Science (Speech - Language Pathology) of the student with Register No. 09SLP006. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Dr. S. R. Savithri

Director

All India Institute of Speech and Hearing

Manasagangothri, Mysore-570 006

Mysore,

June, 2011

DECLARATION

I hereby declare that this dissertation entitled ‘***Perception and Production of Emotive Intonation in Children with Learning Disability with and Without Central Auditory Processing Disorder’*** is the result of my own study under the guidance of Dr. Y. V. Geetha, Professor of Speech Sciences, Department of Speech-Language Sciences, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier to any other University for the award of Diploma or Degree.

Mysore

June, 2011 **Register No. 09SLP006**

A dad is someone who
wants to catch you before you fall
but instead picks you up,
brushes you off,
and lets you try again.

A dad is someone who
wants to keep you from making mistakes
but instead lets you find your own way,
even though his heart breaks in silence
when you get hurt.

A dad is someone who
holds you when you cry,
scolds you when you break the rules,
shines with pride when you succeed,
and has faith in you even when you fail...
My dad is my friend, my hero...
I Love you papa!!!☺

The duo of a mother and her daughter shares a very

beautiful relationship,

like no other relationship in this world.

When a daughter is growing up,

her mother proves to be her guiding light,

making sure that she doesn't end up doing something

that will harm her in future.

Thank you mummy for being my guiding light.

Love U Mummy!!!☺

A brother is someone with fun-loving ways

with wit and good humour to spare.

He does thoughtful things without any fuss

and when you're in trouble he's there.

A brother is more than just part of the family...

he's also a friend through and through.

And that's a description that certainly fits

a wonderful brother like you.

Love U Pratik!!!☺

Acknowledgements

ॐ भूर्भुवः स्वः ।तत् सवितुर्वरेण्यं । भर्गो देवस्य धीमहि । धियो यो नः प्रचोदयात् ॥

Our Father who art in heaven, Hallowed be Thy name, Thy kingdom come, Thy will be done, On earth as in heaven, Give us today our daily bread, And forgive our sins, As we forgive each one of those, Who sins against us, And lead us not to the time of trial, But deliver us from evil, For Thine is the kingdom, The power and the glory.

Let all the people say amen, in every tribe and tongue, Let every heart's desire be joined, To see the kingdom come, Let every hope and every dream, Be born in love again, Let all the world sing with one voice, Let the people say amen.
This was the prayer taught to me in my school days. Thank you God for being with me at each any every step of my life.

I take immense pleasure in thanking, Late. Dr. Vijayalakhmi Basavaraj and Dr. Savithri, for having permitted me to carry out my dissertation.

I wish to express my deep sense of gratitude to my Guide, Prof. Y. V. Geetha, HOD of Speech Sciences,

for her able guidance and useful suggestions, which helped me in completing my dissertation, in time.

Without humor, life sucks; without courage, life is hard; without love, life is hopeless; without friends like you, life is impossible. Thank you would be a very small word to express my gratefulness towards you guys!!☺ Dear Gargi, Priyanka, Hanan, Deepthi, Babi, Madhuban, Akash, Ranjeeth, Kavitha, Piyush, Nirmal, Neha & Lydia. Thank U sooo much!! Will miss U soo much!! ☹

I believe that everything happens for a reason, people change so that you can learn to let go, things go wrong so that you appreciate them when they're right, your believe lies so you eventually learn to trust no one but yourself, and sometimes good things fall apart so better things can fall together. I love you not only for what you are but for what I am when I am with you. May you follow your dreams and always believe in yourself, keep your eyes on the stars and hope in your heart. Thank you dear Sangam for all the help & support you have given me till

now... Every moment of our togetherness is a memory to be cherished forever Thank you for being my best buddy, my teacher, my guiding angel. All the Best for your Future!!!☺

Even though we've changed and we're all finding our own place in the world, we all know that when the tears fall or the smile spreads across our face, we'll come to each other because no matter where this crazy world takes us, nothing will ever change so much to the point where we're not all still friends. Thank you Sai, Rohini, Vidhi, Faran, Meeru, Jaslin, Adi, Avi, Sup, Sujju & Saher for making my days in Bangalore memorable...Love you all!!☺

I would like to thank all my teachers back in school, college & during my bachelor's degree. I am fortunate that I had teachers as wonderful loving, caring as you...

I would like to thank the HOD, Department of Clinical Services, for permitting me to use the test materials and to allow me to access the case files for the study.

I also thank Mrs. Vasanthalakshmi for her help with the statistical analyses.

I am grateful to all the little kiddos, their parents and teachers for their co-operation and participation in the study.

Thanks to all my dear classmates who added colors into every moment of the two years of life at AIISH and made it memorable....Hope the bond remains forever...

I also extend my thanks to Ramesh, for the timely help in providing me the necessary reference articles. You have always been a source of inspiration and support every time I felt I cannot stand up again. Thanks a ton!!!!☺

I would like to Thank U Chetan for your timely help in formatting my dissertation. May god bless U. Thank U once again...

Behind every successful project there stand a myriad of people whose help and contribution make it a success. The *list of people I want to thank is unending. I, hereby, extend my heartfelt thanks to all those, who, directly or indirectly, helped me sail through the tough times and encouraged me in their own ways to undertake and complete this dissertation.*

I thank lord for blessing me with such beautiful people around and making my life more meaningful and happy. ☺

I thank the Almighty for giving me the Best Family; and an opportunity to study in the Best Institute by The Best Teachers. Thank you Lord for Everything…!!!

TABLE OF CONTENTS

LIST OF TABLES……………………………………………………………….. xvi

LIST OF GRAPHS…………………………………………………………. xviii

NO.	CHAPTER TITLE	PAGE NO.
1.	Introduction………………………………………………………….	1
	1.1 Need for the study……………………………………………….……	8
	1.2 Objectives of the study……………………………………….……	8
2.	Review of Literature………………………………………….….……	8
	2.1Speech Perception……………………………………………….…….	8
	2.2Intonation……………………………………………………….…..	12
	2.3 Emotion recognition and production in normals………………..	20
	2.3.1 Emotion recognition in speech……………………………...	21
	2.3.2 System based on speech……………………………………..	22
	2.3.3 Vocal emotion recognition studies………………………….	23
	2.4 Learning disability...	27
	2.4.1 Perceptual Difficulties………………………………….……	31
	2.4.1.1 Central Auditory Processing Disorder in CLD……………...	32
	2.4.1.2 Assessment of CAPD………………………………………..	39
	2.4.1.3Electro-physiologic tests……………………………………..	40
	2.4.2 Types of Learning Disabilities..	40
	2.4.2.1 Common Types of Learning Disabilities............................	40
	2.4.2.2 Based on stages of information processing...........................	40
	2.4.2.3 Based on function impaired...	42
	2.4.3 Causes and Risk factors..	44
	2.4.4 Prevalence..	44

	2.4.4.1 Learning Disability in India..	45
	2.4.5 Associated Problems..	46
	2.4.5.1 Physical Disorders..	46
	2.4.5.2 Social and Emotional Difficulties..	48
	2.4.5.3 Behavioural Problems...	48
	2.4.5.4 Psychiatric Disorders..	49
	2.4.5.5 Dementia..	51
	2.4.5.6 Other Problems..	51
	2.4.6 Social-Emotional Functioning in children with Non Verbal LD (NLD)…………………………………………………………..	52
	2.4.7 Emotion perception and production in other disorders………..	52
	2.4.6.1 Right Hemisphere Damage..	52
	2.4.6.2 Parkinson’s Disorder...	53
	2.4.6.3 Schizophrenia..	54
	2.4.6.4 Asperger’s Syndrome..	54
	2.4.6.5 Dementia of Alzheimer’s Type...	55
	2.4.6.6 Primary Cervical Distonia...	55
	2.4.8 Learning Disability and Emotion recognition..........................	55
3	Method..	63
	3.1 Participants..	63
	3.2 Materials/Instruments..	65
	3.3 Procedure...	65
	3.3.1 Phase I..	66
	3.3.2 Phase II...	68
	3.4 Analysis..	70

	3.4.1 Subjective Analysis..	70
	3.4.2 Objective Analysis..	71
	3.5 Statistical Analysis..	72
4	Results and Discussion..	73
	4.1 Perception Task Analysis..	75
	4.1.1Perceptual analysis of subject's judgment of model utterances.	75
	4.1.1.1 Comparison of SL and SN sentences.....................................	80
	4.1.1.2 Perceptual analysis of the subject's utterances by the judges.	81
	4.2 Production Task Analysis..	82
	4.2.1 Imitation Task..	83
	4.2.2 Reading Task..	89
	4.2.3 Comparison between Groups for Imitation Task......................	93
	4.2.3.1Controls versus CLD without (C)APD………………………	93
	4.2.3.2Controls versus CLD with (C)APD………………………….	96
	4.2.3.3 CLD without (C)APD vs CLD with (C)APD……………….	99
	4.2.4 Comparison between Groups for Reading Task.......................	102
	4.2.4.1Controls versus CLD without (C)APD………………………	102
	4.2.4.2Controls versus CLD with (C)APD………………………….	105
	4.2.4.3 CLD without (C)APD vs CLD with (C)APD……………….	107
5	Summary and Conclusion……………………………………….….	114
	5.1 Clinical Implications……………………..…………..……...	118
	5.2 Limitations……………………..………………………………..	119
	5.3 Recommendations for future Research………………………....	119

LIST OF TABLE

No.	**Title**	**Page**

		No.
1.	Mean Scores on the Perception Task for Semantically Loaded (SL) and Neutral (SN) sentences for all the groups…………………............	76
2.	Mann-Whitney Test scores for Controls vs CLD without (C)APD on the Perception Task……………………………...........................	80
3.	Mann-Whitney Test scores for Controls vs CLD with (C)APD……….	80
4.	Mann-Whitney Test scores for CLD without (C)APD vs CLD with (C)APD groups for Perception Task…………………………...........	81
5.	Comparison between perception of SL and SN sentences in all the three groups..	82
6.	Mean F0 and SD for Imitation Task for all the groups…………………	84
7.	Mean Min F0 and SD for all the groups for Imitation Task……………	86
8.	Depicting mean F0 values……………………………………………	94
9.	Depicting Mean minimum F0 values…………………………………...	95
10.	Depicting mean maximum F0…………………………………………..	96
11.	Depicting mean I0 values……………………………………………	96
12.	Depicting mean F0 values……………………………………………	97
13.	Depicting mean Minimum F0 values…………………………………...	98
14.	Depicting Mean Maximum F0 values………………………………….	99
15.	Depicting mean I0 values……………………………………………	99
16.	Depicting mean F0 values……………………………………………	100
17.	Depicting Mean minimum F0 values…………………………………...	101
18.	Depicting mean Maximum F0 values…………………………………..	102
19.	Depicting mean I0 values……………………………………………	102
20.	Depicting mean F0 values……………………………………………	103
21.	Depicting mean minimum F0 values…………………………………..	104
22.	Depicting mean maximum F0 values………...………………………...	104
23.	Depicting mean I0 values…………………...………………………..	105

24.	Depicting mean F0 values………………………...………………..........	106
25.	Depicting mean minimum F0 values…………………………………...	106
26.	Depicting mean Maximum F0 values…………………………………..	107
27.	Depicting mean I0 values………………………………………………	107
28.	Depicting mean F0 values for CLD groups…………………………….	108
29.	Depicting mean Minimum F0 for the CLD groups…………………….	108
30.	Depicting mean maximum F0 between CLD groups………………….	109
31.	Depicting mean I0 values for subjects with CLD with and without (C)APD………………………………………………………………	110

LIST OF GRAPHS

No.	**Title**	**Page No.**
1.	Mean Perception scores for SL sentences in all the groups..................	77
2.	Mean Perception scores for SN sentences in all the groups..................	77
3.	Perception of SL vs SN sentences in Normal's....................................	79
4.	Perception of SL vs SN Sentences in CLD without (C)APD................	79
5.	Perception of SL vs SN Sentences in CLD with (C)APD.....................	79
6.	Mean F0 for all the groups for Imitation of SL sentences…………….	85
7.	Mean F0 for all the groups for Imitation of SN sentences…………….	85
8.	Mean Min F0 for all the groups for Imitation of SL sentences……….	86
9.	Mean Min F0 for all the groups for Imitation of SN sentences……….	87
10.	Mean Max F0 for all the groups for Imitation of SL sentences……….	88
11.	Mean Max F0 for all the groups for Imitation of SN sentences………	88
12.	Mean I0 for all the groups for Imitation of SL sentences……………..	89
13.	Mean I0 for all the groups for Imitation of SN sentences…………….	90
14.	Mean F0 for all the groups for Reading of SL sentences……………..	90
15.	Mean F0 for all the groups for Reading of SN sentences……………..	91
16.	Mean Min F0 for all the groups for Reading of SL sentences………..	91
17.	Mean Min F0 for all the groups for Reading of SN sentences………..	92
18.	Mean Max F0 for all the groups for Reading of SL sentences………..	92
19.	Mean Max F0 for all the groups for Reading of SN sentences………..	93
20.	Depicts mean I0 Values for SL sentences…………………………….	93
21.	Depicts mean I0 values for SN sentences……………………………..	94
22.	SL vs SN for F0…………………………………………………….	95

23.	SL vs SN for I0…………………………………………………………..	97
24.	SL vs SN for F0………………………………………………………….	101
25.	Depicting mean I0 values……………………………………………..	105
26.	Depicting mean minimum F0 values for CLD groups………………..	109
27.	Depicting mean I0 values for subjects with CLD with and without (C)APD……………………………………………………………..	110

CHAPTER 1
INTRODUCTION

A communication disorder is a speech and language disorder which refers to trouble in communication and in associated areas such as oral motor function. The delays and disorders can range from simple sound substitution to the incapability to comprehend or make use of language.

Communication disorders involve a wide variety of problems in speech, language, and hearing. For example, speech and language disorders include stuttering, aphasia, dysfluency, voice disorders (hoarseness, breathiness, or sudden breaks in loudness or pitch), cleft lip and/or palate, articulation problems, delays in speech and language, autism, and phonological disorders.

Speech and language impairments and disorders can be attributed to environmental factors, of which the most commonly known are High Risk Register problems, which include drugs taken during pregnancy, common STD's such as syphilis, and birthing trauma to name a few. Communication disorders can also stem from other conditions such as learning disabilities, dyslexia, cerebral palsy, and mental retardation.

Communication is the activity of transmission of information. Communication requires a correspondent, a point and an anticipated receiver although the receiver need not be present or aware of the sender's intent to communicate at the time of communication. A variety of verbal and non-verbal ways of communicating exists such as body language; eye contact, sign language, paralanguage, haptic communication, chronemics, and media such as pictures, graphics, sound, and script. Verbal communication also contains nonverbal basics recognized as paralanguage.

Paralanguage refers to the non-verbal fundamentals of communication used to adapt meaning and convey emotion. Paralanguage can be expressed deliberately or automatically, and it includes the pitch, volume, and, in some cases, intonation of speech. Sometimes the meaning is limited to vocally-produced sounds. The paralinguistic properties of speech play a significant function in human speech communication. There are no utterances or speech signals that not have paralinguistic properties, since speech requires the presence of a voice that can be modulated. This voice has got to have several properties, and all the properties of a voice as such are paralinguistic. These contain voice quality, emotion and speaking fashion as well as prosodic characters such as rhythm, intonation and stress. In face to face communication the body language and voice tonality plays a major role and may have a greater impact on the listener than the planned content of the verbal words. A great presenter must capture the concentration of the listeners and join with them. For example, out of two persons telling the same joke one may greatly entertain the listeners due to his body language and tone of voice while the second person, using exactly the same words, bore and irritates the listeners. A extensively cited and widely misinterpreted figure used to emphasize the importance of delivery states that "communication comprise 55% body language, 38% tone of voice, 7% content of words", the so-called "7%-38%-55% rule". This is not however what the cited study shows – rather, when conveying emotion, if body language, tone of voice, and words vary, then body language and tone of voice will be believed more than words.

Communication among persons frequently involves communication of emotion. Much of this emotion is not clearly stated in words, but transferred in the vocal properties of speech. The way words are pronounced may tell something about how a speaker feels. Along with fulfilling a linguistic function such as to structure discourse and dialogue, and signal focus, prosodic cues provide information such as the speaker's gender, age and physical condition, and the speaker's view, emotion and attitude towards the topic, the dialogue partner, or the situation. Basic emotions as described in Parrot (2001) are anger, fear, joy, sad, surprise and love.

Intonation and stress are two main elements of linguistic prosody. Intonation is variation of pitch while speaking, which is not used to distinguish words. All languages use pitch semantically, that is, as intonation, for instance for emphasis, to convey surprise or irony, or to pose a question. In linguistics, prosody is the rhythm, stress, and intonation of speech.

Prosody may reflect various features of the speaker or the utterance: the emotional state of a speaker; whether an utterance is a statement, a question, or a command; whether the speaker is being ironic or sarcastic; emphasis, contrast, and focus; or other elements of language that may not be encoded by grammar or choice of vocabulary.

Prosodic recognition and production has been studied in various communication disorders such as Hearing Impairment, Autism, Mental retardation, fetal alcohol spectrum disorders, Intellectual disabilities, Right Hemisphere Damage, Left Hemisphere Damage, and Down's syndrome and so on. Investigations have mainly focused on recognition of facial emotion abilities in these populations. Few studies also focus on investigating emotion recognition and production both in facial emotions and as well as vocal emotion.

Communication of emotions may be affected in individual with Auditory Processing Disorders (C)APD). (C)APD can be genetic or acquired. It might result from ear infections, head injuries or developmental delays that cause central nervous system difficulties that have an effect on processing of auditory information. This can include trouble with: "...sound localization and lateralization; auditory discrimination; auditory pattern recognition; temporal aspects of audition, including temporal integration, temporal discrimination (e.g., temporal gap detection), temporal ordering, and temporal masking; auditory performance in competing acoustic signals (including dichotic listening); and auditory performance with degraded acoustic signals." (C)APD can have an effect on both children and adults. Around 2-3% of children and 17-20% of adults have this disorder. Males are two times more probable to be affected by the disorder than females. (C)APD usually exists as a blend of difficulties - however, one issue may be more dominant than the others. The main types of (C)APD identified in children are: associative deficit, auditory decoding deficit, auditory integration deficit, organisational deficit, prosodic deficit and auditory hypersensitivity. This disorder has nothing to do with hard of hearing or deafness, but it is the difficulties experienced with how auditory information is processed by the sufferer’s brain. This deficit of auditory processing can directly interfere with language and speech. It can also affect an individual's entire area of learning especially that of spelling and reading.

Learning Disabilities (LD) are the most common form of (C)APD. LD is a general term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities. These disorders are inherent to the individual, presumed to be due to central nervous system dysfunction, and may occur across the life span. Problems in self-regulatory behaviours, social perception, and social interaction may exist with learning disabilities but do not by themselves constitute a learning disability.

Learning disability (sometimes called a learning disorder or learning difficulty), is a classification including several disorders in which a person has difficulty learning in a typical manner, usually caused by an unknown factor or factors. The unidentified aspect is the disorder that affects the brain's ability to receive and process information. This disorder can make it problematic for a person to learn as quickly or in the same way as someone who is not affected by a learning disability. Rather, children with a LD (CLD) have trouble performing specific types of skills or carrying out tasks if left to figure things out by themselves or if taught in predictable ways.

The most common type of LD in children is reading disorder. Of all children with specific learning disabilities, 70%-80% have deficits in reading. The term "dyslexia" is often used as a synonym for reading disability; however, many researchers state that there are different types of reading disabilities, of which dyslexia is one. A reading disability can affect any part of the reading process, including difficulty with accurate or fluent word recognition, or both, word decoding, reading rate, prosody (oral reading with expression), and reading comprehension. Before the term "dyslexia" came to prominence, this LD was identified as "word blindness."

General indicators of reading disability include difficulty with phonemic awareness -the ability to break up words into their constituent sounds, and complexity with matching letter combinations to specific sounds (sound-symbol correspondence). Reading fluency is the skill to read phrases and sentences effortlessly and speedily, while understanding them as expressions of complete ideas. CLD in reading comprehension and basic reading skills commonly have weaknesses in reading fluency. Typically, they do not process groups of words as meaningful phrases. They may also make decoding errors in reading which slow them down and prevent them from grasping the meaning of the sentence. As a result, they do not comprehend and memorize meanings of passages. Reading fluency is composed of 3 main components: speed, accuracy, and prosody.

Research shows that CLD have prosodic deficits. This problem may be more outwardly obvious than any of the others. Children with a prosodic deficit will not modulate their voices to reflect rhythm, tone or stress. Likewise, they are unable to recognise such modulations in other people's voices. This is a fundamental ability for good communication and for this reason this form of (C)APD is commonly accompanied by social problems. Children with this difficulty also have slight understanding or ability in the area of melody.

The literature suggests that children with (C)APD show problems in using proper intonations and a subgroup of CLD demonstrate (C)APD problems. It is interesting to see if there are groups of children showing problems in perception or production of proper prosodic features. There is dearth of information pertaining to the relationship between prosody and auditory processing problems. A subgroup of CLD exhibit (C)APD symptoms and it would be interesting to note if there are problems in the perception and production of emotive intonation in these children compared to those without such deficits in CLD.

Reed and Clements (1989) suggest that emotional awareness is an important precursor of the ability to report accurately on one's own emotional state and is related to language comprehension. Unfortunately, people with learning difficulties do not do well on a range of emotion recognition tasks (Rojahn, Lederer & Tasse, 1995). Furthermore, poor ability in recognising emotions is predictive of behavioural and psychiatric difficulties in people with learning disabilities (Matson & Sevin, 1994). People with learning disabilities are at increased risk for emotional and behavioural problems following bereavement (Day, 1985; Emerson, 1977; McLoughlin, 1986; Hollins & Esterhuyzen, 1997). The connection among receptive language skill, understanding of emotions and the idea of death is explored. Forty-one people with learning disabilities were assessed using a variety of measures, including a picture story describing death and bereavement. Less than a quarter of participants had a fully developed concept of death, two thirds had a partially developed concept of death. While language ability, understanding of emotion and concept of death were positively correlated, the relationship is complicated. For example, nearly three-quarters of participants not achieving a full concept of death score and fifty percent of those failing an assessment of emotion recognition task were able to assign an appropriate emotional response to a bereavement scene. It is suggested that therapeutic interventions and assistance with bereavement issues should incorporate individual assessment, particularly of emotional understanding, and include the teaching of emotional labels in conjunction with the basic components of the death concept. In the light of these results how conceptual ability relates to grieving and emotions might be better pursued via a qualitative research framework.

Individuals with (C)APD face several problems; out of the many problems faced by these individuals temporal processing is one of the problem. Having a deficit in perception of timing characteristics, these individuals may have a deficit in perception of prosodic features in the speech of the other person. This prosodic characteristic is very important for emotive perception. Person with Learning Disability may have (C)APD. There a very limited research to know which try to find the perception and production of emotive intonation in CLD who have CAPD and CLD who do not have CAPD. Hence the need of the study-

1.1 Need for the study

1. Study of emotive intonations in the LD population, with and without Auditory Processing Disorder apart from revealing the differences between the two, would help an SLP to screen/evaluate LD population for their speech and language deficits, if any
2. The increased knowledge of the underlying nature of perception and production of emotive intonation errors will assist clinicians in their treatment of this problematic symptom
3. There exist no studies that had attempted to find the differences between the two groups to understand the nature of perception and production of emotive intonation

The present study is therefore planned with the main aim to check if children diagnosed with LD with and without (C)APD differ in the perception and production of emotive intonation.

1.2 Objectives:

The specific objectives of the present study were to study if CLD with and without (C)APD differ:

1. in the perception of emotive intonation compared to normal children
2. in the production of emotive intonation compared to normal children
3. in perception/production of semantically loaded and semantically neutral sentences in English- compared to normal children
4. in production of imitation and reading tasks compared to normal children
5. perceptually and acoustically compared to normal children

CHAPTER 2

REVIEW OF LITERATURE

Dyslexia is not a disease but it's a lifelong problem and presents challenges that need to be overcome every day. Proper diagnosis, appropriate education, hard work and with support from family, friends, teachers and others, a dyslexic can lead a successful and productive life

- Samir Parikh

2.1 Speech perception

Speech perception can be divided into two main groups: linguistic and non-linguistic. The linguistic aspects of speech include the properties of the speech signal and word sequence. Linguistic aspects deal more with what is being said, not how it is said. The non-linguistic properties of speech have more to do with talker attributes such as age, gender, dialect, and emotion. Cues to non-linguistic properties can also be provided in non-speech vocalizations, such as laughter or crying. In general, emotion has been described in a three dimensional space where arousal (activation), valence (pleasure) and control (power) represent each dimension (Yildirim and Bulut, 2004). Listeners seem to use these three dimensions to understand what is being emoted by a speaker. This understanding is developed from birth. Prosodic modifications include higher overall pitch, wider pitch excursions, more distinctive pitch contours, slower tempo, longer pauses, and increased emphatic stress.

The idea that vocal acoustics are imbued with cues to talker emotional state has a long history in human inquiry. The perception of emotion in the vocal expressions of others is vital for an accurate understanding of emotional messages (Banse and Scherer, 1996). Infant-directed speech captures infants' attention more effectively than does the typical adult-directed speech (Cooper and Aslin, 1990; Fernald, 1985; Werker and McLeod, 1989; Morton and Trehub, 2001). Infants may be responding to the emotionality of this infant-directed speech, since this style of speech often conveys love and/or comfort (Trainor, Austin & Desjardins, 2000; Morton and Trehub, 2001). Infants also respond in a more positive way (e.g., smile or gaze for a longer time) when presented with messages that convey positive emotions, and respond more negatively (e.g., crying, grimacing) to messages that convey negative emotions (Fernald, 1992; Morton and Trehub, 2001). This suggests that some aspects of speech are inherently important (Fernald, 1992; Morton and Trehub, 2001). As children are developing, their understanding of emotion becomes important for their understanding of communicative intent, social competence and social adjustment (Holder and Kirkpatrick, 1991; Nowicki and Duke, 1994; Nowicki and Mitchell, 1998; Motley and Camden, 1988; Creusere, Alt & Plante, 2004). There are diverse ways that emotion is conveyed in communication. Cicero and Aristotle suggested that each emotion is connected with a distinctive quality of voice (Bachorowski and Owren, 2003). Commonly analyzed acoustic parameters for emotion in speech have been pitch, duration at the phoneme or syllable level, inter-word silence duration and voiced/unvoiced duration ratio at the utterance level, energy related to the waveform envelope, the first three formant frequencies, and spectral moment or balance. These parameters reflect speech prosody, vowel articulation and spectral energy distribution (Yildirim, Bulut, Lee, Kazemzadeh, Busso, Deng, Lee, & Narayanan, 2004). Data from Yildirim et al. (2004) show that happiness/anger and neutral/sadness share similar acoustic properties, at least for the speaker used for in their study. Speech associated with anger and happiness was characterized by longer utterance duration, shorter inter-word silence, higher pitch and energy values with wider ranges, showing the characteristics of exaggerated or hyper-speech. Other researchers (House, 1994, Pereira, 2000 & Morton and Trehub 2001) have found some of these acoustic properties to be different. An example of this would be that they found happy to be shorter in duration than sad. In general (across studies of the acoustic properties of emotional speech), there is much overlap in acoustic property values found for different emotions. Yildirim et al., (2004) also found that RMS energy, inter-word silence, and speaking rate are useful in distinguishing sadness from the other emotions they examined. These results were obtained from speech produced by an actress, and may or may not be generalized to other speakers (Yildirim et al., 2004). Bachorowski and Owren (2003) reported that fundamental frequency and amplitude seem to be the most important acoustic aspects of emotional speech. The data concerning production and perception of emotion related acoustic cues in speech are methodologically far from ideal, but they provide strong evidence that F0- and amplitude-related features play a central role in conveying emotion (Bachorowski and Owren, 2003).

In a communication situation the true meaning of the communication is transmitted not only by the linguistic content but also by how something is said, how words are emphasized and by the speaker's mood and attitude toward what is said. The speaker's 'tone of voice' often provides a listener with as much information about the speaker's emotional state as does the semantic content of his/her utterances (Most, Weisel, & Zaychik. 1993). The perception of emotion in the vocal expressions of others is vital for an accurate understanding of emotional messages (Banse and Scherer, 1996).

Speech is a unique dynamic motor activity through which we express our thoughts, emotions, respond to and control our environment (Duffy, 1995).

Speech can be divided into segmental and supra-segmental components. The supra-segmentals are also called as prosodic features and can be described by physical quantities of amplitude, duration and fundamental frequency (F0) of voice. The supra-segmental features include stress, intonation, rhythm and quality. Prosody has been viewed as a decorative ornamentation, functioning to make speech more aesthetically pleasing. It is intrinsic and critical in both perception and production of speech (Freeman, 1983).

Perceptually, intonation assists the listener in segmenting the flow of speech by contouring words, and syntactically they help differentiate among the different sentence types such as declaratives, questions etc. The acoustic cues for prosodic features which have received the most extensive attention are F0, intensity and temporal spacing of acoustic events (duration and rate measurement).

Monrad-Krohn (1947) distinguished four types of prosody:

1) **Intrinsic prosody-** referring to the intonation contour that distinguishes a declarative from an interrogative
2) **Intellectual prosody**- referring to the placement of stress which gives a sentence its particular meaning

3) **Emotional prosody**- conveys the various emotions like joy, anger etc through specific intonation pattern

4) **Inarticulate prosody**- consists of grunts or sighs and conveys approval or hesitation

2.2 Intonation

One of the widely studied prosodic features is intonation. It is defined as the fluctuation of the voice pitch, as applied to the whole sentence. It is the sentence, melody that is superimposed on the sentence as whole (Freeman, 1983).

It must be differentiated from the 'tone' of the tonal languages. 'Tone' refers to a feature of a single syllable in a sequence. Intonation on the other hand, denotes a sequence of tones where function relates to a sentence or part of a sentence. The physical correlate of the intonation contour is the F0 of the excitation source, as a function of time. It is the change in F0 which is important rather than absolute values, as the fundamental frequency of men, women and children cover different frequency ranges.

Intonation has different communication roles, as reported by many authors such as: to convey attitudes such as warning, boredom, surprise and neutrality (Crystal, 1981); to signal whether the information is new or old (Brazil, Coulthard, & Johns 1980); grammatical function (Hargrove and McGarr, 1994). For eg., The normal terminal intonation pattern in a simple declarative and imperative sentence, in English, is falling. On the other hand, Yes-No questions have terminal intonation that rise. Intonation provides information about discourse and about a speaker's attitude (Brazil, Coulthard, & Johns, 1980). As Bordom and Harris (1980) conclusively put forth, “we know how a person feels as often by how he says his message, than by the message itself”, claim that speakers use intonation.

Bolinger (1972) quotes three features on intonation, which have similar cues in all languages.

a) Pitch range- it conveys emotion, e.g., when one gets excited, the voice extends its pitch upwards.
b) Direction of pitch variation- this is usually connected with pause. In most of the utterances, the pitch at the beginning of a sentence is high and then drifts down to the lowest pitch at the end. In some interrogative sentences, the direction often tends to be up all the way.
c) Relative height - it is associated with the importance given to a particular word, or words in a sentence.

Within intonation, the linguistic features of intonation are determined by factors like fundamental frequency (F0), intensity and duration. The intonational differences that are heard as high or low, rising or falling, are primarily related to the frequency of sound waves (Lado, 1961).

The pitch variations in the intonation of a language constitute a system of distinctive units and patterns. It is found that English intonation has four distinctive pitch units, i.e., low, mid, high and extreme high. These are represented with Arabic numbers above the line of print (Lado, 1961; Kurath, 1971; Bolinger, 1972). The absolute pitch of these units varies for different occasions or in different parts of the same conversation.

Although variation in F0 is basic for various intonation contours (Pike, 1945; Lado, 1961), Denes (1959) showed that it was not always true and other acoustic characteristics like intensity, duration and spectrum may also serve as cues for the recognition of intonation. He substantiated this view by citing whispered speech, where there is no vocal fold vibration, but still the speech is able to convey the information. Liberman and Michaels (1962), support Dene’s (1959) view and conducted an experiment to show that although F0 plays an important role in conveying intonation information, other features like amplitude also plays a role. They asked three male Native American English speakers to read eight neutral sentences in various emotional moods like question, statement, fearful utterance, happy utterance etc. Pitch pulses were derived from these utterances and were subjected to perturbation, rapid variation and amplitude modulation. These processed sentences were subjected to a forced choice task. Results revealed that unprocessed speech could be identified correctly 85% of the time. When only pitch information was presented, correct identification reduced to 44% and when only amplitude information was added to pitch information the scores improved to 47%, thus showing that the role of amplitude information is also important in conveying appropriate intonation.

Ross and Duffy (1973) studied the portions of the frequency curve, which contained sufficient prosodic features for listeners to correctly identify the intended emotions of speakers. Nine different emotions in nine different paragraphs were presented under five listening condition viz. unfiltered, 600 Hz, 450 Hz, 300 Hz and 150 Hz low pass filtered (LPF) speech. Results showed that the intended emotion of a speaker could be well indentified when perception task consisted of only the lower audible frequencies of speech.

Intonation has also been classified into linguistic and affective intonation, the former coding for the sentence types like declarative, interrogative etc, and the latter responsible for conveying the various emotions of the speaker like anger, joy, grief etc.

Affective intonation is also defined as those global aspects of intonation, which deals with the attitudinal meaning of intonation (Fry, 1968). Williams and Stevens (1972) studied the gross acoustic attributes as noted below:

Emotions	F0 Range	Peak F0	Duration	Consonant production	Other features
Neutral	-	-	Shorter than emotional situation	Imprecise for unstressed syllables	Little noise and irregularities
Sorrow	Reduced	Less than neutral	Long	-	Voicing irregularities, Occasional noise, and decreased rate of articulation.
Anger	Greater than neutral	High	Long	Precise	Voicing irregularities
Fear	-	Less than anger	Longer than anger	Precise articulation	Voicing irregularities

Based on the above findings, the authors concluded that F0 contour versus time provides the clearest indication of the emotional state of the talker. F0 contour has a prototype shape for a breath group that is generated in a normal manner. Without marked emotion of any kind, normal contour is characterised by a smooth, slow and continuous change in F0 as a function of time. Different emotions affect this basic contour shape differently.

In one of the older Indian studies, Deva (1957) made analytical observation of affective intonation in speech of three Telugu speakers. They were asked to simulate the emotions of sorrow, anger and fear. From F0 measurements, he concluded that degree of emotion is correlated with raise in the frequency. Sorrow showed the least change, followed by anger and then fear, the extent and gradient of frequency rise was positively correlated with the degree of emotion but number of inflection in frequency curve was negatively correlated with it.

Rathan, Nataraja & Samuel (1976) studied identification of intonation with reference to context. They concluded that the listeners were not able to identify the correct pairs of intonation sentence and context sentence. They also found that it is possible to use similar kind of intonation pattern in different contexts in Kannada language. Thus, the reference context may become important in identifying the intonation. Similar to these observations, Ladefoged (1967) and Gunter (1975) also stressed upon the importance of context in intonation perception.

Manjula (1979) studied emotional intonation in Kannada language. She concluded that the emotional sentences in Kannada are expressed with a final fall in the intonation pattern. Contradicting this, Nataraja (1982) in his study of affective intonation, in four Indian language, including Kannada, Tamil, Gujarati and Hindi, under five emotional conditions of anger, joy, jealousy, mercy and neutral conditions, reported that the same intonation contour may be used to express different emotional conditions. Further, he also concluded that same patterns or contours are seen across the different languages used. Hence, there seems to be a common or universal intonation contour across the different languages studied.

Nandini (1985) studied some affective prosodic aspects in Kannada and found that there are different intonation curves for different types of emotions. She reported the following types of intonation associated with different sentence types as markers: Raise-fall contour (Neutral statements), Raise-fall- rise contour (Angry statements), Gradual rise followed by a gradual fall (Statements used on requests), and Steep rise followed by steep fall (Accusing statements). She reported that for anger – a rise (R) (Steep) –Fall (F) level (L) accusing R (Steep) – F (Steep) patterns were observed in instrumental analysis. These correlated with the perceptual judgement also. She concluded that different intonation patterns are used by speakers to express different emotions and intonation patterns seem to depend more upon the F0 variation than on intensity or other factors. She also concluded that the same kind of intonation patterns may be used to express different types of emotions. This is agreement with observations made by Rathna, Nataraja & Samuel, (1976), Manjula (1979) and Nataraja (1982).

Various studies have emphasized the importance of intonation as a medium for expressing emotion in speech. In the present section, a few specific examples of approaches to intonation conveying emotion are described, enhancing the contribution of and/or to general knowledge and assumptions concerning intonation.

Investigation in the framework of a model of intonation Mozziconacci (1998) investigated intonation in production and perception of Dutch speech conveying six emotions or attitudes: joy, boredom, anger, sadness, fear, and indignation, against neutrality as a reference. The issue of the identifiability of the “emotions” was addressed first. The study involved perception tests with natural speech, manipulations of natural speech through analysis-re-synthesis, and synthetic speech, successively. In the first stage of the study, speech material successfully conveying emotion in speech was selected on the basis of a perception test. Optimal values were sought at utterance level, for the global parameters: pitch level, pitch range, and speech rate. These values were derived for the generation of emotional speech from a neutral utterance, and perceptually tested in re-synthesized speech and in synthetic speech. Then, in a production study, the speech of three speakers was analyzed, involving, at the utterance level, the global measures- pitch range, pitch level, and speech rate. A more local analysis, taking variations within utterances into account, involved the prosodic features: relative height of the pitch accents, and final lowering.

The F0 curves of the emotional speech produced by the three speakers were analyzed by means of pitch measurements at anchor points chosen in the utterances. Final lowering and relative height of pitch-accent peaks appeared to be two major sources of deviation between the rule-based pitch curves – tuned as for pitch level and range − that were synthesized according to the IPO model of intonation, and the F0 curves actually realized by the speakers. The relevance of these deviations was perceptually investigated. Another part of the local analysis was concerned with the shape of the pitch curves. The stylized F0 curves were labeled in terms of pitch contours, using the intonation grammar for Dutch (Hart, Collier, & Cohen, 1990). Configurations of pitch movements realized by the speakers in the initial and the final parts of utterances were then considered separately, and the distribution of the configurations of pitch movements over the various emotions was investigated. The perceptual relevance of the choice of type of pitch contour for the identification of emotion was tested in an experiment, and a cluster analysis was run on the results.

Indeed, a study considering speech variations as extreme as the ones occurring in the expression of emotion is a source of opportunities for confronting measurement procedures and models commonly used in prosodic studies, with speech samples displaying a wide range of variations. If a model is found to be adequate for the description of the variations perceptually relevant to the expression of emotion in speech and for the re-synthesis of the emotional speech, its adequacy can be confirmed.

On the other hand, if the model appears either to be insufficient for describing speech variations or for re-synthesizing emotional speech, then the consideration of how to modify the model can contribute to our understanding of speech variation. In this study, analysis, synthesis, and manipulation by means of analysis-re synthesis were carried out within the framework of the IPO model of intonation, which allowed for controlling parameters, enhancing the systematic aspect of procedures, and testing the adequacy of the model for processing emotional speech.

Percentages correct identification of emotion are reported for three types of stimuli, used in three different experiments: close-copy stylization of natural speech, speech generated by manipulating pitch level and pitch range of natural utterances, and rule-based synthetic speech involving rules for pitch level, pitch range, and speech rate. Considering that in this type of study, a typical percentage of identification of emotion in natural speech is approximately five times higher than chance (Siegwart and Scherer, 1995), the results can be considered acceptable, and the IPO model considered adequate for the purpose.

When studying speech variability, estimating pitch level and pitch range is frequently done by means of mean and standard deviation of F0. Such crude measures must be expected to obscure a substantial part of the variation present in the speech material, and do not provide any information concerning the linguistically relevant variation. Their frequent use is probably due to the fact that they are easy to obtain, and that their common use facilitates comparison of results across studies. Moreover, the notions of pitch level and range they stand for correspond to parameters in most synthesizers.

Mozziconacci (1998) discussed two ways of estimating pitch level and pitch range. One estimation, strictly data oriented, was based on the mean and standard deviation of F0, respectively. The other estimation, model-based, was involving the end point of the baseline and the difference between baseline and top line, respectively. It appeared that, though perhaps not very accurate, the crude measures remain quite informative. For an investigation of pitch variations within utterances, the production data were first represented as F0 targets at anchor points, using a tonal approach, and then described within the IPO's model of intonation. It appeared that some details that were observed with the tonal approach, involving pitch measurements at anchor points within the utterances, could not be captured in this model.

These details concern the relative height of the accent peaks and the final lowering, and provide valuable supplementary information to the mean F0 and its standard deviation when estimating pitch level and pitch range by means of these global measures. However, a perceptual evaluation of the relevance of these details showed that they are not very important for the expression of most emotions in speech. Therefore, the difficulty to represent this detailed information within the model should not be considered a major problem. It just means that the model provides a simplification of the pitch phenomena on the basis of perceptual relevance, and does not undermine its adequacy for describing speech, even when the speech involves a wide range of variations. Moreover, it was speculated that other two-component intonation models would also be adequate.

Indeed, Higuchi, Hirai, & Sagisaka, (1997) also carried out an experiment seeking optimal values for pitch level, pitch range, and speech rate. The framework of Fujisaki's (1991) model of intonation was used for the analysis as well as for the synthesis of speech. The results, yielding high percentage identification of the speaking styles confirm the adequacy of this model for describing and generating speech deviating from the expression of neutrality.

2.3 Emotion recognition and production in normals

Humans interact with each other mainly through speech, but also through body gestures, to emphasize a certain part of the speech and display of emotions. Inter-personal human communication includes not only spoken language but also non-verbal cues such as hand gestures, facial expressions and tone of the voice, which are used to express feeling and give feedback. As a consequence, the new interface technologies are steadily driving toward accommodating information exchanges via the natural sensory modes of sight, sound, and touch. In face-to-face exchange, humans employ these communication paths simultaneously and in combination, using one to complement and enhance another. The exchanged information is largely encapsulated in this natural, multimodal format. Typically, conversational interaction bears a central burden in human communication, with vision, gaze, expression, and manual gesture often contributing critically, as well as frequently embellishing attributes such as emotion, mood, attitude, and attentiveness.

It is widely accepted from psychological theory that human emotions can be classified into six archetypal emotions: surprise, fear, disgust, anger, happiness, and sadness. Facial motion and the tone of the speech play a major role in expressing these emotions. De Silva, Miyasato, & Nakatsu (1997) conducted experiments, in which 18 individuals were required to make out emotion by means of visual and acoustic information independently from an audio-visual file recorded from two subjects. They concluded that a number of emotions are better recognized with audio such as sadness and fear, and others with video, such as anger and happiness. Furthermore, Chen et al. showed that these two modalities give balancing information, by arguing that the performance of the system improved when both modalities were considered together.

2.3.1 Emotion recognition in speech

A number of approaches to identify emotions from speech have been reported. Most researchers have used global suprasegmental/prosodic features as their acoustic cues for emotion recognition, in which utterance-level statistics are calculated. For example, mean, standard deviation, maximum, and minimum of pitch contour and energy in the utterances are widely used features in this regard. Dellaert, Polzin &

Waibel (1996) attempted to classify 4 human emotions by the use of pitch-related features. They implemented three different classifiers: Maximum Likelihood Bayes classifier (MLB), Kernel Regression (KR), and K-nearest Neighbours (KNN). Roy and Pentland (1996) classified emotions using a Fisher linear classifier. Using short-spoken sentences, they recognized two kinds of emotions: approval or disapproval. They conducted several experiments with features extracted from measures of pitch and energy, obtaining an accuracy ranging from 65% to 88%. The main limitation of those global-level acoustic features is that they cannot describe the dynamic variation along an utterance. To address this, for example, dynamic variation in emotion in speech can be traced in spectral changes at a local segmental level, using short-term spectral features.

In a study conducted by Lee, Yildirim, Bulut, Kazemzadeh Busso, Deng, Lee & Narayanan (2004), 13 Mel-frequency Ceptrsal Coefficients (MFCC) were used to train a Hidden Markov Model (HMM) to recognize four emotions. Nwe, Wei, & De Silva (2001) used 12 Mel-based speech signal power coefficients to train a Discrete Hidden Markov Model to classify the six archetypal emotions. The average accuracy in both approaches was between 70 and 75%. Finally, other approaches have used language and discourse information, exploring the fact that some words are highly correlated with specific emotions (Lee and Narayanan 2004).

2.3.2 System based on speech

The most widely used speech cues for audio emotion recognition are global-level prosodic features such as the statistics of the pitch and the intensity. Therefore, the means, the standard deviations, the ranges, the maximum values, the minimum values and the medians of the pitch and the energy were computed using Praat speech processing software (Boersma and Weenink). In addition, the voiced/speech and unvoiced/speech ratio were also estimated. By the use of sequential backward features selection technique, an 11-dimensional feature vector for each utterance was used as input in the audio emotion recognition system.

2.3.3 Vocal emotion recognition studies

The vocal aspect of a communicative message carries various kinds of information. If we disregard the manner in which the message was spoken and consider the verbal part (e.g., words) only, we might miss the important aspects of the pertinent utterance and we might even completely misunderstand the meaning of the message. Nevertheless, in distinction to spoken language processing, which has lately witnessed noteworthy advances, the processing of emotional speech has not been extensively explored. Starting in the 1930s, quantitative studies of vocal emotions have had a longer olden times than quantitative studies of facial expressions. Conventional as well as most recent studies in emotional contents in speech (Chiu, Chang & Lai, 1994; Cowie and Douglas-Cowie, 1996; Dellaert, Polzin, & Waibel, 1996; Johnstone, 1996; Murray and Arnott, 1993; Sato and Morishima, 1996; Scherer, 1996) have used “prosodic” information which includes the pitch, duration, and intensity of the expression (Sagisaka, Campbell, &. Higuchi, 1997).

Williams and Stevens (1972) studied the spectrograms of real emotional speech and compared them with acted speech. They found similarities which suggest the use of acted data. Murray and Arnott (1993) reviewed findings on human vocal emotions. They also constructed a synthesis-by-rule system to incorporate emotions in synthetic speech (Murray and Arnott, 1996).

To date, most works have concentrated on the analysis of human vocal emotions. Some studied human abilities to recognize vocal emotions. There has been less work on recognizing human vocal emotions by computers than there has been on recognizing facial expressions by machine. Chiu, Chang, & Lai, (1994) extracted five features from speech and used a multilayered neural network for the classification. For 20 test sentences, they were able to correctly label all three categories. Dellaert, Polzin, & Waibel (1996) used 17 features and compared different classification algorithms and feature selection methods. They achieved 79.5% accuracy with 4 categories and 5 speakers speaking 50 short sentences per category. Petrushin (1998) compared human and machine recognition of emotions in speech and achieved similar rates for both (around 65%). In that work, 30 subjects spoke 4 sentences, with each sentence repeated 5 times, once for each emotion category.

Scherer (1981) performed a large-scale study using 14 professional actors. In this study, he extracted as many as 29 features from the speech. According to Scherer, human ability to recognize emotions from purely vocal stimuli is about 60%. He pointed out that “sadness and anger are most excellently recognized, followed by fear and joy. Disgust is the worst”.

Chen (2000) proposed a rule-based method for classification of input audio data into one of the following emotions categories: happiness, sadness, fear, anger, surprise, and dislike. The input data contained 2 speakers, one speaking Spanish and the other one Sinhala. The choice of these languages was such that the subjective judgments were not influenced by the linguistic content as the observers did not comprehend either language. Each speaker was asked to speak 6 different sentences for each emotion and the contents of the sentences were related in most of the cases to one category and some of them could be applied to two different categories. From the acoustic signals pitch, intensity, in addition to pitch contours were estimated as acoustic characteristics which were then classified using some predefined set of laws.

Current studies appear to make use of the “Ekman six” basic emotions, even though others in the past have used a lot of more categories. The reasons for using these fundamental six categories are frequently not reasonable. It is not apparent whether there exist “worldwide” emotional characteristics in the voice for these six categories. Table below shows a summary of human vocal affects as reported by Murray and Arnott (1993). This table describes mostly qualitative characteristics associated with these emotions. These are listed in relation to the neutral voice.

Summary of human vocal affects described relative to neutral speech

	Anger	Happiness	Sadness	Fear	Disgust
Speech Rate	slightly faster	faster or slower	slightly slower	much faster	very much slower
Pitch Average	very much higher	much higher	slightly lower	very much higher	very much lower
Pitch Range	much wider	much wider	slightly narrower	much wider	slightly wider
Intensity	higher	higher	lower	normal	lower
Voice Quality	breathy	blaring	resonant	irregular	grumbled

Numerous researchers have found that F0 contour is an significant acoustic parameter when emotions are uttered. “Happiness, fear, shyness and to some extend sadness show similarities. F0 is even and quite high, in relation to the other emotions; surprise, anger, and dominance have a strongly varying F0.

According to Yuan, Jiahong, Liqin Shen, Fangxin & Chen (2002) “In Chinese, the prosody of F0 of anger and joy is high and has big fluctuation; that of fear is high and has small fluctuation; that of sadness is low and has small fluctuation; the prosody of F0 of anger and joy is high and has big fluctuation; that of fear is high and has small fluctuation. That of sadness is low and has small fluctuation.” Speech will sound happy if we adjust the F0 contour of neutral speech by elevating the register, decreasing the declination degree of the sentence, and increasing slope of F0 contour of the final syllable in the prosodic word, especially for the final syllable of sentences.

Speech prosody can be decomposed into three features: pitch contour (variations in fundamental frequency, f0), word stress (amplitude variation, dB), and timing variation (pause and word durations) (Shattuck- Hufnagel & Turk, 1996). For controls, pitch plays a major role for happy and especially angry sentences. The controls’ demonstration of the primacy of f0 variation for identification of emotion.

Paulmann, Pell, & Kotz (2008) explored to what extent emotional speech recognition of 'basic' emotions (anger, disgust, fear, happiness, pleasant surprise, sadness) differs between different sex (male/female) and age (young/middle-aged) groups in a behavioural experiment. Participants were asked to identify the emotional prosody of a sentence as accurately as possible. As a secondary goal, the perceptual findings were examined in relation to acoustic properties of the sentences presented.

Findings indicate that emotion recognition rates differ between the different categories tested and that these patterns varied significantly as a function of age, but not of sex.

Collignon, Girard, Gosselin, Roy, Saint-Amour, Lassonde & Lepore (2008) in their study, showed results of three experiments on multisensory perception of emotions using newly validated sets of dynamic visual and non-linguistic vocal clips of affect expressions. In Experiment 1, participants were required to categorize fear and disgust expressions displayed auditorily, visually, or using congruent or incongruent audio-visual stimuli. Results showed faster and more accurate categorisation in the bimodal congruent situation than in the unimodal conditions. In the incongruent situation, participant preferentially categorized the affective expression based on the visual modality, demonstrating a visual dominance in emotional processing.

However, when the reliability of the visual stimuli was diminished, participants categorized dissimilar bimodal stimuli preferentially via the auditory modality. These results reveal that visual dominance in affect perception does not occur in a inflexible way, but follows flexible situation-dependent system. In Experiment 2, authors requested the participants to pay attention to only one sensory modality at a time in order to test the putative mandatory nature of multisensory affective interactions. The authors observed that even if they were asked to ignore concurrent sensory information, the irrelevant information significantly affected the processing of the target. This observation was especially true when the target modality was less reliable.

2.4 Learning disability

The identification and description of LD began in the western world in the 1950s and 60s. The major developments of the LD movement during this period centred on children, who appeared normal in many intellectual skills but displayed a variety of cognitive limitations that seemed to interfere with their ability to read, write and learn in the classroom. These were essentially deficient general learning processes centring mostly on what we today call distractibility, hyperactivity and visual-perceptual and perceptual-motor problems. The term learning disability and its first formal definition was first put forth by Kirk (1962) and according to him, learning disability refers to a retardation, disorder or delayed development in one or more of the processes of speech, language, reading, spelling, writing, arithmetic or other school subjects resulting from a psychological handicap caused by a possible cerebral dysfunction and/or emotional or behavioral disturbance. It is not the result of a mental retardation, sensory deprivation or cultural and instructional factors. This definition was the first to introduce the notion of psychological process disorders and how they interfered with academic performance. But the definition faced certain criticisms. The actual problem might be either retardation, disorder, or delay, but the differences among these possibilities was not specified. With respect to etiology, Central Nervous System (CNS) dysfunction was affirmed but some confusion was introduced by suggesting that learning disability might be caused by emotional or behavioral disturbances. This may confound with "emotionally handicapped" category. The definition also introduced the exclusion clause as a definitional component by emphasizing that learning disabilities cannot be primarily due to some other condition. Although useful in providing a separate identity, exclusion is not a positive criterion for explicating what characteristics are represented in the learning disability concept.

The evolution of the learning disability definitions appears to have converged on the following ideas:

1. Learning disability is marked by heterogeneity
2. Learning disability is probably the result of CKS dysfunction
3. Learning disability involves psychological process disorders
4. Learning disability is associated with underachievement
5. Learning disability can be manifested in spoken language, academic, or thinking disorders
6. Learning disability occurs across the life span
7. Learning disability does not result from other conditions

The concept of learning disability has matured over the years. There is a finer understanding of the group of disabilities now than ever before.

Learning disability is a disorder in the psychological processes involved in understanding or using language, spoken or written, which may manifest in an imperfect ability to listen, think, speak, read, write, spell or do mathematical calculations. Exclusions from this group are based upon organic deficits including visual, hearing, motor or economic disadvantage (Public Law-94, 1992). Thus learning disability can be termed a syndrome processing a cluster of symptoms and different deficits can underlie learning disability. Prevalence estimates of this disability have been found to range from 3% to 10% (Snowling, 2000). Prevalence rates can vary across languages (Kujala and Naatanen, 2001).

The definition according to the Learning Disability Association of America says that: “Learning Disabilities are defined as neurologically-based processing problems. These processing problems can interfere with learning basic skills such as reading writing or math. They can also interfere with higher- level skills such as organisation, time planning and abstract reasoning. The types of LD are identified by the specific processing problems. They might relate to getting information into the brain (input), making sense of this information (organization), storing and later retrieving this information (memory), or getting this information back out (output). Learning disabilities are an ‘umbrella’ term describing a number of other, more specific learning disabilities”. The familiar term dyslexia, which is a reading language disorder, is only one of the learning disabilities that fall under this large umbrella.

According to the National Centre for Learning Disabilities, LD is a neurological disorder that affects the brain's ability to receive process, store and respond to information. The term learning disability is used to describe the seeming unexplained difficulty a person of at least average intelligence has in acquiring basic academic skills. These skills are essential for success at school and at workplace and for coping with life in general. LD is not a single disorder. It is a term that refers to a group of disorders in listening, speaking, reading, writing and mathematics.

The other features of LD are: (a) a distinct gap between the level of achievement that is expected and what is actually being achieved (b) difficulties that can become apparent in different ways with different people (c) difficulties with socio-emotional skills and behaviour. However, specific reading disabilities, in children and adults, have been classified as 'dyslexia' or 'developmental dyslexia' or even 'specific developmental dyslexia'. These terms are in use interchangeably with LD.

Learning disabilities can affect a person's ability in the areas of listening, speaking, reading writing and mathematics and is often first suspected when there is a clear and unexplained gap between an individual's level of expected and actual levels of achievement. Learning disabilities also can encompass problems in the area of social-emotional skills and behaviour, and some individuals with learning disabilities struggle with peer relationships and social interactions in addition to academic challenges.

Learning disability is a general term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning or mathematical abilities. These disorders are intrinsic to the individual, presumed to be due to central nervous system dysfunction, and may occur across the life span. Problems in self-regulatory behavior, social perception and social interaction may exist with learning disability but do not by themselves constitute a learning disability. Although learning disabilities may occur concomitantly with other handicapping conditions (e.g., sensory impairments, mental retardation, serious emotional disturbance] or with extrinsic influences (such as cultural influences, insufficient or inappropriate instructions, they are not the result of these conditions or influences (National Joint Committee for Learning Disabilities, 1994).

A variety of learning problems are listed under the umbrella of learning disabilities. However, there are some discriminative characteristics that separate children with learning disability from others. These characteristics include discrepancy between intellectual capacity and actual performance; with better intellectual capability and poor performance, reading problems, writing problems, arithmetic problems, study problems, communication problems, auditory/visual perceptual problems, conceptual deficits, meta-cognitive deficits, memory deficits, behavioral problems, neurological problems, motor output deficits, spatial relationship and body awareness deficits, academic failure, emotional problems, and social problems. But not all children with learning disability exhibit all these problems.

2.4.1 Perceptual Difficulties

The perceptual problems may be either exhibited in the auditory mode or in the visual mode. The most commonly observed auditory perceptual problems in children with learning disability include the following:

(a) Auditory attention or attending behaviors: CLD have difficulty in attending to pertinent auditory stimuli, particularly when multiple background stimuli are present.

(b) Auditory sequential memory and/or serial memory: CLD have a general difficulty in remembering and carrying out verbal instructions, particularly in a group setting. Recalling and sequencing auditory stimuli (strings of digits or words) and learning from rote memory (days of week) seem to take longer in these children.

(c) Auditory discrimination: CLD may not perceive the differences in sounds like /p-b/, /t-d/, /k-g/ and hence may confuse rhyming words like pat-bat (Tallal, Stark, Kallman, & Mellits, 1981). They may not be able to perceive the difference between various consonant blends or may not be able to differentiate between the front door bell and the first ring of the telephone; they may also not hear the final consonants accurately.

d) Auditory sound blending: These children often have problems in learning to blend the sounds of a word into a whole word (for e.g., c-a-t is cat).

(e) Spatial and temporal concepts and relationships: CLD not only experience difficulty m learning the sequencing of concepts, such as days of the week/months of the year, but also have problems with relationships of these concepts. For example, questions such as 'What day comes after Tuesday'? may pose a problem for these children. Concepts relating directions of left and right or even telling time or recalling events of time, such as their birth date, are frequently more complicated for these children to learn.

(f) Auditory processing: CLD listen to conversation delivered at a normal rate; but they may comprehend only if information is presented very slowly and repeated several times.

2.4.1.1 Central Auditory Processing Disorder in CLD

A Number of extremely encouraging experimental studies in the area of learning disabilities have been conducted. Studies have revealed that heterogeneity seen in learning disability in terms of characteristics, causes, associated deficits, and results of various investigations have revealed that there is a sub group of children with learning disability having auditory processing deficits. The incidence of auditory processing disorder in children with dyslexia is estimated to be 40% (Ramus, 2003).

Jerger and Musiek, (2000), defined auditory processing disorder (APD) as a deficit in the processing of information that is specific to auditory modality. The problem may be exacerbated in unfavourable conditions and may be associated with difficulties in understanding speech and language development and learning. It includes disability in subtle sound difference discrimination that interferes with accurate perception of individual word and leads to confusion in conversation, difficulty in auditory figure-ground (presence of noise) and auditory lags or delays in speech processing.

Goswami, Thomson, Richardson, Stainthorp, Hughes, Rosen, et al, (2002) attributed the core difficulty to the deficits in the accurate specifications and neural representation of speech. They observed significant difference between children with dyslexia and normally reading children in amplitude envelope onset detection. They proposed that a likely perceptual cause of this difficulty is a deficit in the perceptual experience of rhythmic timing.

Auditory temporal processing deficits hypothesis suggests that at least a sub group of children with reading disorder have a deficit in low level auditory temporal processing that affects the perception of short translational acoustic elements that provide important cues for phonemic contrast (Tallal, Miller, & Fitch, 1993).

Studies support that ABR responses are reported to be useful than monaural responses tests in identification of auditory processing disorder (Gopal and Kowalski, 1999).

(Central) auditory processing disorder [(C)APD] can be operationally defined as a deficit in the "perceptual processing of auditory information in the central nervous system (CNS) and the neurobiologic action that underlies that processing and gives rise to the electro-physiologic auditory potentials" (American Speech Language-Hearing Association [ASHA], 2005).

(C)APD may affect auditory skills such as localization/lateralization, performance with competing or degraded acoustic stimuli, and temporal processing and patterning abilities, among others. According to current consensus statements and guiding principle (American Academy of Audiology [AAA], 2010; ASHA, 2005), the diagnosis of (C)APD should be made via a test battery approach using psychophysical (behavioural) and/or electro-physiologic measures that have been shown to be susceptible, specific, and efficient for identification of disorders of the central auditory nervous system (CANS).

A diagnosis of (C)APD is made only when performance is >2 standard deviations below the mean (regarding age-specific normative data) on two or more tests of central auditory function, combined with a pattern of deficits based on intra- and interest comparison measures (e.g., ear differences, response condition differences, consistency across tests) that has been shown to be consistent with underlying CANS dysfunction. As with dyslexia, (C)APD is a heterogeneous disorder, with deficit patterns that vary depending on presumed region of dysfunction within the CANS (AAA, 2010; ASHA, 2005; Bellis, 2003; Musiek and Chermak, 2007, for comprehensive reviews). Several researchers have investigated the performance of children with dyslexia on behavioural tests of central auditory processing. Children with dyslexia have been shown to exhibit poorer dichotic listening abilities, particularly for the left ear, as compared with normal controls (Bakker, 1973; Moncrieff and Musiek, 2002; Purdy, Kelly, & Davies, 2002). Walker, Givens, Cranford, Holbert, & Walker, (2006) found that children with dyslexia had more difficulty recognizing patterns of differing frequency and temporal duration for tonal stimuli. It was suggested that poor performance in children with dyslexia may be due to underdevelopment of the CANS.

In addition to dichotic speech tests, more comprehensive central auditory test batteries have been administered to children with reading disorders including temporal patterning tests, tests of monaural low-redundancy speech, and gap detection. Results have indicated that children with dyslexia perform poorly on one or more components of the test battery compared with controls (Sharma, Purdy, Newall, Wheldall, Beaman, & Dillon, 2006; Welsh, Welsh, & Healy, 1980).

Disruptions in temporal processing may have adverse effects on speech perception and understanding (Hayes, Tiippana, Nicol, Sams, & Kraus, 2003; King, Warrier, Hayes, & Kraus, 2002; Phillips, 1995). The ability to discriminate stop consonants often is affected in individuals with lesions of the primary auditory cortex (Phillips and Farmer, 1990). Fast speaker rates and presence of background noise are examples of conditions that affect the accurate perception and recognition of speech. The importance of temporal processing for hearing, speech, and language is evident, and it could be expected that temporal processing deficits would disrupt these skills. A number of studies that have associated poor auditory processing abilities with reading disorders have focused on the listener's ability to process rapid verbal and nonverbal stimuli (Kraus et al., 1996; McAnally and Stein, 1996; Tallal, 1980). Tallal (1980) found that children with reading disorders were able to sequence and discriminate the stimuli as well as their normal peers when the stimuli were presented at a slower rate; however, when presented more rapidly, the children with reading disorders performed more poorly. A significant correlation was established between the children's ability to process the rapid nonverbal information and phonic skills, suggesting a possible fundamental perceptual deficit underlying the inability to analyze the phonetic code efficiently. Studies investigating speech-syllable discrimination abilities of these children also have suggested that children with learning difficulties have difficulty behaviourally discriminating rapid spectro-temporal changes in speech syllables, which is also reflected in electro-physiologic test measures (Kraus, McGee, Carrell, Zecker, Nicol, & Koch, 1996; Sharma, Purdy, Newall, Wheldall, Beaman, & Dillon, 2006).

Not all research supports the idea that deficits in auditory processing are present in individuals with reading disorders. Some studies have failed to demonstrate auditory temporal processing deficits in these children (Bretherton and Holmes, 2003; Brier, Fletcher, Foorman, Klaas, & Gray, 2003; Mody, Studdert-Kennedy, & Brady, 1997; Schulte-Korne, Deimel, Bartling, & Remschmidt, 1999; Watson and Miller, 1993; Watson and Kidd, 2002; Ziegler, Pech-Georgel, George, & Lorenzi, 2009). Others have concluded that temporal processing deficits appear to be pansensory in nature, meaning that they affect processing in multiple sensory modalities (Cacace and McFarland, 1998; Farmer and Klein, 1995; McFarland and Cacace, 1995).

Nevertheless, numerous studies suggest that, at least for some children with dyslexia, there may be a relationship between reading and auditory processing abilities. Present findings investigating the relationship between dyslexia and central auditory processing suggest that some children with dyslexia may exhibit a (C)APD that is a contributing or co-morbid factor to their reading deficits. However, not all children with dyslexia exhibit these deficits, and the heterogeneous nature of reading disorders makes it difficult to determine the prevalence of auditory processing deficits in this population. Because the performance of children with dyslexia is quite variable for auditory tasks, it is difficult to determine conclusively if the relationship between auditory skills and dyslexia is causal or associated (Rosen, 2003; Walker, Givens, Cranford, Holbert, & Walker 2006). If auditory deficits are present, they may not be evident on all measures of auditory processing; therefore, the severity of the auditory deficit does not necessarily predict the severity of the reading disorder (Rosen, 2003).

Regardless of the fact that central auditory processing has been characterized as a likely contributing aspect to dyslexia, children recognized with dyslexia typically are not assessed for (C)APD. Fascinatingly, temporal processing deficits also are prominent in children with (C)APD, and a lot of of these children also show signs of problems in reading and spelling (ASHA, 2005; Bellis, 2002, 2003). The Biological Marker of Auditory Processing (BioMARK), a brainstem electro-physiologic response elicited by speech stimuli, may provide additional insight into the auditory processing abilities of some children with dyslexia. As described by Johnson, Nicol, and Kraus (2005), the BioMARK is a neurophysiologic response recorded to multiple presentations of a 40-ms synthetic /da/ syllable. The response manifests as a series of brief neural events that are time-locked to the onset, offset, and periodic information of the stimulus /da/. The response consists of two components: an onset response composed of Waves V, A, and C, and a sustained frequency-following response composed of Waves D, E, F, and O. This tool has been used to investigate temporal processing deficits displayed by children with language-based learning (including reading) disorders. Researchers have concluded that some children with language-based learning deficits exhibit abnormal brainstem timing for speech signals, which has been linked to reduced cortical processing of acoustic changes compared with normal children (Banai, Hornickel, Skoe, Nicol, Zecker, & Kraus, 2009; Banai, Nicol, Zecker, & Kraus, 2005; King, Warrier, Hayes, & Kraus, 2002; Warrier, Johnson, Hayes, Nicol, & Kraus, 2004). Approximately 30% of children with language-based learning problems, including dyslexia, demonstrate differences in brainstem encoding of speech sounds despite normal click-evoked auditory brainstem responses (ABRs; Abrams, Nicol, Zecker, & Kraus, 2006; Banai et al., 2009, 2005; Johnson, Nicol, & Kraus, 2005; Johnson, Nicol, Zecker, & Kraus, 2007; King, Warrier, Hayes, & Kraus, 2002; Russo, Nicol, Musacchia, & Kraus, 2004; Song, Banai, Russo, & Kraus, 2006; Wible, Nicol, & Kraus, 2005). It should be noted that a disruption in latency as minimal as fractions of a millisecond may be diagnostically significant. Specifically, delayed peak latencies for Waves V, A, C, and O and a shallow slope for the V/A complex have been found in children with language-based learning problems (Banai, Abrams, & Kraus, 2007; Banai et al., 2009; Johnson, Nicol, & Kraus, 2005; Johnson, Nicol, Zecker, & Kraus, 2007; Kraus and Nicol, 2005; Song, Banai, Russo, & Kraus, 2006). Inter-peak latencies and the magnitude of Waves D, E, and F typically do not differ between normal children and children with language-based learning problems (Johnson et al., 2005, 2007). Abnormal brainstem responses to speech also may be an indicator of poor responses at the cortical level. Wible, Nicol, and Kraus (2004) found that broader V/A slopes were correlated with an increased vulnerability of the cortical response to the effects of background noise. Banai et al. (2005) found that children with language-based learning disorders who exhibited abnormal speech-evoked brainstem responses also had reduced speech-evoked mismatch negativity responses compared with normal children. Banai et al. (2009) suggested that the deficits observed may be due to a disruption at the brainstem level in timing and harmonic encoding, leading to abnormal cortical processing of speech sounds and, in turn, phonological processing and reading difficulties. In contrast, it is also likely that top-down involvement in which abnormal cortical processes affect the sub-cortical structures by means of the cortico-fugal pathway might be happening in these children.

Additional support for the interaction of top-down and bottom-up factors is provided by studies demonstrating benefit from auditory training for those with abnormal brainstem timing for speech signals (Cunnigham, Nicol, Zecker, Bradlow, & Kraus, 2001; Hayes, Warrier, Nicol, Zecker, & Kraus, 2003; King et al., 2002; Russo, Nicol, Zecker, Hayes, & Kraus, 2005; Warrier et al., 2004). Specifically, children with abnormal brainstem timing involving Waves A and C exhibited improvement in both physiological and behavioural measures following auditory training.

2.4.1.2 Assessment of CAPD

CAPD is assessed through the use of special tests designed to assess the various auditory functions of the brain. However, before this type of testing begins, it is important that each person being tested receives a routine hearing test for reasons that will become obvious later. There are numerous auditory tests that the audiologist can use to assess central auditory function. This fall into two major categories: behavioral tests and electro-physiologic tests. The behavioral tests are frequently broken down into four subcategories, including monaural low-redundancy speech tests, dichotic speech tests, temporal patterning tests, and binaural interaction tests. It should be noted that children being assessed for CAPD will not necessarily be given a test from each of these categories. Rather the audiologist will choose a battery of tests for each child. The choice of tests will depend upon a number of factors, including the age of the child, the exact auditory difficulties the child displays, the child's native language and cognitive status, and so forth. For the most part, children under the age of 7 years are not candidates for this type of diagnostic testing. In addition, central auditory processing assessments may not be appropriate for children with significant developmental delays (i.e., cognitive deficits). Space restrictions prevent an comprehensive discussion of each of the central tests that are accessible for clinical use. However, a brief overview of the major test categories is provided, along with an abbreviated description of a few tests that are considered representative of the many tests available for use in central auditory assessments.

2.4.1.3 Electro-physiologic tests

Electro-physiologic tests are measures of the brain's response to sounds. For these tests, electrodes are placed on the earlobes and head of the child for the purpose of measuring electrical potentials that arise from the central nervous system in response to an auditory stimulus. An auditory stimulus, often a clicking sound, is delivered to the child's ear and the electrical responses are recorded. Some electro physiologic tests are used to evaluate processing lower in the brain (auditory brainstem response audiometry), whereas others assess functioning higher in the brain (middle latency responses, late auditory evoked responses, auditory cognitive or P300 responses). The results obtained on these tests are compared to age appropriate norms to determine if any abnormalities exist.

2.4.2 Types of Learning Disabilities

2.4.2.1 Common Types of Learning Disabilities

LD also can be categorized either by the type of information processing that is affected or by the specific difficulties caused by a processing deficit.

Dyslexia	Difficulty processing language	Problems reading, writing, spelling, speaking
Dyscalculia	Difficulty with math	Problems doing math problems, understanding time, using money
Dysgraphia	Difficulty with writing	Problems with handwriting, spelling, organizing ideas
Dyspraxia (Sensory Integration Disorder)	Difficulty with fine motor skills	Problems with hand–eye coordination, balance, manual dexterity
Auditory Processing Disorder	Difficulty hearing differences between sounds	Problems with reading, comprehension, language
Visual Processing Disorder	Difficulty interpreting visual information	Problems with reading, math, maps, charts, symbols, pictures

2.4.2.1 Based on stages of information processing

Learning disabilities fall into broad categories based on the four stages of information processing used in learning: input, integration, storage, and output.

- ***Input:*** This is the information perceived through the senses, such as visual and auditory perception. Difficulties with visual perception can cause problems with recognizing the shape, position and size of items seen. There can be problems with sequencing, which can relate to deficits with processing time intervals or temporal perception. Difficulties with auditory perception can make it difficult to screen out competing sounds in order to focus on one of them, such as the sound of the teacher's voice. Some children appear to be unable to process tactile input. For example, they may seem insensitive to pain or dislike being touched.

- ***Integration:*** This is the stage during which perceived input is interpreted, categorized, placed in a sequence, or related to previous learning. Children with problems in these areas may be unable to tell a story in the correct sequence, unable to memorize sequences of information such as the days of the week, able to understand a new concept but be unable to generalize it to other areas of learning, or able to learn facts but be unable to put the facts together to see the "big picture." A poor vocabulary may contribute to problems with comprehension.

- ***Storage:*** Problems with memory can occur with short-term or working memory, or with long-term memory. Most memory difficulties occur in the area of short-term memory, which can make it difficult to learn new material without many more repetitions than is usual. Difficulties with visual memory can impede learning to spell.

- ***Output:*** Information comes out of the brain either through spoken words, that is, language output, or through muscle activity, such as gesturing, writing or drawing. Difficulties with language output can create problems with spoken language, for example, answering a question on demand, in which one must retrieve information from storage, organize thoughts, and put the thoughts into words before one speaks. It can also cause trouble with written language for the same reasons. Problems with motor abilities can root problems with gross and fine motor skills. Individuals with gross motor difficulties may be gauche, that is, they may be prone to stumbling, falling, or bumping into things. They may as well have difficulty running, climbing, or learning to ride a cycle. People with fine motor difficulties may have trouble buttoning shirts, tying shoelaces, or with handwriting.

2.4.2.2 Based on function impaired

Deficits in whichever area of information processing can manifest in a variety of specific learning disabilities. It is likely for a person to have more than one of these difficulties. This is referred to as co morbidity or co-occurrence of learning disabilities. In the UK, the term dual diagnosis is often used to refer to co-occurrence of learning difficulties.

1. Reading disorder (ICD-10 and DSM-IV codes: F81.0/315.00)

It is the most common learning disability of all children with specific learning disabilities, 70%-80% having deficits in reading. The term "Developmental Dyslexia" is often used as a synonym for reading disability; however, many researchers assert that there are different types of reading disabilities, of which dyslexia is one. A reading disability can affect any part of the reading process, including difficulty with accurate or fluent word recognition, or both, word decoding, reading rate, prosody (oral reading with expression), and reading comprehension. Before the term "dyslexia" came to prominence, this learning disability used to be known as "word blindness." Frequent indicators of reading disability comprise complexity with phonemic awareness - the ability to break up words into their constituent sounds, and difficulty with matching letter combinations to specific sounds (sound-symbol correspondence).

2. Writing disorder (ICD-10 and DSM-IV codes F81.1/315.2)

Impaired written language ability may include impairments in handwriting, spelling, organization of ideas, and composition. The term "dysgraphia" is often used as an overarching term for all disorders of written expression. Others, such as the International Dyslexia Association, use the term "dysgraphia" exclusively to refer to difficulties with handwriting.

3. Math disability (ICD-10 and DSM-IV codes F81.2-3/315.1)

Sometimes called dyscalculia, a math disability can cause such difficulties as learning math concepts (such as quantity, place value, and time), difficulty memorizing math facts, difficulty organizing numbers, and understanding how problems are organized on the page. Children with Dyscalculia are often referred to as having poor "number sense".

4. Non ICD-10/DSM

- *Nonverbal learning disability:* Nonverbal learning disabilities often manifest in motor clumsiness, poor visual-spatial skills, problematic social relationships, difficulty with math, and poor organizational skills. These individuals often have specific strengths in the verbal domains, including early speech, large vocabulary, early reading and spelling skills, excellent rote-memory and auditory retention, and eloquent self-expression.

- *Disorders of speaking and listening:* Difficulties that often co-occur with learning disabilities include difficulty with memory, social skills and executive functions (such as organizational skills and time management).

- *Auditory processing disorder:* Difficulties processing auditory information include difficulty comprehending more than one task at a time and a relatively stronger ability to learn visually.

2.4.3 Causes and Risk factors

The causes for learning disabilities are not well understood, and sometimes there is no apparent cause for a learning disability. However, some causes of neurological impairments include:

- Heredity - Learning disabilities often run in the family

- Problems during pregnancy and birth - Learning disabilities can result from anomalies in the developing brain, illness or injury, fetal exposure to alcohol or drugs, low birth weight, oxygen deprivation, or by premature or prolonged labour.

- Accidents after birth - Learning disabilities can also be caused by head injuries, malnutrition, or by toxic exposure (such as heavy metals or pesticides).

2.4.4 Prevalence

In 1975, the prevalence of learning disabilities was estimated to be about 1-3% of the school population (Lerner, 1993). But at present, it is 4-5% of students aged 6-17 years (Hallahan and Kauffmann, 1994). The substantial reasons why the prevalence rate in learning disabilities soared are increased public awareness of learning disabilities, and improved assessment techniques of learning disabilities across the years (Lerner, 1993).

2.4.4.1 Learning disability in India:

Prevalence rate in India varies from 3% to 10% (Ramaa, 2000). Malik (2009) opines that the past decade has witnessed a sudden spurt in the recognition of learning disabilities in India. This sensitivity has benefited some children who have to cope with the invisible learning disability. Besides the growing awareness, there are still a number of misconceptions that are associated with the term 'learning disabilities'. The reasons for these misconceptions are manifold. Learning disabilities are heterogeneous with different manifestations.

The hard fact is that learning disability (LD) is real and a stumbling block for a nation’s development process. The question is why and how it affects development? A person can be of average or above-average intelligence, without any sensory problems (like blindness or hearing impairment) and yet struggle to keep up with people of the same age in learning and regular functioning.

In India, around 13 to 14% of all school children suffer from learning disorders. Unfortunately, most schools fail to lend a sympathetic ear to their problems. As a result, these children are branded as failures.

The Nalanda Institute report has highlighted that in India during the last two-decades or so, there has been an increasing awareness and identification of children with LD. Despite this growing interest, India still does not have a clear idea about the incidence and prevalence of LD. Unfortunately, epidemiological studies of LD are fraught with difficulties ranging from the very definition of LD, identification, assessment, to socio-cultural factors unique to India.

2.4.5 Associated problems

2.4.5.1 Physical disorders

Serious physical disorders are more common as the severity of learning disability increases. People with severe learning disability usually have one or often several of these problems. People with mild learning disability may have similar problems but these occur less frequently. The presence of physical disorders tends to increase the overall level of disability.

The most important physical disorders are:

- Visual impairment - Severe visual impairment is present in 8% of people with severe learning disability and 5% of people with mild learning disability.
- Hearing impairment - Severe hearing impairment is present in 9% of people with severe learning disability and 4.5% of people with mild learning disability.

- Motor disabilities - These include spasticity, ataxia [unsteadiness] and abnormal movements.

- Abnormal movements - Abnormal movements including head banging and rocking are common in people with severe learning disability, occurring in 20% of adults. Although they may be due to motor pathology, in the majority they are due to behavioural problems.

- Epilepsy - Epilepsy is common among people with learning disability, especially those with severe learning disability. It occurs in approximately 22% of people with learning disability compared to 1% of the general population.

People with learning disability often have the same types of epilepsy that occur in the general population. However, severe and mixed epilepsy syndromes are more common.

Also, there are some specific types of epilepsy associated with specific syndromes, for example “infantile spasms” or “salaam attacks.” These are associated with West’s syndrome, which is a form of myoclonic epilepsy with onset in infancy or early childhood. It is characterised by seizures involving the muscles of the neck, trunk and limbs with nodding of the head and flexion and outward movement of the arms. Learning disability is associated in most cases. Some epilepsy syndromes tend to improve with age but others may worsen, especially if there is an associated neuro-degenerative disorder, for example Tay Sachs disease.

Difficulty in school does not always stem from a learning disability. Anxiety, depression, stressful events, emotional trauma, and other conditions affecting concentration make learning more of a challenge.

- **ADHD** – Attention Deficit Hyperactivity Disorder (ADHD), while not considered a learning disability, can certainly disrupt learning. Children with ADHD often have problems with sitting still, staying focused, following instructions, staying organized, and completing homework.
- **Autism** – Difficulty mastering certain academic skills can stem from Pervasive Developmental Disorders such as Autism and Asperger's syndrome. Children with an autism spectrum disorder may have trouble making friends, reading body language, communicating, and making eye contact.

2.4.5.2 Social and emotional difficulties

Sometimes kids have trouble expressing their feelings, calming themselves down, and reading nonverbal cues, which can lead to difficulty in the classroom and with their peers. Social and emotional skills are an area where you can have a huge impact as a parent. For all children, but especially those with learning disabilities, social and emotional skills are the most consistent indicators of success, outweighing everything else, including academic factors. Academic challenges may lead to low self-esteem, withdrawal and behaviour problems

2.4.5.3 Behavioural problems

The consequences of learning disabilities are rarely confined to school or work. Many areas of life are affected, including the role of the person with learning disabilities in their family, relationships with friends, non-academic functioning such as sports or dancing, self-esteem and self-confidence to handle daily situations.

Individuals who have learning disabilities may be less observant in their social environment, may misinterpret the social behaviour of others at times, and may not learn as easily from experiences or social "cues" as their friends. Some children may exhibit an immaturity and social ineptness due to their learning disability. While seeking acceptance, their eagerness may cause them to try too hard in inappropriate ways.

Common behavioural characteristics of individuals with learning disabilities:

- Inability to interpret environment and social cues
- Poor judgment; little thought about logical consequences
- Poor impulse control
- Need for immediate gratification
- Inability to set realistic priorities and goals
- Inappropriate conclusions due to deficient reasoning ability
- Illogical reasons for actions
- Inability to develop meaningful relationships with others
- Immature and "bossy" behaviour

- Low frustration tolerance resulting in disruptive behaviour

Direct instruction in social skills training is highly recommended to help individuals with learning disabilities cope with their innate lack of social perception. Professional help from a variety of disciplines on an ongoing basis may be necessary.

2.4.5.3 Psychiatric disorders

Psychiatric disorders are reported to be more common in people with learning disability than in the general population. Estimates vary due to difficulties in definition and recognition but it is thought that up to one third of people with a learning disability also have mental health problems.

People with learning disability experience psychiatric disturbances similar to those affecting the general population. However, the symptoms are often greatly modified by low intelligence. The person with learning disability may not be able to clearly communicate psychiatric symptoms and therefore more emphasis has to be given to the behavioural effects of the psychiatric symptoms.

- Schizophrenia - This affects approximately 3% of people with learning disability compared to 1% of the general population. Poverty of thinking is common, delusions tend to be less elaborate and hallucinations have a simple repetitive content.

- Depression - People with learning disability are less likely to complain of symptoms of depression than people in the normal population and the diagnosis has to be made on the appearance of sadness, changes in appetite and sleep and behavioural changes of retardation or agitation.

- Anxiety disorders - Adjustment disorders are common in people with learning disability, occurring when there are changes to life routine. Anxiety disorders are common especially at times of stress. Phobic disorders also develop but are often overlooked. Obsessive-compulsive disorders are more common than in the general population.

- Eating disorders - Anorexia and bulimia are less common in people with learning disability than in the general population. However, overeating and unusual dietary preferences are common.

- Personality disorders - These are common in people with learning disability but they are difficult to diagnose and may lead to increased difficulties with management.

2.4.5.5 Dementia

Dementia affects people with learning disability at a younger age than the general population. A progressive decline in intellectual and social functioning may be the first manifestation of dementia. As the life expectancy of people with learning disability is increasing, dementia in later life is becoming more common.

2.4.5.6 Other problems

1. Behavioural disorder/problems [Challenging behaviour]

This is behaviour that impairs the physical safety of the person or others or makes participation in the community difficult. It affects about 15% of adults with learning disability. The causes are multi-factorial and include difficulties in communication, side effects of medication and psychiatric disorders.

The following behaviours are likely to be associated with severe disability:

- Threatening and violent behaviour including assault and verbal abuse
- Self injury, for example biting and head banging
- Disinhibition, for example self - exposure
- Damage to property
- Putting oneself at risk, for example running into the road without warning
- Refusal to comply with person assisting with activities of daily living

2. Forensic problems - People with learning disability have a higher rate of criminal behaviour than the general population. The causes are multi-factorial and include family influences, environment, impulsivity, suggestibility and exploitability. Among the more serious offences, arson and sexual offences (usually exhibitionism) are said to be particularly common.

3. Sleep disorders - Serious sleep disorders are common among people with learning disability. They are associated with subsequent behavioural disorder and a worsening of cognitive function and can cause considerable distress to the person and their caregivers.

2.4.6 Social-Emotional Functioning in children with Non Verbal LD (NLD)

Social relationships are a significant concern for NLD children. They may appear confused and may misinterpret body language and/or tone of voice. They do not perceive subtle cues in the environment, such as judging when an incident or reaction has gone far enough, or the limits of personal 'space.' These are all social skills that are normally grasped intuitively through observation, not directly taught. Emotional development can be problematic for NLD children. They are particularly inclined toward the development of internalizing symptoms such as depression, withdrawal, and anxiety. NLD children can experience feelings of hopelessness, which can stem from being picked on for circumstances that he or she cannot help.

2.4.7 Emotion perception and production in other disorders

2.4.7.1 Right Hemisphere Damage

Ryalls, Joanette, & Feldman (1987) experimented on a group of 19 male right-brain-damaged (RBD) and 9 male control subjects who were recorded repeating the same 5 non-emotional sentences after the investigator. These recordings then underwent acoustic analysis for extraction of the fundamental frequency of phonation (F0) and duration. The resulting pitch plots were analyzed for (a) average F0, (b) range of F0, (c) adjusted F0 range, (d) slope of F0 declination, and (e) overall sentence duration. Statistical comparisons were then conducted comparing these acoustic characteristics for (1) right-hemisphere-damaged (RBD) subjects versus controls. In no case were differences found to reach statistical significance.

Pant (2001) studied the reception and expression of emotive intonation in Right Hemisphere Damaged subjects. Subjects were analysed on the bases of F0 measures. The results of perceptual task and acoustical analysis varied significantly.

The perceptual abilities of the subjects were much better than their expressive skills, even in the RHD subjects with posterior lesion.

2.4.7.2 Parkinson's Disorder

Ariatti, Benuzzi, & Nichelli (2008) compared 27 cognitively unimpaired Parkinson's Disorder (PD) patients with control subjects by means of the Facial Emotion Recognition Battery and the Emotional Prosody Recognition Battery. Face emotion processing was found impaired in PD patients, with a disproportionate deficit involving fear and sadness. A deficit in the perception of negative emotion was seen in PD patients in the study by Dara, Monetta, & Pell (2008).

Barkhuysen, Krahmer, & Swerts (2010) recorded emotional utterances of the speakers who displayed positive or negative emotions, which were congruent or incongruent with the (emotional) lexical content of the uttered sentence. It was found that incongruent emotional speech leads to significantly more extreme perceived emotion scores than congruent emotional speech, where the difference between congruent and incongruent emotional speech is larger for the negative than for the positive conditions. Interestingly, the largest overall differences between congruent and incongruent emotions were found for the audio-only condition, which suggests that posing an incongruent emotion has a particularly strong effect on the spoken realization of emotions.

2.4.7.3 Schizophrenia

In a study by Roux, Christophe, & Passerieux (2010) a dual processing model suggesting dissociation between the neural networks involved in explicit and implicit recognition of emotional prosody is yet to be validated. 21 participants with schizophrenia and 21 controls were recruited. In the explicit recognition task, individuals' listened to semantically neutral words pronounced with two different emotions and judged their emotional prosody. In the vocal emotional Stroop task, patients and controls listened to words with a positive or negative emotional valence pronounced with congruent or incongruent emotional prosody and judged their emotional content. Results provide evidence that at a behavioural level, the implicit and explicit processing of emotional prosody can be dissociated.

2.4.7.4 Asperger's Syndrome

Heikkinen, JanssonVerkasalo, Toivanen, Suominen, Vayrynen, Moilanen,& S eppanen (2010) focused on how adolescents with Asperger's syndrome (AS) (n=12) and their typically developed controls (n=15) recognize the basic emotions happy, sad, angry, and 'neutral' from speech prosody. Adolescents with AS recognized basic emotions from speech prosody as well as their typically developed controls did. Possibly the recognition of basic emotions develops during the childhood.

2.4.7.5 Dementia of Alzheimer's Type

Horley, Reid, & Burnham (2010) studied Twenty Dementia of the Alzheimer's type (DAT) and 20 control participants engaged in 2 expressive and 2 receptive tasks with randomly presented exemplars of sentences targeting the emotions of happiness, anger, sadness, and surprise. In the expressive tasks, objective acoustic measurements revealed significantly less pitch modulation by the patient group, but these measurements showed that they retained the ability to vary pitch level, pitch modulation, and speaking rate as a function of emotion. In the receptive tasks, perception of emotion by the patient group was significantly inferior to the control group.

2.4.7.6 Primary Cervical Distonia

Nikolova, Fellbrich, Born, Dengler, & Schroder (2011) studied 30 patients with primary cervical dystonia (CD) and 30 healthy control subjects (HC) where they had to classify auditorily presented words according to their emotional prosody (angry, happy, relaxed, sad). They conclude the basal ganglia involvement in processing of emotional prosody. Similar conclusions were made by Paulmann, Pell, & Kotz (2009).

2.4.8 Learning Disability and emotion recognition

In recent years there has been a growing interest in research on emotional aspects in individuals with learning disabilities (Rojahn, Lederer, & Tasse, 1995a). One aspect of this research has been in the area of emotion recognition abilities. Emotion recognition involves the discrimination, identification, interpretation, and labelling of emotion expressions (Bullock and Russell, 1984). While it has been well documented that individuals with autistic spectrum disorders have emotion processing deficits, including deficits in emotion recognition, (Hobson, 1986), emotion recognition research in non-autistic individuals with learning disabilities remains a relatively recent area of research (Rojahn, Raybould, & Schneider, 1995b). Nonetheless, a number of studies have clearly demonstrated that non-autistic individuals with learning disabilities do not perform as well as controls on a range of emotion recognition tasks (that is, matching to sample of non-verbal stimuli, matching to sample of verbal stimuli, labelling, and rating tasks) using facial or vocal stimuli, pictures, cartoons or story vignettes (Adams and Markham, 1991; Harris, 1977; Marcell and Jett, 1985; Mcalpine, Kendall, & Singh, 1991). Rojahn et al. (1995b) concluded that emotion recognition ability decreased with increasing levels of cognitive impairment. Despite recent research attempting to control for non-emotion-related factors that may impair test performance (Hobson, Ouston, & Lee, 1989; Rojahn, Raybould, & Schneider, 1995c), it has not yet conclusively been demonstrated whether emotion recognition deficits represent a specific deficit in emotion processing or the effects of more general cognitive deficits. A number of studies have addressed the question of whether the emotion recognition deficits of individuals with learning disabilities are global across all the basic emotion categories or are specific to certain emotion categories. For example, in a study by McAlpine, Kendall, & Singh, (1991), adults with learning disabilities recognized the emotion category of happiness more accurately than the other basic emotion categories of surprise, anger, sadness, fear, and disgust (Ekman and Friesen, 1975; 1976).They also found that the categories of surprise and fear posed the most difficulties for these participants.

On the other hand, Gioia and Brosgole (1988) reported that it was the ability to recognize anger that was the most impaired in their sample of adults with learning disabilities. Other studies, however, found no evidence of significant differential abilities in the recognition of different emotion categories (Iacobbo, 1978). In their review, Rojahn et al. (1995b) suggested that the facial expression of happiness seemed to be the most easily recognized emotion category by individuals with learning disabilities.

Given the myriad of cognitive, emotional and social problems encountered by many individuals with learning disabilities, emotion recognition deficits is considered important because it is an integral component of social interaction (Stewart and Singh, 1995). The correct recognition of emotional cues in others is thought to allow for the selection of an appropriate behavioural response (Adams and Markham, 1991). Indeed, according to Davis (1996) emotion recognition is a prerequisite for empathetic responding. It is, therefore, assumed to play an important role in the development of social competence, and may be an essential factor for social learning (Morrison and Bellack, 1981; Rojahn et al., 1995c). Indeed, performance on a test of facial emotion recognition has been shown to correlate significantly with scores on a rating scale assessing social skills. Social incompetence is, of course, one aspect of the definition of learning disability (Adams and Markham, 1991), and social isolation and exclusion a considerable problem for many people with learning disabilities. Emotion recognition deficits in people with learning disabilities, therefore, may be important factors that contribute to the deficits in social skills, and the poor social adaptation, that are common in this population.

Previous research has used the categorical approach to the study of emotion recognition abilities in individuals with learning disabilities, focusing predominately on the six primary expressions of emotion (Ekman and Friesen, 1975; 1976). This approach to emotion study (Ekman, 1992) is based on the premise that the knowledge of emotion is organized hierarchically around a small group of primary or basic emotions. Evidence of the universality of facial expressions is cited to support this view. There is, however, a second school of thought that calls into question the thesis that emotions are primarily organized as a small number of discrete basic categories. This view is based on the premise that emotions and emotion knowledge, like other forms of knowledge and meaning (Osgood, 1952) are situated along a number of continuous dimensions. Although there has been some debate as to the number and the labelling of the dimensions underlying the structure of emotion, valence (pleasure–displeasure) is generally considered to be the fundamental emotion dimension and arousal (excitement–calm) a second major dimension (Russell, 1980; Russell & Mehrabian, 1977).

According to this approach, specific emotional states can be defined by their location along these dimensions (Bradley, 1994). So, for example, if one considered a two-dimensional model of affect, happiness would be situated as high on the valence dimension and mid-way or 'neutral' on the arousal dimension; surprise situated as mid-way on the valence dimension and high on arousal; sadness as low on valence and arousal; anger as low on valence and high on arousal; fear as low on valence and high on arousal; and disgust situated as low on valence and mid-way on arousal. Both categorical and dimensional approaches are considered potentially useful (Bradley, 1994) and viable in research (Ekman & Davidson, 1994). Moreover, Mchugo, Smith, & Lanzetta, (1982) argued that the two approaches can be successfully combined in research. To date, however, the dimensional approach to emotion has not been used in studies of emotion recognition in individuals with learning disabilities. To summarize, previous research suggests that individuals with learning difficulties may have deficits in the ability to recognize a number of categories of emotion. Little is known, however, of their ability to recognize emotions in terms of their underlying dimensions.

Commonly analyzed acoustic parameters for emotion in speech are pitch, durations of phonemes or syllables, inter-word silence duration, voiced/unvoiced duration ratio in utterances, energy in the waveform envelope, the first three formant frequencies and spectral moment or balance. These parameters are related to speech prosody, vowel articulation and spectral energy distribution (Yildirim et al., 2004). The clearest and most consistent factors in signalling the speaker's emotional state were found to be the mean value of the fundamental frequency, the range of the fundamental frequency, and the rate of its changes. The duration of the production and changes in the intensity of the voice were described as important parameters as well (Williams & Stevens, 1972; Scherer, 1982, 1986, 1992; Siegman & Feldstein, 1987; Most et al., 1993). Another research team found that the most important factor in signalling the speaker's mood is the mean fundamental frequency and the range, but that other factors also contribute (Oster & Risberg, 1986). There can be little doubt, however, that the following acoustic variables are strongly involved in vocal emotion signalling: (a) the level, range, and contour of the fundamental frequency (it reflects the frequency of the vibration of the vocal folds and is perceived as pitch); (b) the vocal energy (or amplitude, perceived as loudness of the voice); (c) the distribution of the energy in the frequency spectrum (particularly the relative energy in the high vs. the low-frequency region, affecting the perception of voice quality or timbre); (d) the location of the formants (F1, F2…Fn, related to the perception of articulation); and (e) a variety of temporal phenomena, including tempo and pausing (Banse & Scherer, 1996).

Karen (1995) examined the link between visual-spatial perception and emotion perception in boys with learning disabilities. The author hypothesized that students with visual-spatial difficulties lack the ability to accurately perceive the emotional affordances of others. As a result, they would be less accurate perceivers of emotions than would their learning disabled peers without visual-spatial deficits. Students were assessed on the Perception of Emotional Affordances Test (PEAT), which was designed to measure the ability to perceive emotional affordances expressed during interactions between people. The PEAT required students to identify the emotion depicted in each of 16 short, silent video clips as either "happy", "sad", "mad" or "scared" which was extensively pilot tested. Forty-nine 8-12 year old boys with learning disabilities were administered the PEAT. The social problems scale of the Achenbach Teacher's Report Form, a global measure of social competence, were completed by each subject's classroom teacher. Hierarchical multiple regression analyses were used to investigate the predictive power of subjects' visual-spatial skills on both emotion perception and social competence, as well as the effect of emotion perception on social competence. Results did not indicate a significant relationship between visual-spatial skill and emotion perception, but visual-spatial skill did significantly predict overall social competence. Theoretical and methodological limitations were discussed as the primary reasons for the lack of support of the major hypothesis. There is dearth of studies with regard to relationships between the cognitive deficits and the social/emotional difficulties of children with learning disabilities. No study talks about the expressive speech of CLDs distinguishing them in groups of CLD with and without CAPD and investigating their speech in semantically loaded and neutral sentences in different emotions. A comparison between imitation and spontaneous production also has not been compared. Present study has addressed this issue.

Owen, Browning and Jones (2001) in their study they studied adults with mild–moderate learning disabilities, together with non-learning disabled adults, were given emotion recognition tasks through photographs. Adults with learning disabilities demonstrated impaired performance, relative to controls, in categorical emotion recognition, and recognition of the arousal dimension of emotion. No group differences were found, however, in the recognition of valence, the primary dimension of emotion. Their results suggest that emotion recognition deficits in individuals with learning disabilities may be confined to categorical recognition or labelling deficits. Many more investigators have studied about perception of emotions in LD group but all the studies used stimulus which portrayed emotions pictures, memory tasks, stories etc.

Karin, Frances, Carol, and Frank (2011) examined sixteen right handed participants for the activation of brain regions for the Auditory (A), Visual (V) and Audiovisual (AV) as they watched and listened to a saxophonist improvising three different emotions (Happy, Sad and Surprise). They concluded that right thalamus may subtend the audiovisual integration of emotional signals from music as well as from speech. They support the idea that to some extent the processing of speech and music multisensory information overlaps, and they extend this possibility to the processing of emotional information.

Dawes, Sirimanna, Burton, Vanniasegaram, Tweedy, and Dorothy (2009) examined the hypothesis that the underlying cause of APD is a modality-specific deficit in auditory temporal processing and also considered how far the auditory impairments in APD differ from those in children with dyslexia. Authors investigated the performance of children diagnosed with APD (N 22) was compared with that of a normative group (N 98) as well as with children with dyslexia (N 19) on a battery of temporal auditory tasks; 2-Hz frequency modulation (FM), 40-Hz FM, and iterated rippled noise detection as well as a control task (240-Hz FM), which is thought to draw on peripheral spectral mechanisms. Visual tasks were coherent form and coherent motion detection. Results showed that on an average, the APD group performed more poorly than the normative group on the 40-Hz FM, 240-Hz FM, and iterated rippled noise tasks. There were no significant differences between the APD and dyslexia group's performance and no evidence for a specific temporal auditory impairment. A higher proportion of children in the APD group performed poorly (< -1 SD) on the visual tasks than those in the normative group.

From the review of the studies on perception of emotions in Learning Disabilities, we can find that studies on facial recognition of emotions have been studied to some extent but not many investigators have studied the perception of emotive intonation considering only acoustic identification of emotions.

CHAPTER 3

METHOD

People with (C)APD face many problems; one of them is the deficit in the perception of prosodic features in the speech of the other person. This prosodic characteristic is very important for emotive perception. Person with Learning Disability may have (C)APD. This study aims at investigating if there exists a difference in the perception and production of emotions in children with LD with and without (C)APD as compared to the typically developing children.

3.1 Participants

The participants were classified into experimental and control groups.

i). Experimental group

The experimental group had two subgroups namely; children with Learning Disability without Central Auditory Processing Disorder (Group I) and Learning Disability with Central Auditory Processing Disorder (Group II).

Inclusionary criteria for the experimental group:

- All the participants studying in schools with English as the medium of instruction. No change in the medium of instruction at any time for any of the participants

- Diagnosis for all the subjects with learning disability made by a Speech Language Pathologist on the basis of the performance in the test of Early Reading Skills (norms developed by Prema & Jayaram, 2002)
- The subjects who passed 'Screening Checklist for Auditory Processing' (SCAP) developed by Yathiraj and Mascarenhas (2002, 2004) were included in Group I
- Subjects failing in the APD checklist were referred for a detailed APD evaluation consisting of a Pure Tone Audiometry, and (C)APD testing battery (Duration Pattern Test, Speech In Noise and Dichotic Digit Test)
- Assessment of IQ was done by a certified clinical psychologist and all children falling within an average normal range were selected for this study.

Exclusionary criteria for the experimental group:

- Children with additional disabilities like ADHD, stuttering, articulation disorders, associated visual or hearing deficit or any other neurological deficits

ii). Control group

Equal number of typically developing children, matched for age and gender of the subjects in the experimental group constituted the control group.

Inclusionary criteria:

Participants in this group were screened using the WHO Ten Question Disability Screening Checklist to rule out learning disability, language deficits, delayed speech and language milestones, hearing impairment, mental retardation, behavioural and emotional disorders and neurological deficits.

3.2 Materials/Instruments:

- Early Reading Skills (Prema & Jayaram, 2002) for diagnosing all the subjects with learning disability
- 'Screening Checklist for Auditory Processing' (SCAP) (Yathiraj & Mascarenhas. 2002), 2004) to screen subjects with Learning Disability for the presence or absence of Auditory Processing Disorder

- Pure Tone Audiometer - Orbitor OB 922
- Central Auditory Processing evaluation included the following tests:

✓ Duration Pattern Test (Pinheiro and Musiek, 1985)

✓ Speech in Noise (Kalikow, Stevens and Elliot 1977)

✓ Dichotic Digits Test (Kimura 1961a, Revised by Musiek, 1983a)

- A total of 150 sentences were prepared for the study, perception task, imitation task and reading task consisted of 50 sentences each which was divided into sets of 25 sentences each for semantically loaded (SL) and semantically neutral (SN) sentences. 5 sentences depicting emotions like Happy, Sad, Fear, Anger and Surprise
- Pratt Software
- SPSS software version 10

3.3 ***Procedure:***

Participants and/or parents were explained about the purpose of the study and an informed written consent was taken. The study was carried out in 2 Phases:

3.3.1 Phase I

Material preparation: A pool of 150 sentences was prepared, 75 sentences each in SL and SN category.

Semantically loaded sentences: In rhetoric, SL language (also known as emotive language or high-inference language) is wording that attempts to influence the listener or reader by appealing to emotion. Loaded words and phrases have strong emotional overtones or connotations, and evoke strongly positive or negative reactions beyond their literal meaning.

Semantically neutral sentences: A SN entity lacks inherent meaning, content, or semantic properties. It could have had a different meaning, or no meaning at all, without any change in its fundamental nature, identity, or essence.

Pilot study 1:

Pilot study was done for familiarity check using the 250 sentences on 10 normal children in the third grade. The sentences that were read correctly 100% of the times by all the children were taken as the final stimulus for the study. These sentences were divided into 3 sets which contained 5 sentences in each emotion under each task. First set was taken for spontaneous production, second for the imitation task and third for perception task. A total of 25 sentences were selected under each task.

The audio recording of the stimulus sentences for the Imitation task and Perception task was done by ‘good fluent speaker’. He was requested to utter the experimental sentences, simulating the appropriate emotions to be conveyed by the sentence. The speaker, a speech language pathologist, who had experience in dramatics and a working knowledge in the area of prosody having recorded the sentences using the Cool Edit software.

Pilot study 2:

In order to check whether the model speaker has effectively expressed the intended emotions, a pilot study was carried out. The recorded sentences were played to three judges through the headphones, to judge the emotions the sentences portrayed. These judges were speech language pathologists with a working knowledge in the field for a minimum of five years. The sentences correctly identified for the desired emotions by the judges were selected for final study. The scoring was done on a two point rating scale as 'Yes/No'. Each answer marked 'Yes' carried 1 point and each 'No' was marked 0. The sentences which were scored 100% accurate by the judges ie., 5/5 was taken as stimulus for the Perception task and Imitation Task.

The sentences with different emotions were randomized and recorded on a CD with ten seconds inter-stimulus interval for production and perception tasks with five sentences for each emotion.

Subjects having LD were divided in two groups, first group consisted of subjects having only LD without (C)APD, second group comprised of subjects having LD with (C)APD. This grouping was done after they were screened on the (C)APD checklist (Yathiraj & Mascarenhas. 2002). Subjects failing in the checklist had then undergone tests to confirm for (C)APD. The following tests were carried out.

1. **Dichotic Digits Test (DDT):** Different stimuli are presented to each ear simultaneously. The binaural integration part of the test requires the patient to repeat everything that is heard in both ears. The binaural separation part requires them to ignore what is presented to one ear and repeat the information from the target ear. This tests binaural separation and integration.
2. **Duration Pattern Test (DPT):** Tests temporal patterning and ordering by asking the patient to discriminate between different pitches presented to both ears. The Duration Pattern Test asks the patient to discriminate the duration of tonal stimuli and describe it. This tests temporal processing.
3. **Speech In Noise (SPIN):** This test assesses a patient's ability to repeat back the correct word when it is presented in competition with background noise, often speech babble.

3.3.2 Phase II:

1. *Perception task:*

Testing was done in a relatively quiet room. The stimulus was given randomly to the subjects through the Intex headphones. The subjects were supposed to respond within the inter stimulus gap of ten seconds given in between two sentences. The subjects were given a response sheet with closed set responses, on which they had to put a tick "√" mark in the respective column. (See Appendix for Score Sheet)

Subjects were read instructions describing the task. They were told that they would hear some English sentences, and that they were required to decide as quickly and as accurately as possible, about which emotion the sentence is portraying. Two minutes break was given after every task.

Instructions given to the subjects for Perception task:

"The sentences you hear are in English and are of varied length. There is a gap of 10 seconds between each sentence. In this time you must determine the emotion in the sentence and record it on the given recording sheet. On the recording sheet, you can indicate with tick mark (√) which emotion the sentence is indicating out of the 5 emotions ('Happy', 'Sad', 'Fear', 'Surprise' and 'Angry'). As a practice task before starting, you will listen to 2 sample sentences along with the correct response for each sentence Please ask any questions you may have about the study at this time."

***2.** Production task:*

This task was divided into two: Imitation and Spontaneous production task.

- *Imitation task:*

The subjects in all the three groups were made to hear pre recorded stimulus items which were recorded in the respective emotional tone through the headphone. The subjects were asked to listen to the recorded stimulus and were told to repeat them as they hear it. The responses from the subjects were recorded in sound recorder through Intex microphone which was placed at a distance of 3 cm from the mouth.

Instructions given to the subjects for Imitation task:

"The sentences you hear are in English and are of varied length. There is a gap of 10 seconds between each sentence. You have to imitate the sentence you hear exactly the way it is. The sentences will be in different emotions, you have to imitate them in the same emotion. As a practice task before starting, you will listen to 2 sample sentences for imitation. Please ask any questions you may have about the study at this time."

- *Spontaneous production task:*

Subjects were given the sentences in a written form which had 18 font size and was printed in black ink on an A4 sheet paper with 2.5 inter sentence gap. These printed stimuli were kept at distance of 30 cms from the subject's visual field. The subjects were asked to say these sentences in the emotion which was told before every stimulus. Responses from the subjects were recorded in sound recorder through Intex microphone which was placed at a distance of 3 cm from the mouth.

Instructions given to the subjects for Production task:

"You will have to read the given sentences in the emotions given in brackets. As a practice task before starting, you will be given 2 sample sentences for reading. Please ask any questions you may have about the study at this time."

3.4 Analysis:

The subject's responses were analysed both perceptually and acoustically.

3.4.1 Subjective (perceptually) analysis:

The sentences imitated after the model and read by the subjects were played through headphones to the same five judges who had participated in the pilot study for the judgement of the correctness of emotions in both control and experimental groups of subjects. They were given the same checklist and were asked to identify the emotional tone conveyed by the utterances. They were also asked to rate the utterances in the same way as was done in the pilot study.

3.4.2 Objective (acoustically) analysis:

The utterances were also subjected to acoustic analysis. The aim was to analyze the intonation features in the sentences uttered by the subjects and look for differential features, if any in the:

- Control subjects versus children with LD (CLD) with (C)APD
- Control subjects versus CLD without (C)APD
- CLD with (C)APD versus CLD without (C)APD
- Imitated versus Reading sample
- Semantically neutral versus semantically loaded sentences.

The utterances of the children with LD were compared against the typically developing group to find the deviancy from normal if any, in terms of intonation contours. Acoustic analysis was done using the PRAAT software to study the pattern of prosodic aspects and to note the differences between the groups in the following parameters.

The parameters analysed in the acoustic analysis were:

*Fundamental Frequency (F0)

*Maximum F0

*Minimum F0

*Intensity (I0)

3.5 STATISTICAL ANALYSIS

The raw data tabulated and was subjected to statistical analysis using SPSS 17 software. Descriptive statistical analysis was used to find out the means of scores in all the groups in each task and for each sentence type. Maan Whitney U test was done to find out the statistical significance.

CHAPTER 4

RESULTS AND DISCUSSION

This study was designed to examine the abilities of children with Learning Disability (CLD) with and without Central Auditory Processing Disorder ((C)APD) for the perception and production of emotive intonation as compared to the control subjects.

The performance of the experimental and control subjects, on both perception and production task were analyzed. Scores of the perception task were obtained for each emotion in both semantically loaded and neutral sentences. Sentences produced in the production task were perceptually and acoustically analyzed. Perceptual analysis of the production task was obtained from 3 judges. Acoustic analysis included F0 and Intensity measures. A statistical analysis pattern was adopted for the perception task and a descriptive as well as statistical analysis pattern was adopted for the production task. During interview and experimental phases with the subjects, several observations were made which will be discussed later.

Even among the subjects having the same diagnosis, there is a marked difference in intonation patterns used, which is evident during normal conversation, experimental tasks and after the statistic analysis.

There is a dearth of studies in the area of emotion perception and production in children with LD (CLD) with and without (C)APD.

The results of the study have been analyzed and discussed under five broad headings:

I. Perceptual Task

- A comparison between the groups
- Within group comparison between semantically loaded and neutral sentences

II. Production Task

- Perceptual analysis of utterances of the subjects, by the judges
- Acoustic analysis of the utterances of subjects for Imitation and Reading Task:
    - Fundamental Frequency (F0)
    - Maximum F0
    - Minimum F0
    - Intensity (I0)
- The above mentioned acoustic measures were compared between:
    - Control subjects versus children with CLD with (C)APD
    - Control subjects versus children with CLD without (C)APD
    - Children with CLD with (C)APD versus children with CLD without (C)APD
    - Imitated versus Reading sample
    - Semantically neutral versus semantically loaded sentences

4.1 Perception Task Analysis

4.1.1 Perceptual analysis of subject's judgment of model utterances

The normal and CLD subjects were asked to perceptually judge the emotions conveyed by the model speaker's utterances. They were provided with a score sheet (Appendix A), to record their responses.

The responses of the subjects to the perception task for the loaded and neutral sentences are given in Table 1. It is depicting the Mean and Standard Deviation of the three groups in the perception of emotionally loaded sentences.

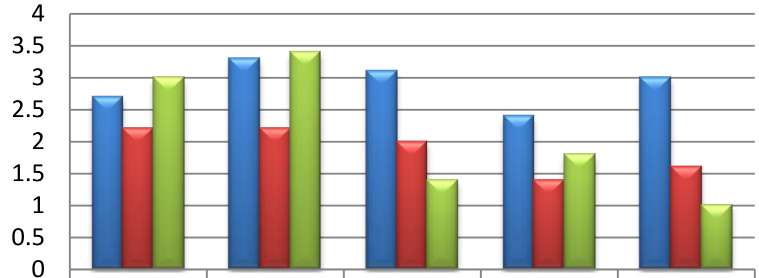
Comparison between the perceptions of emotions by the control subjects show that they perceived Happy, Angry and Sad emotions correctly most number of times followed by Surprise and Fear. A similar trend was seen in CLD groups.

Table 1: Mean Scores on the Perception Task for Semantically Loaded (SL) and Neutral (SN) sentences for all the groups

	Controls			CLD without (C)APD			CLD with (C)APD		
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
LH	10	2.7	1.76	5	2.2	1.3	5	3.0	1.5
NH	10	4.1	1.10	5	3.2	1.3	5	2.6	2.3
LSa	10	3.3	1.88	5	2.2	1.0	5	3.4	1.1
NSa	10	3.8	1.68	5	3.2	2.1	5	3.8	1.6
LA	10	3.1	1.37	5	2.0	1.5	5	1.4	1.1
NA	10	3.9	1.85	5	3.8	1.0	5	2.0	1.8
LF	10	2.4	1.77	5	1.4	1.1	5	1.8	0.4
NF	10	2.3	0.97	5	2.4	1.1	5	1.0	1.7
LSur	10	3.0	1.70	5	1.6	1.6	5	1.0	0.7
NSur	10	2.5	1.26	5	1.8	1.0	5	1.6	1.1

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

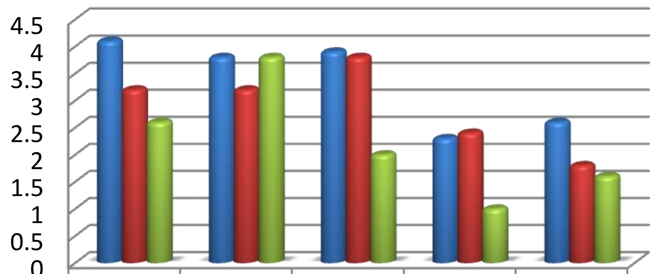
Subjects in this study would have shown a better performance if the stimulus was presented both through Auditory (A) and Visual (V) mode i.e. Audiovisual (AV) mode. As said by Karin, Frances, Carol, and Frank (2011) in their study showed that young children find it difficult to entrain to a purely auditory rhythmic stimulus, or to a visible drum-beating robot.



	Happy	Sad	Angry	Fear	Surprise
controls	2.7	3.3	3.1	2.4	3
LD without CAPD	2.2	2.2	2	1.4	1.6
LD with CAPD	3	3.4	1.4	1.8	1

Graph 1: Mean Perception scores for SL sentences in all the groups

It is seen that in Graph 1 controls performed better when compared to the LD groups for SL sentences. Within the LD groups, LD without (C)APD had better perception for Angry and Surprise where as in emotions such as Happy, Sad and Fear their scores was less than for LD with (C)APD group.



	Happy	Sad	Angry	Fear	Surprise
Controls	4.1	3.8	3.9	2.3	2.6
LD without CAPD	3.2	3.2	3.8	2.4	1.8
LD with CAPD	2.6	3.8	2	1	1.6

Graph 2: Mean Perception scores for SN sentences in all the groups

For SN sentences also control group performed better (Graph 2) than the LD groups. But when the LD groups were compared it is seen that for SN sentences LD without (C)APD group performed better than LD with (C)APD group for almost all the emotions except Sad.

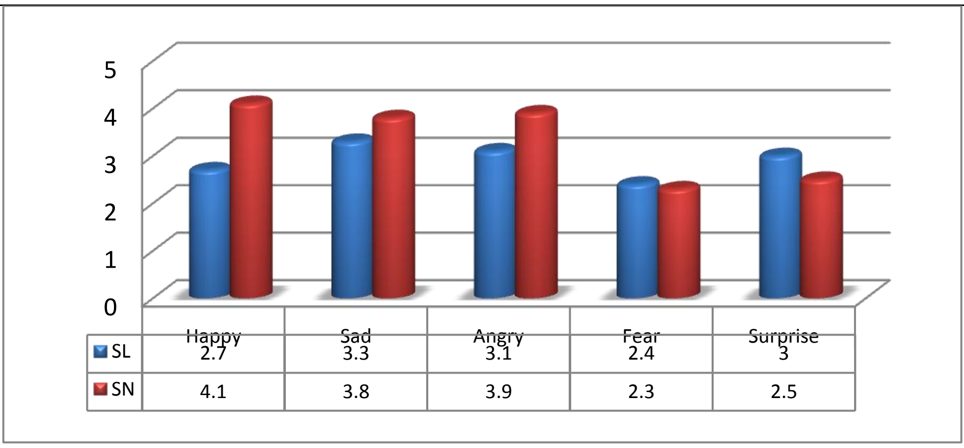
Collignon, Girard, Gosselin, Roy, Saint-Amour, Lassonde, & Lepore (2008) also show the same findings which indicate that the perception of emotion expressions is a robust multisensory situation which follows rules that have been previously observed in other perceptual domains. Similar findings were found in Barkhuysen, Krahmer, & Swerts (2010) study. The LD groups would have performed better with an AV combination.

Nikolova, Fellbrich, Born, Dengler, & Schroder (2011) studied primary focal dystonia and observed that they had deficient recognition of emotional prosody when asked to classify auditory presented words according to their emotional prosody (angry, happy, relaxed, and sad). Similar finding are reported by Paulmann, Pell, & Kotz (2009)

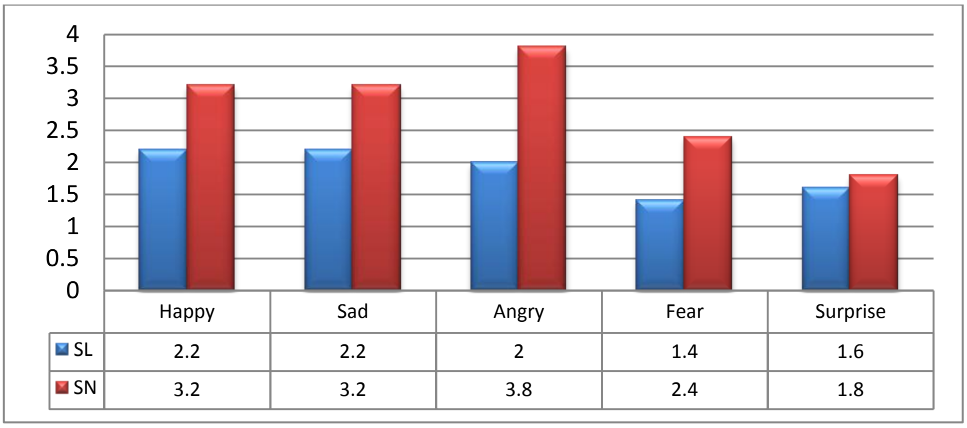
People with schizophrenia show well-replicated deficits on tasks of explicit recognition of emotional prosody Roux, Christophe, & Passerieux (2010).

When analyzed across emotions, Happy, Sad and Angry is found to be perceived correctly maximum number of times across different groups. While other emotions showed poor performance for fear and surprise.

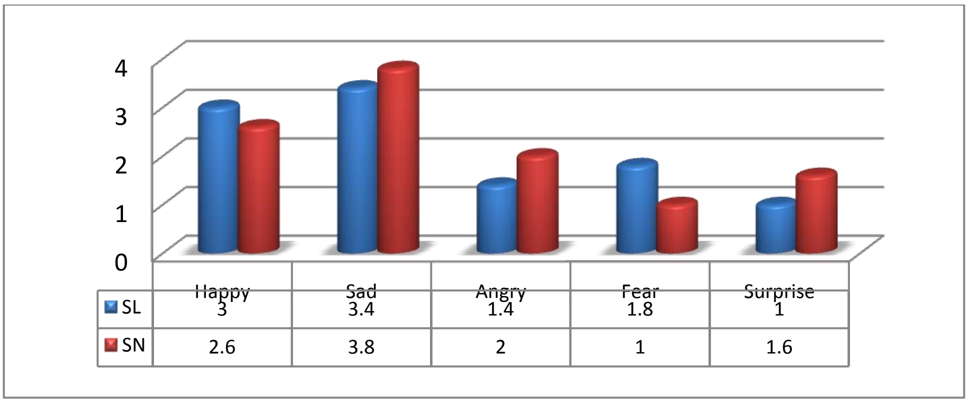
F0 variations do not allow to globally differentiate between Anger and Fear (Devillers, Vasilescu &Vidrascu 2004).



Graph 3: Perception of SL vs SN sentences in Normal's



Graph 4: Perception of SL vs SN Sentences in CLD without (C)APD



Graph 5: Perception of SL vs SN Sentences in CLD with (C)APD

It was observed that surprise was often mistaken for the other emotions both in the SL and SN sentences as surprise is somehow ambivalent as it can be perceived positively or negatively. Where Happy was a positive emotion and other i.e. Sad, Angry and Fear are negative emotions. This was observed in both the LD groups and to some extent in the control group also.

Table 2: Mann-Whitney Test scores for Controls vs CLD without (C)APD on the Perception Task

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
LH	20.50	35.50	-.561	.575
NH	14.50	29.50	-1.344	.179
LSa	15.00	30.00	-1.247	.212
NSa	20.00	35.00	-.666	.506
LA	15.00	30.00	-1.247	.212
NA	18.00	33.00	-.922	.356
LF	17.00	32.00	-1.018	.309
NF	24.00	79.00	-.128	.898
LSur	13.50	28.50	-1.428	.153
NSur	15.50	30.50	-1.238	.216

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

CLD without (C)APD group did not have a significant difference when compared to the control group on the perception task (Table2). They also did not show a significant difference in the perception of loaded versus neutral sentences.

Table 3: Mann-Whitney Test scores for Controls vs CLD with (C)APD

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
LH	22.50	77.50	-.311	.756
NH	15.50	30.50	-1.230	.219
LSa	24.00	39.00	-.126	.900
NSa	23.00	38.00	-.267	.789
LA	8.50	23.50	-2.058	**.040**
NA	13.00	28.00	-1.555	.120
LF	23.00	38.00	-.253	.800
NF	10.50	25.50	-1.814	.070
LSur	8.00	23.00	-2.163	**.031**
NSur	13.50	28.50	-1.467	.142

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

As can be seen in Table 3 and 4, CLD with (C)APD showed a significant difference in the perception of loaded angry and Surprise sentences when compared with the control group.

Table 4: Mann-Whitney Test scores for CLD without (C)APD vs CLD with (C)APD groups for Perception Task

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
LH	8.50	23.50	-.854	.393
NH	10.00	25.00	-.535	.592
LSa	6.00	21.00	-1.453	.146
NSa	11.00	26.00	-.328	.743
LA	9.50	24.50	-.640	.522
NA	5.50	20.50	-1.504	.133
LF	9.00	24.00	-.791	.429
NF	5.00	20.00	-1.601	.109
LSur	10.00	25.00	-.542	.588
NSur	11.00	26.00	-.337	.736

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

Both the CLD groups did not show a significant difference between each other in the perception task (Table 3).

4.1.1.1 Comparison of SL and SN sentences

Wilcoxon Signed Ranks Test was administered to analyze the difference between semantically loaded (SL) versus semantically neutral (SN) utterances in terms of number of errors. Perception errors were found to be almost equally distributed across both the categories. When studied individually across all subjects (Table 3) slight variations were observed. For the control group, ratings were same for SL and SN except for Happy and Sad emotion.

Table 5: Comparison between perception of SL and SN sentences in all the three groups

Groups ►	Controls		CLD without (C)APD		CLD with (C)APD	
Neutral – Loaded▼	Z	Asymp. Sig. (2-tailed)	Z	Asymp. Sig. (2-tailed)	Z	Asymp. Sig (2-tailed)
NH – LH	-2.565	**.010**	-1.890	.059	-.535	.593
NSa - LSa	-2.236	**.025**	-1.225	.221	-.743	.458
NA - LA	-1.452	.146	-1.604	.109	-1.089	.276
NF - LF	-.351	.725	-1.512	.131	-.966	.334
NSur - LSur	-.676	.499	-.272	.785	-1.732	.083

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

A significant difference was noted in the perception of these 2 emotions in SL and SN category in the control group. Other emotions did not show a significant difference, but when means were compared (Table1) it was seen that SN sentences were better perceived than SL sentences. A similar trend was found in both the CLD groups, i.e., they showed better perception of SN sentences than for SL sentences.

4.1.1.2 Perceptual analysis of the subject's utterances by the judges

The judges were given the responses of all the groups and were asked to judge if the responses were similar as to what the target response should be. It was seen that even the control subjects could not produce the right emotion in their sentences, 100% of the time. Within the control group only 4 participants could portray the target emotion most of the times. The other controls could not depict the required emotion; judges reported that most of the utterances sounded like statements, without depicting any particular emotion.

The CLD group performed very poorly, almost all their utterances being judged as deviant from the target. Most of the utterances could not be identified as one of the five target emotions. Often the judges identified the sentences as a statement, without depicting any particular emotion. Even in conversational speech, observations made during the experimental stage, it was observed that the CLD group especially the CLD with (C)APD used improper rhythm and emotion in their speech. Their speech sounded very dull and monotonous. These subjects also showed maximum errors in the perception task, among the groups. It may be presumed that the perceptual deficit led to imprecise productions also.

Another observation that was made was that the CLD group had less number of words in their responses both in imitation and reading tasks, i.e., they either omitted or the substituted another word for the target word.

4.2 Production Task

The responses of the subjects were acoustically analyzed using the Praat software. The following parameters were analyzed:

(a) Fundamental Frequency (F0)

(b) Minimum F0 (Min F0)/ the lowest F0 value in an utterance

(c) Maximum F0 (Max F0)/highest F0 value in an utterance

(d) Intensity (I0)

Comparison between the following was made:

- Control subjects versus CLD with (C)APD
- Control subjects versus CLD without (C)APD
- CLD with (C)APD versus CLD without (C)APD
- Imitated versus Reading sample
- Semantically neutral versus semantically loaded sentences

4.2.1 Imitation Task

a) <u>Fundamental Frequency (F0)</u>

Table 6: Mean F0 and SD for Imitation Task for all the groups

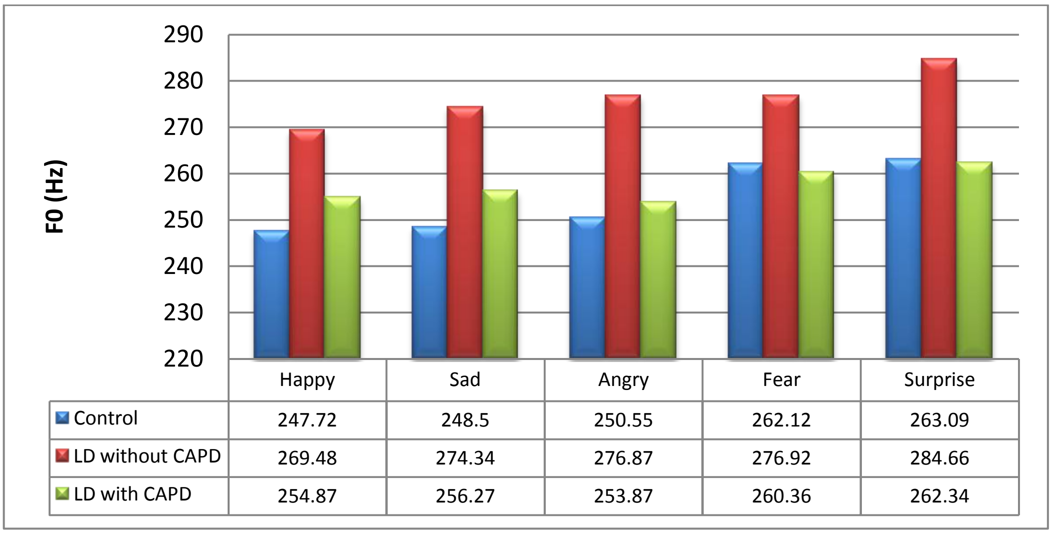
	Controls			**CLD without (C)APD**			**CLD with (C)APD**		
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
LH	10	247.72	21.94	5	269.48	6.87	5	254.87	26.41
NH	10	260.35	22.62	5	284.74	11.02	5	256.66	29.14
LSa	10	248.50	21.14	5	274.34	15.99	5	256.27	25.76
NSa	10	246.24	21.08	5	273.57	4.63	5	248.77	29.22
LA	10	250.55	24.44	5	276.87	6.78	5	253.87	25.59
NA	10	253.14	20.06	5	274.15	6.00	5	247.89	19.72
LF	10	262.12	32.11	5	276.92	3.70	5	260.36	33.20
NF	10	258.37	22.88	5	278.79	2.75	5	252.18	21.85
LSur	10	263.09	35.74	5	284.66	7.17	5	262.34	33.04
NSur	10	269.77	32.78	5	293.80	7.69	5	250.67	24.95

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

From Table5, it can be observed that all the groups showed a similar trend in Happy and Sad emotions when compared between SL and SN. But in Angry emotion an opposite pattern was seen i.e., Control subjects showed an increase in the mean F0 value whereas both the CLD groups showed a reduction in this parameter. In Fear emotion CLD with (C)APD showed a similar pattern as in control subjects i.e. both showed a reduction in the Mean F0 value whereas CLD without (C)APD group showed an increase in the Mean F0. The exact opposite was seen in Surprise emotion where controls and CLD without (C)APD showed a similar pattern, and CLD with (C)APD group did not go along with the other groups.

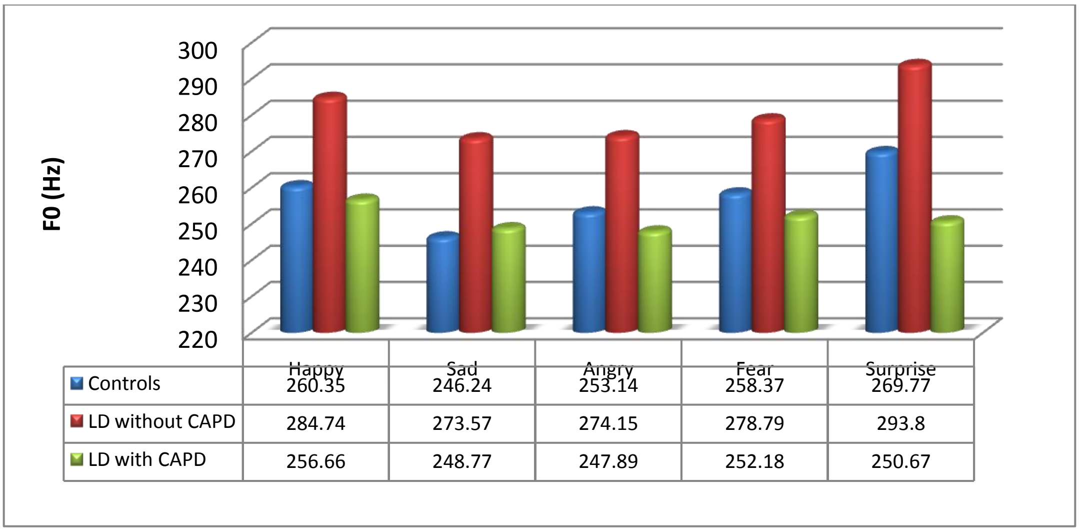
It can be seen in the above Graph that the CLD without (C)APD group had the maximum Mean F0 followed by the CLD with (C)APD group where they showed higher mean F0 value for Happy, Sad and Angry emotion than for the control group.

The mean F0 values for Fear and Surprise emotion for control group and CLD with (C)APD group were almost similar.



	Happy	Sad	Angry	Fear	Surprise
Control	247.72	248.5	250.55	262.12	263.09
LD without CAPD	269.48	274.34	276.87	276.92	284.66
LD with CAPD	254.87	256.27	253.87	260.36	262.34

Graph 6: Mean F0 for all the groups for Imitation of SL sentences



	Happy	Sad	Angry	Fear	Surprise
Controls	260.35	246.24	253.14	258.37	269.77
LD without CAPD	284.74	273.57	274.15	278.79	293.8
LD with CAPD	256.66	248.77	247.89	252.18	250.67

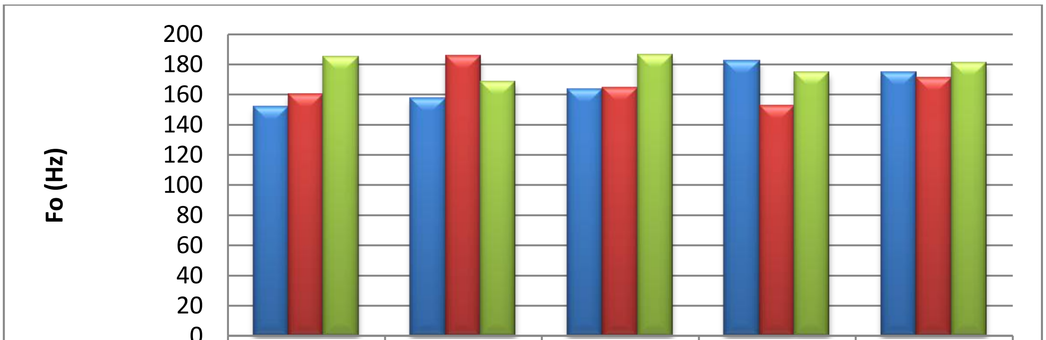
Graph 7: Mean F0 for all the groups for Imitation of SN sentences

b) Minimum F0

Table 7: Mean Min F0 and SD for all the groups for Imitation Task

Loaded/ Neutral▼	Controls			CLD without (C)APD			CLD with (C)APD		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
LH	10	152.07	45.00	5	160.31	23.88	5	185.02	26.53
NH	10	194.19	34.60	5	205.20	46.85	5	201.13	25.49
LSa	10	157.33	54.66	5	185.42	21.91	5	168.49	42.48
NSa	10	179.20	44.14	5	181.60	31.01	5	184.62	30.82
LA	10	163.42	51.38	5	164.82	9.48	5	185.88	29.40
NA	10	195.12	25.54	5	190.91	20.22	5	192.15	25.04
LF	10	182.54	46.26	5	152.13	13.17	5	174.62	46.72
NF	10	180.82	39.29	5	179.89	13.13	5	176.94	35.11
LSur	10	174.96	45.79	5	170.81	38.46	5	181.28	34.92
NSur	10	195.12	25.54	5	190.91	20.22	5	192.15	25.041

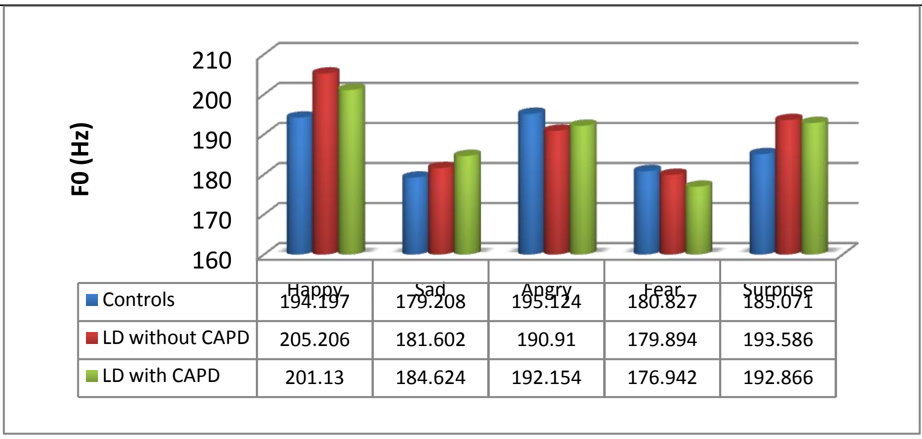
L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise



	Happy	Sad	Angry	Fear	Surprise
Controls	152.07	157.33	163.42	182.54	174.96
LD without CAPD	160.31	185.42	164.82	152.13	170.81
LD with CAPD	185.02	168.49	185.88	174.62	181.28

Graph 8: Mean Min F0 for all the groups for Imitation of SL sentences

From Table 6 and Graph 8 it can be seen that control group had the least mean Min F0 values for the Imitation of SL sentences in almost all the emotions except Fear when compared to the CLD groups. The second least Mean min F0 values were seen for CLD without (C)APD group in all the emotions except for Sad where Mean min F0 value was more than for CLD with (C)APD group.

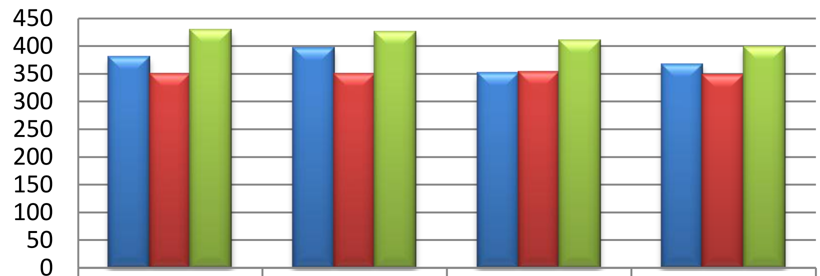


Graph 9: Mean Min F0 for all the groups for Imitation of SN sentences

From Table 6 and Graph 9 it can be seen that control group had the least mean min F0 values for the Imitation of SN sentences in almost all the emotions except Angry and Fear when compared to the CLD groups. The CLD groups almost had equal mean min F0 values in the Imitation of SN sentences.

c) <u>Maximum F0</u>

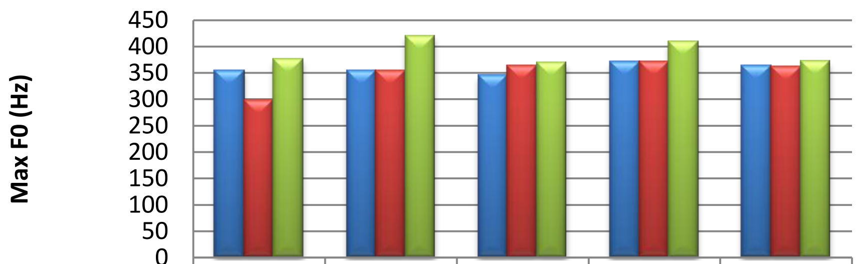
It can be seen from the Graph 10 that CLD with (C)APD group had the highest mean Maximum F0 values followed by the control group. CLD without (C)APD group had the least mean Maximum F0 value for the imitation of SL sentences.



	Happy	Sad	Angry	Fear
Controls	380.722	396.317	350.649	366.92
LD without CAPD	350.242	348.59	353.712	347.8
LD with CAPD	428.524	426.376	409.41	398.156

Graph 10: Mean Max F0 for all the groups for Imitation of SL sentences

A similar trend was seen in the mean maximum F0 for imitation of neutral sentences. Highest Mean Maximum F0 value was seen for CLD with (C)APD in all the emotions. Controls and CLD without (C)APD groups showed almost similar values except in happy emotion where Mean Minimum F0 for controls was more than CLD without (C)APD.



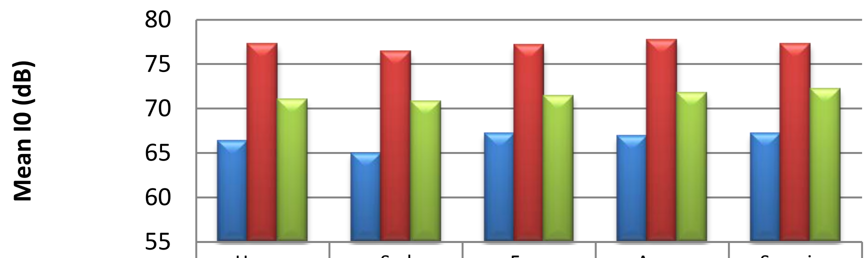
	Happy	Sad	Angry	Fear	Surprise
Controls	354.428	354.543	345.165	369.69	362.392
LD without CAPD	297.896	354.708	363.28	370.862	361.562
LD with CAPD	376.278	420.574	369.504	408.878	371.856

Graph 11: Mean Max F0 for all the groups for Imitation of SN sentences

Controls and CLD without (C)APD groups showed almost similar values except in happy emotion where mean minimum F0 for controls was more than for CLD without (C)APD.

Fear, Joy requires excessive variations in FO, which is not reflected in CLD's monotonous voice.

d) **<u>Intensity (I0)</u>**

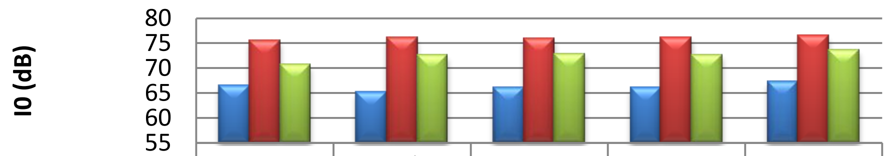


	Happy	Sad	Fear	Angry	Surprise
Controls	66.343	64.986	67.193	66.84	67.188
LD without CAPD	77.298	76.4	77.19	77.66	77.298
LD with CAPD	71.01	70.782	71.424	71.76	72.158

Graph 12: Mean I0 for all the groups for Imitation of SL sentences

In I0 measure for imitation task a similar fashion was seen in SL (Graph 12) and SL (Graph 13) sentences. CLD with (C)APD group had the highest I0 followed by CLD with (C)APD group and the controls had least Mean I0 among the three groups.

It can be said that CLD without (C)APD use I0 to portray the emotions, where as in the literature it is said that variations in F0 are used by normal's to show the different emotions.

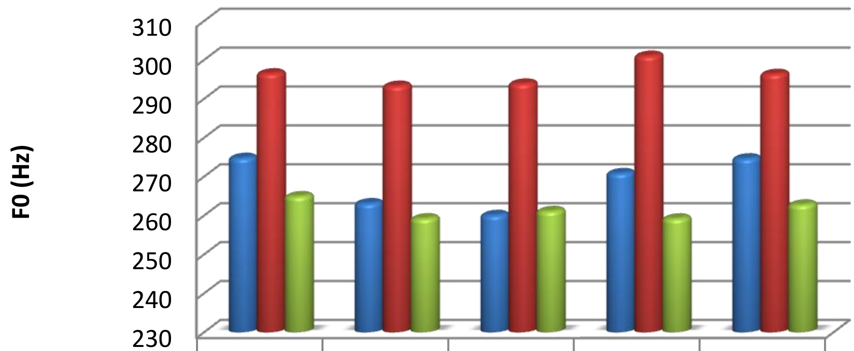


	Happy	Sad	Angry	Fear	Surprise
Controls	66.417	65.091	66.133	66.074	67.224
LD without CAPD	75.486	76.06	75.904	76.088	76.394
LD with CAPD	70.658	72.602	72.896	72.72	73.614

Graph 13: Mean I0 for all the groups for Imitation of SN sentences

4.2.2Reading Task

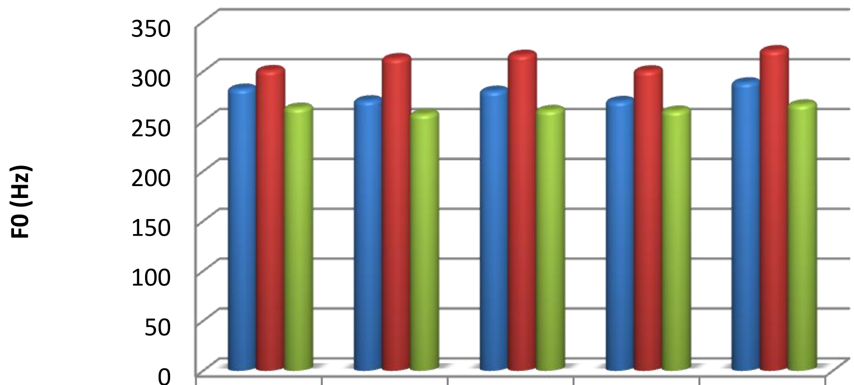
i) <u>Fundamental Frequency (F0)</u>



	Happy	Sad	Angry	Fear	Surprise
Controls	274.7956	263.1389	260.1144	270.8867	274.66
LD without CAPD	296.514	293.338	293.878	301.052	296.378
LD with CAPD	264.95	259.26	261.1425	259.2275	262.8225

Graph 14: Mean F0 for all the groups for Reading of SL sentences

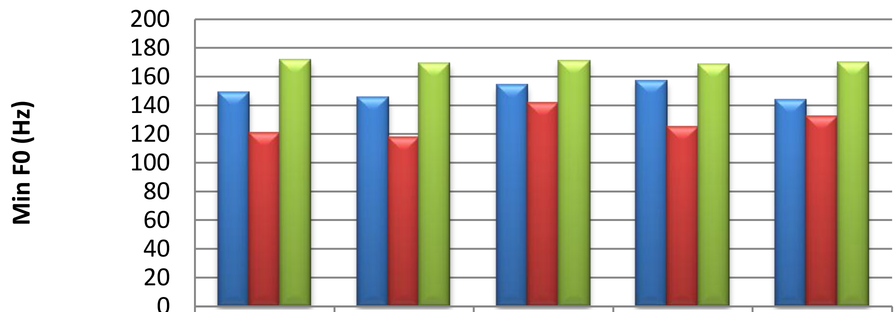
Graph 14 and 15 shows that CLD without (C)APD group had the highest mean F0 values followed by control group and then CLD with (C)APD group.



	Happy	Sad	Angry	Fear	Surprise
Controls	282.5967	270.8578	280.5167	270.2367	288.92
LD without CAPD	301.218	313.142	316.616	300.956	321.202
LD with CAPD	263.5825	257.3775	261.27	260.645	266.8275

Graph 15: Mean F0 for all the groups for Reading of SN sentences

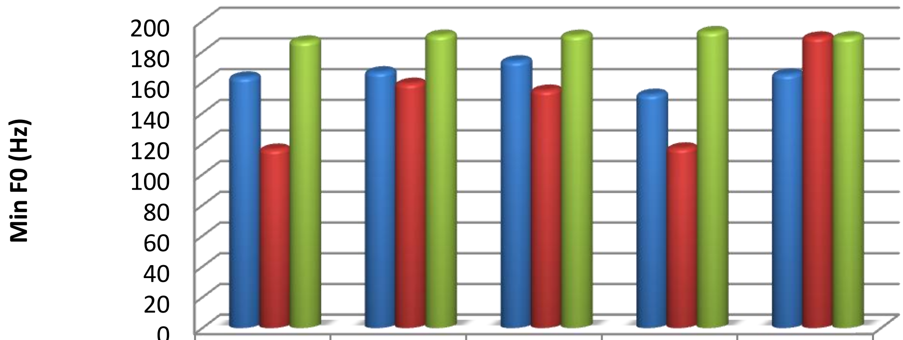
ii) Minimum F0



	Happy	Sad	Angry	Fear	Surprise
Controls	148.8289	145.5567	154.0589	157.1144	143.61
LD without CAPD	120.93	117.746	141.698	125.122	132.346
LD with CAPD	171.7675	169.1875	171.0925	168.035	169.8925

Graph 16: Mean Min F0 for all the groups for Reading of SL sentences

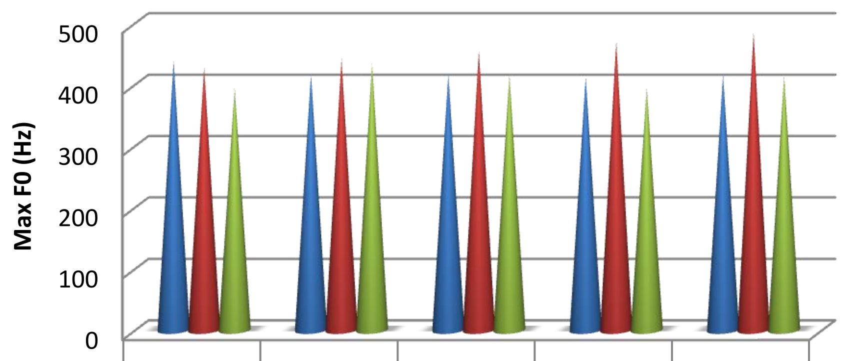
Graph 16 & 17 shows that CLD with (C)APD had the highest mean Minimum F0 values followed by controls and then CLD without (C)APD group for the production of SL and SN sentences.



	Happy	Sad	Angry	Fear	Surprise
Controls	163.3544	166.7589	173.8856	152.1367	165.21
LD without CAPD	116.368	159.278	154.85	117.14	189.44
LD with CAPD	186.8225	190.67	190.585	192.9975	189.495

Graph 17: Mean Min F0 for all the groups for Reading of SN sentences

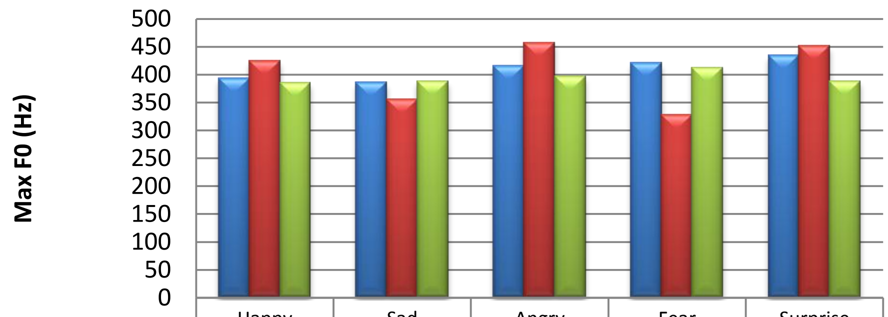
iii) Maximum F0



	Happy	Sad	Angry	Fear	Surprise
Controls	438.8111	417.4467	417.8133	412.9378	416.2522
LD without CAPD	428.612	442.272	455.922	470.19	485.92
LD with CAPD	394.8675	434.6925	416.465	396.2025	415.105

Graph 18: Mean Max F0 for all the groups for Reading of SL sentences

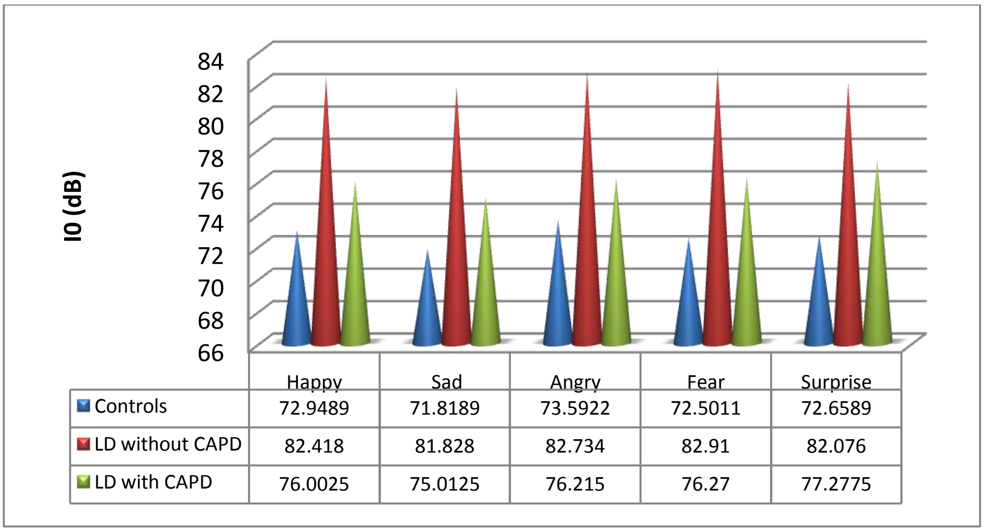
Graph 18 and 19 shows that CLD without (C)APD group had the highest mean maximum F0 values except in the Sad and Fear emotion in the neutral sentences. Controls had the second highest mean maximum F0 values followed by CLD with (C)APD group.



	Happy	Sad	Angry	Fear	Surprise
Controls	393.36	385.17	415.84	420.33	433.81
LD without CAPD	424.11	354.32	456.53	326.54	450.73
LD with CAPD	384.64	387.88	395.96	411.99	388.35

Graph 19: Mean Max F0 for all the groups for Reading of SN sentences

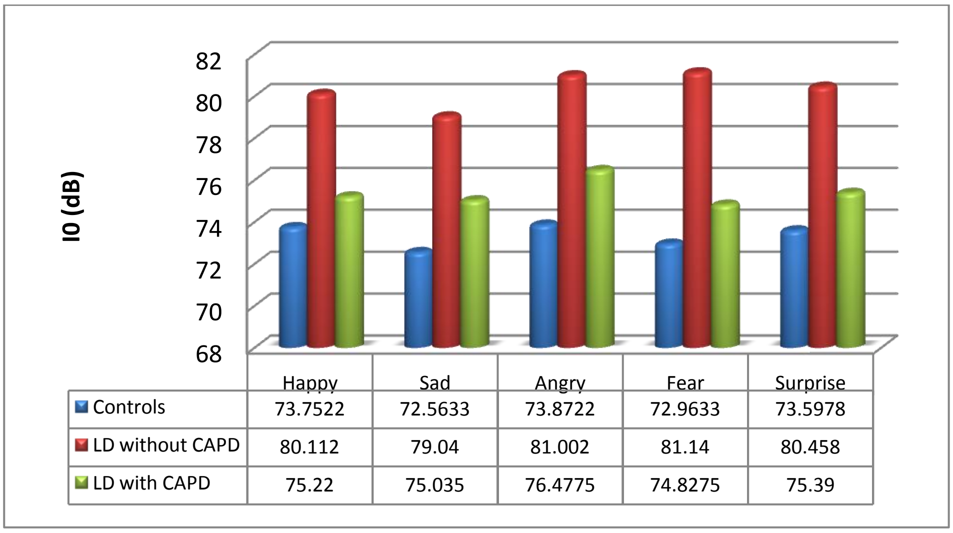
iv) Intensity (I0)



	Happy	Sad	Angry	Fear	Surprise
Controls	72.9489	71.8189	73.5922	72.5011	72.6589
LD without CAPD	82.418	81.828	82.734	82.91	82.076
LD with CAPD	76.0025	75.0125	76.215	76.27	77.2775

Graph 20: Depicts mean I0 Values for SL sentences

Graph 20 & 21 shows a similar trend, where CLD without (C)APD show highest mean I0 values than the other groups, second highest values was seen in the CLD without (C)APD group, Control group had the least I0 values. As mentioned above CLD without (C)APD may be using a rise in I0 to depict emotions. This may be a way to compensate for their inability to vary their F0.



	Happy	Sad	Angry	Fear	Surprise
Controls	73.7522	72.5633	73.8722	72.9633	73.5978
LD without CAPD	80.112	79.04	81.002	81.14	80.458
LD with CAPD	75.22	75.035	76.4775	74.8275	75.39

Graph 21: Depicts mean I0 values for SN sentences

All the three groups showed relatively better performance in the production of angry sentences, both SL and SN ,it may be because it can be expressed by variation in intensity also, which is used as a cue by this subject.

Nandini (1987) in her study concluded that intensity variations do not show difference between different types of sentences. This may probably be the reason as to why no difference was perceived by the judges even after CLD without CAPD raising their loudness to portray the required emotions.

4.2.3 Comparison between Groups for Imitation Task

4.2.3.1 Controls versus CLD without (C)APD

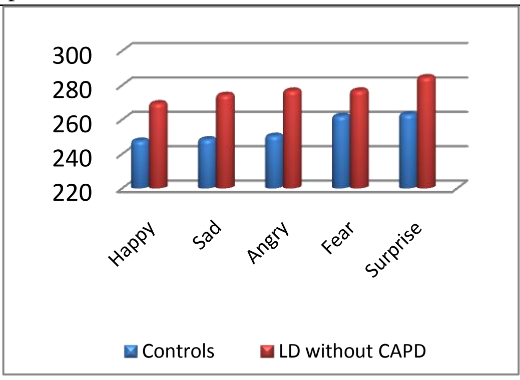
i) SL vs SN for F0

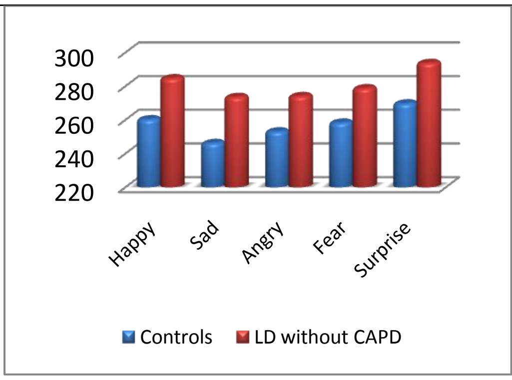
Table 8: Depicting mean F0 values

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
ILHF0	12.50	67.50	-1.536	.124
INHF0	8.00	63.00	-2.088	**.037**
ILSaF0	7.00	62.00	-2.210	**.027**
INSaF0	4.00	59.00	-2.579	**.010**
ILAF0	7.00	62.00	-2.210	**.027**
INAF0	6.00	61.00	-2.333	**.020**
ILFF0	18.00	73.00	-.860	.390
INFF0	13.00	68.00	-1.474	.141
ILSurF0	13.00	68.00	-1.474	.141
INSurF0	10.00	65.00	-1.842	.065

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

Table.7 shows the comparison of F0 values for SL and SN sentences, between the controls and CLD without (C)APD group for the Imitation Task. According to Mann-Whitney test, a significant difference was seen between these groups in the production of NH (0.037), LS (0.027), NS (.010), LA (0.027) and NA (0.020) sentences.





Graph 22: SL vs SN for F0

ii) SL vs SN for Minimum F0

Table 9: Depicting Mean minimum F0 values

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
ILHMinF0	25.00	40.00	.000	1.000
INHMinF0	24.00	39.00	-.123	.902
ILSMinF0	21.00	76.00	-.491	.623
INSMinF0	24.00	79.00	-.123	.902
ILAMinF0	21.00	36.00	-.491	.623
INAMinF0	21.00	36.00	-.491	.623
ILFMinF0	16.00	31.00	-1.105	.269
INFMinF0	24.00	79.00	-.123	.902
ILSurMinF0	19.00	34.00	-.737	.461
INSurMinF0	20.00	75.00	-.614	.539

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

Table 8 show the comparison of Min F0 values for SL and SN sentences, between the control and CLD without (C)APD group for the Reading Task. According to Mann-Whitney Test, a significant difference was not seen between these groups in any of the emotions.

iii) SL vs SN for Maximum F0

Table 10: Depicting mean maximum F0

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
ILHMaxF0	13.00	28.00	-1.474	.141
INHMaxF0	19.00	34.00	-.737	.461
ILSaMaxF0	15.00	30.00	-1.228	.219
INSaMaxF0	18.00	73.00	-.860	.390
ILAMaxF0	15.00	70.00	-1.228	.219
INAMaxF0	22.00	77.00	-.368	.713
ILFMaxF0	25.00	40.00	.000	1.000
INFMaxF0	25.00	40.00	.000	1.000
ILSurMaxF0	24.00	79.00	-.123	.902
INSurMaxF0	19.00	74.00	-.737	.461

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

No significant difference was seen in the mean F0 values between controls and CLD without (C)APD.

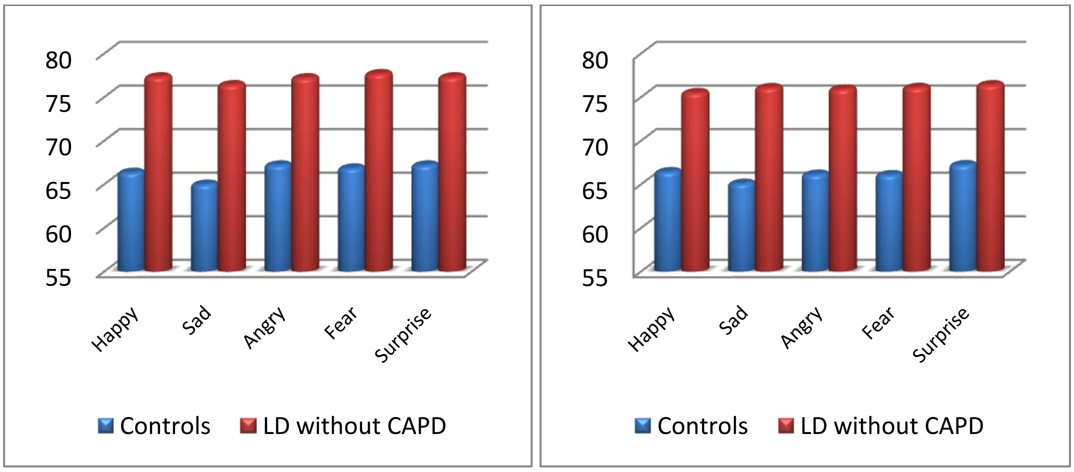
iv) SL vs SN for Intensity

Table 11: Depicting mean I0 values

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
ILHI0	.00	55.00	-3.070	**.002**
INHI0	4.00	59.00	-2.579	**.010**
ILSaI0	1.00	56.00	-2.955	**.003**
INSaI0	.00	55.00	-3.070	**.002**
ILAI0	4.00	59.00	-2.579	**.010**
INAI0	.00	55.00	-3.070	**.002**
ILFI0	.00	55.00	-3.070	**.002**
INFI0	4.00	59.00	-2.579	**.010**
ILSurI0	2.00	57.00	-2.824	**.005**
INSurI0	4.00	59.00	-2.579	**.010**

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

A major difference was seen in the mean I0 values between control group and CLD without (C)APD group. CLD without (C)APD had notably higher I0 values than the control subjects. CLD without (C)APD may be using intensity as a parameter to show the required emotion in their utterances.



Graph 23: SL vs SN for I0

Nandini (1987) in her study concluded that intensity variations do not show difference between different types of sentences. This may probably be the reason as to why no difference was perceived by the judges even after CLD without CAPD raising their loudness to portray the required emotions.

4.2.3.2 Controls versus CLD with (C)APD

i) SL vs SN for F0

Table 12: Depicting mean F0 values

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
LHF0	22.00	77.00	-.368	.713
INHF0	23.00	38.00	-.245	.806
ILSaF0	21.00	76.00	-.490	.624
INSaF0	25.00	40.00	.000	1.000
ILAF0	23.00	78.00	-.245	.806
INAF0	22.00	37.00	-.368	.713
ILFF0	24.00	39.00	-.123	.902

INFF0	21.00	36.00	-.490	.624
ILSurF0	24.00	79.00	-.123	.902
INSurF0	15.00	30.00	-1.226	.220

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

No significant difference was seen in the mean F0 values between controls and CLD with (C)APD.

ii) SL vs SN for Minimum F0

Table 13: Depicting mean Minimum F0 values

	Mann-Whitney U	**Wilcoxon W**	**Z**	**Asymp. Sig. (2-tailed)**
ILHMinF0	15.00	70.00	-1.226	.220
INHMinF0	21.00	76.00	-.490	.624
ILSaMinF0	22.00	77.00	-.368	.713
INSaMinF0	24.00	79.00	-.123	.902
ILAMinF0	20.00	75.00	-.613	.540
INAMinF0	24.00	39.00	-.123	.902
ILFMinF0	24.00	39.00	-.123	.902
INFMinF0	21.00	36.00	-.490	.624
ILSurMinF0	23.00	78.00	-.245	.806
INSurMinF0	23.00	78.00	-.245	.806

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

No significant difference was seen in the mean minimum F0 values between controls and CLD with (C)APD.

iii) SL vs SN for Maximum F0

Table 14: Depicting Mean Maximum F0 values

	Mann-Whitney U	**Wilcoxon W**	**Z**	**Asymp. Sig. (2-tailed)**
ILHMaxF0	14.00	69.00	-1.348	.178
INHMaxF0	25.00	40.00	.000	1.000
ILSaMaxF0	16.00	71.00	-1.103	.270
INSaMaxF0	16.00	71.00	-1.103	.270

ILAMaxF0	14.00	69.00	-1.348	.178
INAMaxF0	20.00	75.00	-.613	.540
ILFMaxF0	19.00	74.00	-.736	.462
INFMaxF0	14.00	69.00	-1.348	.178
ILSurMaxF0	21.00	76.00	-.490	.624
INSurMaxF0	22.00	37.00	-.368	.713

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

No significant difference was seen in the mean maximum F0 values between controls and CLD with (C)APD.

iv) SL vs SN for Intensity

Table 15: Depicting mean I0 values

	Mann-Whitney U	**Wilcoxon W**	**Z**	**Asymp. Sig. (2-tailed)**
ILHI0	13.00	68.00	-1.471	.141
INHI0	13.00	68.00	-1.471	.141
ILSaI0	12.00	67.00	-1.594	.111
INSaI0	5.00	60.00	-2.452	**.014**
ILAI0	14.00	69.00	-1.348	.178
INAI0	10.00	65.00	-1.839	.066
ILFI0	14.00	69.00	-1.348	.178
INFI0	10.00	65.00	-1.839	.066
ILSurI0	16.00	71.00	-1.103	.270
INSurI0	11.00	66.00	-1.716	.086

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

No large difference was seen in the mean I0 values between controls and CLD with (C)APD, expect for neutral Sad (0.014) imitation. CLD without (C)APD may be using intensity as a parameter to show the required emotion in their utterances.

4.2.3.3 CLD without (C)APD vs CLD with (C)APD

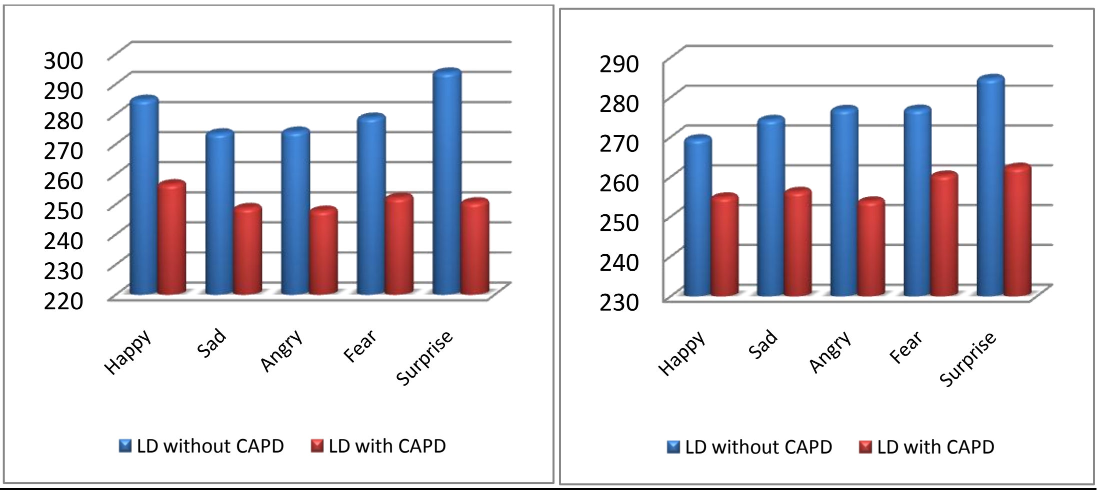
i) SL vs SN for Fundamental Frequency (F0)

Table 16: Depicting mean F0 values

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
ILHF0	6.00	21.00	-1.366	.172
INHF0	3.00	18.00	-1.997	**.046**
ILSaF0	8.00	23.00	-.946	.344
INSaF0	5.00	20.00	-1.576	.115
ILAF0	4.00	19.00	-1.786	.074
INAF0	2.00	17.00	-2.207	**.027**
ILFF0	10.00	25.00	-.525	.599
INFF0	3.00	18.00	-1.997	**.046**
ILSurF0	6.00	21.00	-1.366	.172
INSurF0	2.00	17.00	-2.207	**.027**

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

Significant difference in the mean F0 values was seen in the imitation of neutral sentences except in the Sad emotion (Table. 15). Graph.23 shows that CLD without (C)APD group had higher F0 values as compared to the CLD with (C)APD group.



Graph 24: SL vs SN for F0

ii) SL vs SN for Minimum F0

Table 17: Depicting Mean minimum F0 values

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
ILHMinF0	6.00	21.00	-1.366	.172
INHMinF0	11.00	26.00	-.315	.753
ILSaMinF0	8.00	23.00	-.946	.344
INSaMinF0	12.00	27.00	-.105	.916
ILAMinF0	5.00	20.00	-1.576	.115
INAMinF0	12.00	27.00	-.105	.916
ILFMinF0	10.00	25.00	-.525	.599
INFMinF0	10.00	25.00	-.525	.599
ILSurMinF0	12.00	27.00	-.105	.916
INSurMinF0	12.00	27.00	-.105	.916

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

No significant variation was noticed in the mean minimum F0 values between the CLD groups.

iii) SL vs SN for Maximum F0

Table 18: Depicting mean Maximum F0 values

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
ILHMaxF0	5.00	20.00	-1.576	.115
INHMaxF0	6.00	21.00	-1.366	.172
ILSaMaxF0	5.00	20.00	-1.576	.115
INSaMaxF0	10.00	25.00	-.525	.599
ILAMaxF0	5.00	20.00	-1.576	.115
INAMaxF0	10.00	25.00	-.525	.599
ILFMaxF0	10.00	25.00	-.525	.599
INFMaxF0	6.00	21.00	-1.366	.172
ILSurMaxF0	12.00	27.00	-.105	.916
INSurMaxF0	10.00	25.00	-.525	.599

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

No significant variation was noticed in the mean maximum F0 values between the CLD groups.

iv) SL vs SN for Intensity

Table 19: Depicting mean I0 values

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
ILHI0	2.00	17.00	-2.207	**.027**
INHI0	9.00	24.00	-.736	.462
ILSaI0	2.00	17.00	-2.207	**.027**
INSaI0	8.00	23.00	-.946	.344
ILAI0	4.00	19.00	-1.786	.074
INAI0	9.00	24.00	-.736	.462
ILFI0	5.00	20.00	-1.576	.115
INFI0	8.00	23.00	-.946	.344
ILSurI0	5.00	20.00	-1.576	.115
INSurI0	10.00	25.00	-.525	.599

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

Significant variation was not seen in the mean I0 values between the CLD groups except in the Happy (0.027) and Sad (0.027) emotion in the loaded sentences. Positive-activation emotions correlate with higher F0 measurement than negative-activation emotions and they have a faster speaking rate, generally speaking. Liscombe, Venditti & Hirschberg (2003) in their study have shown that emotions can be distinguished in terms of activation using any one of a multitude of easily obtainable features: pitch, energy, and speaking rate.

4.2.4 <u>Comparison between groups for Reading Task</u>

4.2.4.1 Controls vs CLD without (C)APD

i) Fundamental Frequency (F0)

Table 20: Depicting mean F0 values

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
RLHF0	15.00	60.00	-1.003	.316
RNHF0	16.00	61.00	-.870	.385

RLSaF0	11.00	56.00	-1.538	.124
RNSaF0	8.00	53.00	-1.940	.052
RLAF0	12.00	57.00	-1.405	.160
RNAF0	11.00	56.00	-1.538	.124
RLFF0	11.00	56.00	-1.538	.124
RNFF0	14.00	59.00	-1.137	.256
RLSurF0	14.00	59.00	-1.137	.256
RNSurF0	12.00	57.00	-1.405	.160

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

Table20 shows the comparison of F0 values for SL and SN sentences, between the control and CLD without (C)APD group for the Reading Task. According to Mann-Whitney Test, a significant difference was not seen between these groups in any of the emotions.

ii) Minimum F0

Table 21: Depicting mean minimum F0 values

	Mann-Whitney U	**Wilcoxon W**	**Z**	**Asymp. Sig. (2-tailed)**
RLHMinF0	18.00	33.00	-.602	.547
RNHMinF0	14.00	29.00	-1.137	.256
RLSaMinF0	17.00	32.00	-.736	.462
RNSaMinF0	20.00	65.00	-.334	.738
RLAMinF0	21.00	36.00	-.201	.841
RNAMinF0	10.00	25.00	-1.672	.094
RLFMinF0	16.00	31.00	-.870	.385
RNFMinF0	18.00	33.00	-.602	.547
RLSurMinF0	21.00	66.00	-.201	.841
RNSurMinF0	20.00	65.00	-.334	.738

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

No significant variation was noticed in the mean maximum F0 values between the control and CLD without (C)APD group.

iii) Maximum F0

Table 22: Depicting mean maximum F0 values

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
RLHMaxF0	18.00	63.00	-.602	.547
RNHMaxF0	17.00	62.00	-.736	.462
RLSaMaxF0	19.00	64.00	-.468	.640
RNSaMaxF0	17.00	32.00	-.736	.462
RLAMaxF0	15.00	60.00	-1.003	.316
RNAMaxF0	9.00	54.00	-1.806	.071
RLFMaxF0	9.00	54.00	-1.806	.071
RNFMaxF0	6.00	21.00	-2.207	**.027**
RLSurMaxF0	12.00	57.00	-1.405	.160
RNSurMaxF0	13.00	58.00	-1.271	.204

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

No noteworthy variation was noticed in the mean maximum F0 values between the control and CLD without (C)APD group except in the Fear (0.027) emotion in the SN sentences.

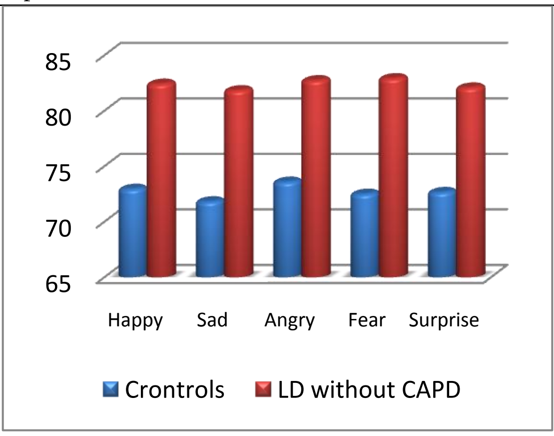
iv) Intensity (I0)

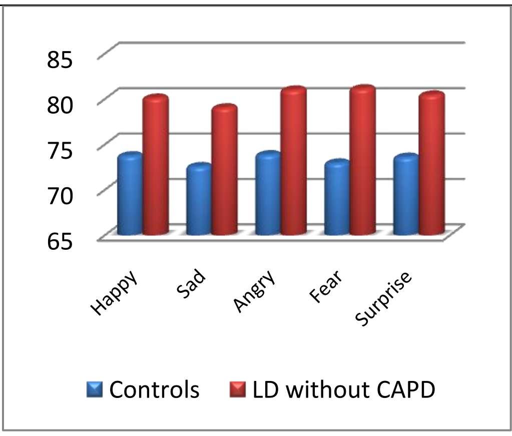
Table 23: Depicting mean I0 values

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
RLHI0	.00	45.00	-3.010	**.003**
RNHI0	3.00	48.00	-2.609	**.009**
RLSaI0	.00	45.00	-3.010	**.003**
RNSaI0	.00	45.00	-3.010	**.003**
RLAI0	.00	45.00	-3.010	**.003**
RNAI0	1.00	46.00	-2.876	**.004**
RLFI0	.00	45.00	-3.010	**.003**
RNFI0	.00	45.00	-3.010	**.003**
RLSurI0	.00	45.00	-3.010	**.003**
RNSurI0	1.00	46.00	-2.876	**.004**

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

A significant difference was noticed in the mean I0 values when Controls and CLD without (C)APD subjects were compared (Table.23, Graph.24).





Graph 25: Depicting mean I0 values

4.2.4.2 <u>Comparison between Control vs CLD with (C)APD</u>

2.5 SL vs SN for F0

Table 24: Depicting mean F0 values

	Mann-Whitney U	**Wilcoxon W**	**Z**	**Asymp. Sig. (2-tailed)**
RLHF0	15.00	25.00	-.464	.643
RNHF0	12.00	22.00	-.927	.354
RLSaF0	18.00	28.00	.000	1.000
RNSaF0	16.00	26.00	-.309	.757
RLAF0	17.00	27.00	-.155	.877
RNAF0	11.00	21.00	-1.082	.279
RLFF0	18.00	28.00	.000	1.000
RNFF0	17.00	27.00	-.155	.877
RLSurF0	12.00	22.00	-.927	.354
RNSurF0	13.00	23.00	-.773	.440

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

No significant difference was noticed in the mean F0 values between controls and CLD with (C)APD group.

i) SL vs SN for Minimum F0

Table 25: Depicting mean minimum F0 values

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
RLHMinF0	12.00	57.00	-.927	.354
RNHMinF0	14.00	59.00	-.618	.537
RLSaMinF0	12.00	57.00	-.927	.354
RNSaMinF0	14.00	59.00	-.618	.537
RLAMinF0	12.00	57.00	-.927	.354
RNAMinF0	17.00	27.00	-.155	.877
RLFMinF0	16.00	61.00	-.309	.757
RNFMinF0	12.00	57.00	-.927	.354
RLSurMinF0	15.00	60.00	-.464	.643
RNSurMinF0	16.00	61.00	-.309	.757

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

No significant difference was noticed in the mean minimum F0 values for control group and CLD with (C)APD group.

ii) SL vs SN for Maximum F0

Table 26: Depicting mean Maximum F0 values

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
RLHMaxF0	18.00	28.000	.000	1.000
RNHMaxF0	17.00	27.00	-.155	.877
RLSaMaxF0	15.00	60.00	-.464	.643
RNSaMaxF0	14.00	24.00	-.618	.537
RLAMaxF0	16.00	61.00	-.309	.757
RNAMaxF0	17.00	27.00	-.155	.877
RLFMaxF0	18.00	28.00	.000	1.000
RNFMaxF0	18.00	28.00	.000	1.000
RLSurMaxF0	17.00	27.00	-.155	.877
RNSurMaxF0	15.00	25.00	-.464	.643

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

No significant difference was found in the mean Maximum values between control group and CLD with (C)APD group.

iii) SL vs SN for Intensity

Table 27: Depicting mean I0 values

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
RLHI0	9.00	54.00	-1.391	.164
RNHI0	12.00	57.00	-.927	.354
RLSaI0	12.00	57.00	-.927	.354
RNSaI0	9.00	54.00	-1.391	.164
RLAI0	10.00	55.00	-1.236	.216
RNAI0	10.00	55.00	-1.236	.216
RLFI0	7.00	52.00	-1.700	.089
RNFI0	10.00	55.00	-1.236	.216
RLSurI0	3.00	48.00	-2.318	**.020**
RNSurI0	14.00	59.00	-.618	.537

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

No significant difference was noticed in the mean I0 values except in the surprise (0.020) emotion in the comparison of controls and CLD with (C)APD.

4.2.4.3 <u>CLD without (C)APD vs CLD with (C)APD</u>

i) SL vs SN for Fundamental Frequency

Table 28: Depicting mean F0 values for CLD groups

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
RLHF0	5.00	15.00	-1.235	.217
RNHF0	5.00	15.00	-1.235	.217
RLSaF0	3.00	13.00	-1.729	.084
RNSaF0	2.00	12.00	-1.976	**.048**
RLAF0	5.00	15.00	-1.235	.217
RNAF0	3.00	13.00	-1.729	.084
RLFF0	3.00	13.00	-1.729	.084
RNFF0	3.00	13.00	-1.729	.084
RLSurF0	6.00	16.00	-.988	.323
RNSurF0	2.00	12.00	-1.976	**.048**

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

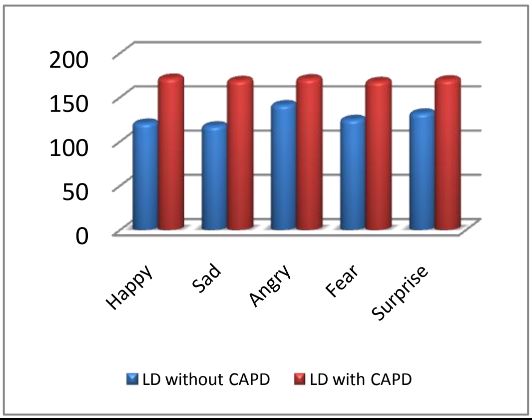
Mean F0 values did not show a significant difference in most of the emotions except in reading of Sad (0.048) and Surprise (0.048) emotions *ii) SL vs SN for Minimum F0*

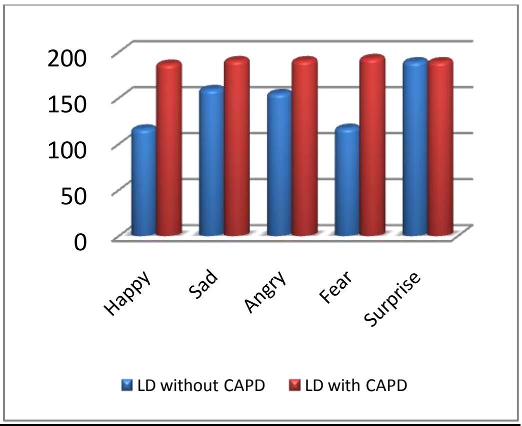
Table 29: Depicting mean Minimum F0 for the CLD groups

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
RLHMinF0	2.00	17.00	-1.976	**.048**
RNHMinF0	.00	15.00	-2.470	**.014**
RLSaMinF0	4.00	19.00	-1.482	.138
RNSaMinF0	4.00	19.00	-1.482	.138
RLAMinF0	6.00	21.00	-.988	.323
RNAMinF0	2.00	17.00	-1.976	**.048**
RLFMinF0	6.00	21.00	-.988	.323
RNFMinF0	.00	15.00	-2.470	**.014**
RLSurMinF0	2.00	17.00	-1.976	**.048**
RNSurMinF0	9.00	24.00	-.247	.805

L-Loaded; N-Neutral; H-Happy; S-Sad; A-Angry; F-Fear; Sur-Surprise

A significant difference was noticed in the mean minimum values in the imitation of Happy (0.014), Angry (0.048) and Fear (0.014) emotions in the SN sentences and Happy (0.048) and Surprise (0.048) in the SL sentences (Table.29). No significant difference was seen in the other emotions (Graph.26).





Graph 26: Depicting mean minimum F0 values for CLD groups

iii) SL vs SN for Maximum F0

Table 30: Depicting mean maximum F0 between CLD groups

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
RLHMaxF0	7.00	17.00	-.741	.459
RNHMaxF0	6.00	16.00	-.988	.323
RLSaMaxF0	8.00	18.00	-.494	.621

RNSaMaxF0	10.00	20.00	.000	1.000
RLAMaxF0	6.00	16.00	-.988	.323
RNAMaxF0	6.00	16.00	-.988	.323
RLFMaxF0	5.00	15.00	-1.23	.217
RNFMaxF0	4.00	19.00	-1.48	.138
RLSurMaxF0	6.00	16.00	-.988	.323
RNSurMaxF0	8.00	18.00	-.494	.621

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

No significant difference was seen in the mean maximum F0 values between the CLD groups.

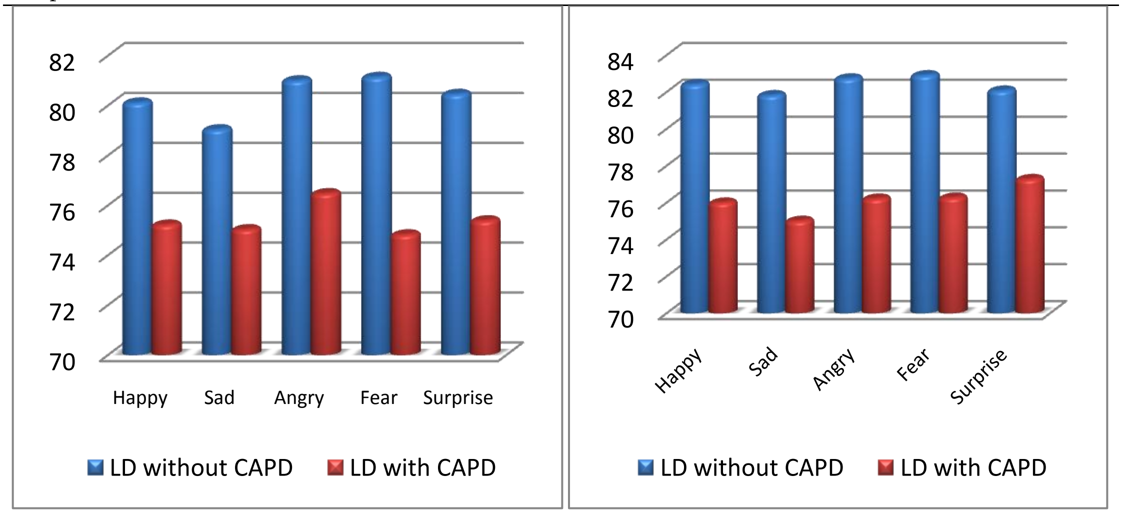
iv) SL vs SN for Intensity

Table 31: Depicting mean I0 values for subjects with CLD with and without (C)APD

	Mann-Whitney U	**Wilcoxon W**	**Z**	**Asymp. Sig. (2-tailed)**
RLHI0	.00	10.00	-2.470	**.014**
RNHI0	.00	10.00	-2.470	**.014**
RLSaI0	.00	10.00	-2.470	**.014**
RNSaI0	2.00	12.00	-1.976	**.048**
RLAI0	.00	10.00	-2.470	**.014**
RNAI0	1.00	11.00	-2.223	**.026**
RLFI0	.00	10.00	-2.470	**.014**
RNFI0	.00	10.00	-2.470	**.014**
RLSurI0	.00	10.00	-2.470	**.014**
RNSurI0	2.00	12.00	-1.976	**.048**

L-Loaded; N-Neutral; H-Happy; Sa-Sad; A-Angry; F-Fear; Sur-Surprise

Table 31 show significance difference in CLD with and without (C)APD group in the mean I0 values in reading task.



Graph 27: Depicting mean I0 values for subjects with CLD with and without (C)APD

In the above Graph. 27 it is evident that CLD without (C)APD group had a notably higher values from CLD with (C)APD group.

Ariatti, Benuzzi and Nichelli (2008) suggested that the widespread involvement of both emotional and propositional prosodic processing parallels the aprosodic characteristics of Parkinsonian speech production.

Piers, Tony, Martin, Iynga, Frances, and Dorothy (2009) hypothesized regarding the cause of APD is a problem with temporal coding of sound. The hypothesis was that if children with APD have a problem with temporal coding of sound, they will have a deficit in performance on one or more of the tasks 2 Hz, 40 Hz, with normal performance on the 240-Hz task. , poor performance is hypothesized to be caused by either a spectral processing problem or, in the case of poor scores across tasks, a global processing difficulty such as attention or memory problems. In both the APD and dyslexia groups, a similar proportion displayed poor auditory performance, and this does not seem entirely accounted for by attention or performance I.Q. However, the significance of these auditory difficulties is uncertain. Both children with dyslexia and children with an APD diagnosis tended to do more poorly than the normative group on the psychophysical tasks. Although auditory and literacy problems were a feature of both clinical groups, there was no correlation between literacy skill and auditory performance. In the Introduction section, we noted that a major issue in APD and in learning disabilities research is the relation between auditory impairments and language or literacy problems. The results in this study support the view that auditory impairments co-occur with literacy problems although they are not themselves directly related.

Paulmann, Pell and Kotz (2008) indicate that emotion recognition rates differ between the different categories tested and that these patterns varied significantly as a function of age, but not of sex.

Children's performance in identifying emotion from such photographs improves with age (Herba and Phillips, 2004), with positive expressions recognized earlier and more accurately than negative expressions (Boyatzis, Chazan, & Ting, 1993; Camras and Allison, 1985; Widen and Russell, 2003).

Heikkinen, JanssonVerkasalo, Toivanen, Suominen, Vayrynen, Moilanen, Sep panen (2010) studied adolescents with asperger's syndrome recognized basic emotions from speech prosody as well as their typically developed controls did. Possibly the recognition of basic emotions develops during the childhood.

Ekman & Friesen, (1975; 1976) in their study, all three LD groups as well as their normally achieving peers, both boys and girls, were more accurate in identifying expressions of affect from female faces.

In the present study following observations were made:

- It was hypothesized that CLD with (C)APD would have difficulty in the perception and production of emotive intonation; this was said because these subjects have (C)APD and one of the prominent characteristics seen in (C)APD individuals is that they have temporal processing difficulties. During the (C)APD evaluation it was seen that all the subjects with CPAD had deficits in the duration pattern test which checks for the temporal processing in an individual.
- Results for the perception task show that control group performed relatively better than the LD groups. But within the LD groups emotion specific performances were seen. Where CLD without (C)APD showed better perception of Happy, Surprise and Angry emotions. Literature shows that these emotions have a relatively higher intensity values than the others. This may have been the reason for this group to show significantly higher intensities than the control and CLD with (C)APD group.
- It is also noticed that the variation of F0 in comparatively higher in control subjects than for that of LD groups. Within the LD groups the LD with (C)APD subjects had the least F0 range than the LD without (C)APD group. This may restricted the LD with (C)APD group to show the variations in different emotions.

- From these results it is evident that CLD have difficulty in modulating the F0, to inflict appropriate variations suggestive of particular emotions. This also gives a subjective impression of monotony in their voice. Appropriate intonation could not be simulated even in the subject whose range was in excess to the normal.
- During the experimental stage, it was noticed that the control subjects performed the imitation task in one chance. The LD groups asked for the play back of the sentences many number of times. Within the LD group, CLD with (C)APD needed the maximum repetitions.
- Comparison between the SL and SN sentences show that SN sentences were better perceived as well as were easy for the subjects for the imitation and the reading task.
- Among the production task, LD subjects found reading task easy than the imitation task. This may be because in the imitation task the subjects had to remember the sentence and then produce it where as in reading task the sentence is there in front of them in the written format. Control subjects had comparable scores for both the tasks.

Finally, reminding that non-vocal paralinguistic features such as co-speech gestures, posture, gaze, facial expression, and proximity changes are all relevant to expression, and that the term ‘paralinguistic’ can be used in the visual as well as the auditory modality might constitute a motivation for a further extension of our interdisciplinary field. That might lead us to study the linguistic and paralinguistic aspects of prosody in a cross-modality field.

CHAPTER 5

SUMMARY AND CONCLUSION

Emotions play a significant role in our daily life and appropriate perception and production of emotions is an important pragmatic skill in our day-to-day communications. Typically developing children learn this skill during their early language developmental stages whereas children with communication disorders fail to various extents in this depending on the type and extent of the disabilities.

Children with Learning disability (CLD) may not appear to have any significant communication deficits in a brief conversation, but it may become apparent in extended and complex conversation. Among these children there are children who have auditory perceptual difficulties in the presence of normal peripheral hearing, although these processing difficulties are not restricted to the auditory modality alone.

Prosodic impairments, specifically affective prosody might affect individuals with LD. Very few studies have been done to understand the emotional sides of CLD. Studies have been carried out to understand the nature of perception and production abilities of CLD, in both affective and linguistic context. Among the limited studies most of the studies have been carried out using facial emotion recognition as their method. There is dearth of studies investigating to know the perception and production of emotions in children in general and more so in CLDs, and also through the acoustic measures. Hence the present investigation was taken up with an aim to study the perception and production of affective intonation in CLD with and without CAPD individuals, across semantically loaded versus semantically neutral sentences, in perception, imitation and reading tasks. The performance of the CLD was analyzed both perceptually and acoustically.

This study consisted of a total of twenty subjects. Five CLD without CAPD and five CLD with CAPD, and ten age and gender matched control subjects, were selected for the study. The CLD groups were made on the bases of audio-logical evaluation which consisted a battery of tests to confirm for the presence or absence of CAPD. The battery included tests for the temporal processing (duration pattern test), auditory closure (speech in noise test) and binaural integration (dichotic digit test). The presence of CAPD was decided if the subjects failed in at least two out of the three tests. It was found that all the subjects diagnosed with CAPD had deficits in the temporal processing i.e. they showed poor performance in the duration pattern test.

Three sets of fifty sentences each were prepared for each task. Two types of sentences, were also considered - semantically loaded (SL) and semantically neutral (SN), for all the emotions. Each SL and SN had twenty five sentences. The subjects were evaluated on two tasks - perception and production. In the perception task, they were asked to judge the emotions conveyed by fifty model utterances (Set1) of English for each sentence types (SL and SN). They were given a closed choice out of five – Happy, Sad, Angry, Fear and Surprise emotions to be identified. In the production task, the children were asked to imitate another set of fifty sentences (Set 2), producing the same emotion that they perceived, after the model utterances. In reading task, they were given another fifty written sentences (Set 3) and were asked to produce the required emotion. The utterances of the participants were subjected to both perceptual and acoustical analysis. Three judges were selected for perceptual judgments. Acoustical analysis was carried out using the Praat software.

The following F0 parameters studied were Fundamental Frequency (F0), Maximum F0, Minimum F0, and Intensity (I0). The results of the present study yielded the following conclusions:

Conclusions:

- The results of perceptual task and acoustical analysis varied significantly. The perceptual abilities of the subjects were much better than their expressive skills.

- The results obtained on acoustical analysis highlight the way in which the three groups portrayed the necessary emotions. It is known that normals use variations in frequency parameters to convey their emotions. Intonation patterns were believed to be due to variation in F0. Dennis (1959) suggest that variation in other acoustic characteristics like intensity, duration and spectrum also cue for recognition of intonation. F0 range in one of the feature which convey emotion (Bolinger 1975). The same finding was seen in CLD with CAPD group i.e. CLD with CAPD did not show an increase in I0 but on observation had an overall reduced range than normals. How a significant difference was not seen in this group compared to the controls even after having temporal processing deficits is not clear. Further investigations could be carried out to understand this phenomenon, or to see if they have some other ways to compensate for their temporal processing deficits.

- The performance of subjects in both the tasks across SL and SN sentences was not comparable. Subjects showed an overall better performance in the semantically neutral sentences. This could be because SN sentences lacks inherent meaning, content, or semantic properties, it could have had a different meaning, or no meaning at all, without any change in its fundamental nature, identity, or essence. So the children may be finding it easier to put in any meaning, or bring about a change in the sentence to portray the required emotion.

- All the three groups did not show a significant difference in the F0 parameters but when intensity was compared across groups CLD without CAPD had higher intensity for SL as well as for SN sentences for both the tasks. It may be concluded that CLD without CAPD compensate their inability to vary pitch by increasing their loudness to convey emotions. But it may be difficult for the listener to understand the emotion the child is trying to convey as not all emotions show an increase in loudness when they are spoken e.g. Sad and Fear.

- There was a difference seen in imitation versus reading task. The performance of all the subjects was better for imitation than reading, suggesting better abilities in matching intonation when given a model. Moreover, as expected, the CLD groups found it difficult to read the sentences when compared to the control group.

The results of acoustic analysis showed that:

(a) There was no significant difference but an overall reduction in the range of F0 in CLD with CAPD group, indicating limited capacity to bring variations in intonation.

(b) The CLD without CAPD group showed a significant difference from the control and CLD with CAPD group on the intensity measure. They showed relatively higher I0 values than the other groups.

It was hypothesized that the CLD with CAPD have temporal processing problems so they may show a deficit in the perception of emotion and hence the production of those emotions. Children with LD with CAPD on observation showed poor performance on production than in perception task. In production task, CLD with CAPD group did not show significant difference in the acoustic parameters. But instead CLD without CAPD group did show a significant difference in the acoustic parameters, specially the intensity parameter. Therefore, future researches should focus on finding what the compensatory strategies which the subjects with LD with CAPD use to convey emotions. Researches can be carried out using other parameters as well.

5.1 Clinical implications:

- It is important that children diagnosed with LD undergo CAPD evaluation to note if there are any deficits this would help the clinicians in planning management.

- To prevent a child from being socially deprived it is important that the emotional side of the child be given treatment if any deficits are present.
- It is possible to train and improve auditory skills, but this need not lead to improvements in language or literacy relative to control groups (Cohen et al. 2005; Gillam et al. 2008; McArthur et al. 2008).
- It was noteworthy that the children in both the LD groups had high rates of literacy and auditory perceptual problems. One obvious implication is the need for multidisciplinary evaluation of such children.
- At present, the best approach may be to view auditory perceptual difficulties as part of a multi-factorial description of learning problems rather than as a diagnostic category in their own right. In both the research and clinical settings, any distinction between children on the basis of categories such as dyslexia or APD may actually be unhelpful because it may focus attention on a single aspect of a child's difficulties - reading or auditory abilities - when it may be more appropriate to view each case as involving contributions from multiple areas.
- Moreover, the very results of this experiment may lead to a better understanding of the prevalence of auditory discrimination problems if any affecting emotions in children with learning disabilities, and etiology of learning disabilities that could result in improved diagnostic and therapeutic techniques. In addition, this line of research may help us to determine whether fine-grained auditory discrimination can be used as a tool to differentiate children with learning disabilities from normal children.

- As a comparison of the auditory discrimination abilities in normal children and children with learning disabilities is undertaken, the results may indicate the specific synthetic material which could be used in therapy. This will help in designing auditory training procedures or compensation for CLD with auditory discrimination deficits.

5.2 Limitations:

- The study was carried out on very less number of subjects
- Only F0 and I0 parameters were considered under acoustic analysis
- Merely five emotions have been considered in the present study

5.3 Recommendations for future research:

- The same study can be replicated with more number of CLD subjects, in each group
- A comparison study between the other deficits in CLDs e.g., CAPD and Visual deficits
- A combination effect can be studied using Audio, Visual and Audiovisual stimuli.
- Researches are mostly limited to visual perception of emotion using facial emotion, picture etc. More research needs to be carried out in the same line as the present study to add on to the present data
- Other acoustic parameter can also be taken to get a more detailed picture about the deficits in the individuals with LD in the production of emotions.

- Investigations may be carried out on the bases of auditory emotion perception in other communication disorders.
- The effect of male/female voice differences can be investigated.
- To see the age effect investigation can be carried out across various age groups.
- A screening checklist for emotion perception and production can also be developed for a handy evaluation of the child's emotional understanding, which would help in knowing if the child has any emotional deficits.
- The significance of auditory perceptual difficulties and what to do about them are matters for further investigation.

REFERENCES

Abrams, D. A., Nicol, T., Zecker, S. G., & Kraus, N. (2006). Auditory brainstem timing predicts cerebral asymmetry for speech. *The Journal of Neuroscience*, *26*, 11131–11137.

Adams, K . & Markham, R. (1991). 'Recognition of Affective Facial Expressions by Children and Adolescents With and Without Mental Retardation'. *American Journal on Mental Retardation*, *96* (I): 21-8.

American Academy of Audiology. (2010). Guidelines for the diagnosis, treatment, and management of children and adults with central auditory processing disorders. Available from http://www.audiology.org/resources/documentlibrary/Documents/CAPDGuidelines 8-2010.pdf.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: American Psychiatric Association.

American Speech-Language-Hearing Association. (2005b). *(Central) auditory processing disorders: The role of the audiologist* [Position statement]. Available from http://www.asha.org/docs/html/PS2005-00114.html

Argyle, M. (1988). *Bodily Communication*, 2nd ed. New York, NY: Methuen.

Ariatti A, Benuzzi F, Nichelli P.(2008). Recognition of emotions from visual and prosodic cues in Parkinson's disease. *Neurological Sciences. 29(4):*219-27. Epub 2008 Sep 20.

Abelin, A., and Allwood, J. (2000). Cross linguistic interpretation of emotional prosodic. ISCA work group on emotion.

Bachorowski, J. and Owren M. J. (2003). “Sounds of Emotion; Production and Perception of Affect-Related Vocal Acoustics.” *Annals of the New York Academy of Sciences 1000*, 244-265.

Bakker, D. J. (1973). Hemispheric specialization and stages in the learning to read process. *Bulletin of the Orton Society*, *23*, 15–27.

Balsiger, L.E. (n.d.). Reading Fluency and Your Child. Retrieved from Internet Special Education Resources website: http://www.iser.com/resources/reading fluency.html

Banai, K., Abrams, D., & Kraus, N. (2007). Sensory-based learning disability: Insights from brainstem processing of speech sounds. *International Journal of Audiology*, *46*, 524–532.

Banai, K., Hornickel, J., Skoe, E., Nicol, T., Zecker, S., & Kraus, N. (2009). Reading and subcortical auditory function.*Cerebral Cortex*, *19,* 2699–2707. doi: 10.1093/cercor/bhp024.

Banai, K., Nicol, T., Zecker, S. G., & Kraus, N. (2005). Brainstem timing: Implications for cortical processing and literacy.*Journal of Neuroscience*, *25*, 9850–9857.

Banse, R. and Scherer K.R. (1996). “Acoustic Profiles in Vocal Emotion Expression.” *Journal of Personality and Social Psychology 70*, 614-636.

Banse, R., & Scherer K.R. (1996). “Acoustic Profiles in Vocal Emotion Expression.” *Journal of Personality and Social Psychology, 70*, 614-636.

Barkhuysen P, Krahmer E, Swerts M. (2010). Crossmodal and incremental perception of audiovisual cues to emotional speech. *Language and Speech.* ;*53*(Pt 1):3-30.

Bellis, T. J. (2003). *Assessment and management of central auditory processing disorders in the educational setting: From science to practice*(2nd ed.). Clifton Park, NY: Thomson Learning.

Billiet CR, Bellis TJ. (2011). The relationship between brainstem temporal processing and performance on tests of central auditory function in children with reading disorders. *Journal of Speech Language and Hearing Research. 54(1):*228-42. Epub 2010 Aug 5.

Boersma, P., Weenink, D., Praat Speech Processing Software, Institute of Phonetics Sciences of the University of Amsterdam. http://www.praat.org.

Bolinger, D. (1972). *Intonation: Selected readings*. Middlesex, England.

Bordom, G.J., & Harris, K.S (1980). *Speech Science Primer : Physiology, acousitics and perception of speech.* Baltimore, MD: Williams & Wilkins.

Borod, J. C., & Madigan, N. K. (2000). Neuropsychology of emotion and emotional disorders: An overview and research directions. In J. C. Borod (Ed.), *The Neuropsychology of Emotion* (pp. 3–28). New York: Oxford University Press.

Boyatzis, C. J., Chazan, E., & Ting, C. Z. (1993). Preschool children's decoding of facial emotions. *Journal of Genetic Psychology, 154*, 375–382.

Bradley, M. M. (1994). 'Emotional Memory: A Dimensional Analysis', in S. S. M. Van Goozen, N.E. Van De Poll, & J. A. Sergeant (eds) Emotions: Essays on Emotion Theory, pp. 97-134. Hillsdale, NJ: Lawrence Erlbaum.

Bradley, R., Danielson, L., & Hallahan, D. P. (Eds.) (2002). *Identification of learning disabilities: Research to practice.* Mahwah, NJ: Lawrence Erlbaum.

Brazil, D., Coulthard, M., & Johns, C. (1980). *Discourse intonation and language teaching.* Essex, England : Longman Publishers.

Bretherton, L., & Holmes, V. M. (2003). The relationship between auditory temporal processing, phonemic awareness, and reading disability.*Journal of Experimental Child Psychology*, *84*, 218–243.

Brier, J. I., Fletcher, J. M., Foorman, B. R., Klaas, P., & Gray, L. C. (2003). Auditory temporal processing in children with specific reading disability with and without attention deficit/hyperactivity disorder. *Journal of Speech Language and Hearing Research*, *46*, 31–42.

Bullock, M. & Russell, J. A. (1984). Preschool children's interpretations of facial expressions of emotion. *International Journal of Behavioural Development*, 8, 1538.

Cacace, A. T., & McFarland, D. J. (1998). Central auditory processing disorder in school-aged children: A critical review. *Journal of Speech, Language, and Hearing Research*, *41*, 355–373.

Camras, L. A., & Allison, K. (1985). Children’s understanding of emotional facial expressions and verbal labels. *Journal of Nonverbal Behavior*, *9*, 84–94.

Capellini, S.A. (2007) *Neuropsycholinguistic perspectives on dyslexia and other learning disabilities*. New York: Nova Publishers.

(Central) Auditory Processing Disorders. Technical Report, (2005). *Working Group on Auditory Processing Disorders.*. American Speech-Language-Hearing Association.. Learning disorders at Dorland's Medical Dictionary

Charles Darwin (1871). *“The Descent of Man”*. Citing Johann Rudolph Rengger, Natural History of the Mammals of Paraguays. 49.

Chen L.S. (2000). Joint processing of audio-visual information for the recognition of emotional expressions in human-computer interaction. PhD thesis, University of Illinois at Urbana-Champaign, Dept. of Electrical Engineering.

Chiu C.C., Chang Y.L., and Lai Y.J. (1994) The analysis and recognition of human vocal emotions. In Proc. International Computer Symposium, pages 83–88.

Collignon O, Girard S, Gosselin F, Roy S, Saint-Amour D, Lassonde M, Lepore, F. (2008). Audio-visual integration of emotion expression. Brain Research. Nov 25; 1242:126-35. Epub 2008 Apr 20.

Cooper, R. P., & Aslin, R. N. (1990). Preference for infant directed speech in the first month after birth. *Child Development, 61,* 1584-1595.

Cowie R. and Douglas-Cowie E. (1996). Automatic statistical analysis of the signal and prosodic signs of emotion in speech. In Proc. International Conf. on Spoken Language Processing, pages 1989–1992.

Creusere, M, Alt, M., & Plante, E. (2004). Recognition of vocal and facial cues to affect in language-impaired and normally-developing preschoolers. *Journal of Communication Disorders, 37,* 5-20.

Crystal, D. (1981). *Clinical Linguistics*. New York: Springer- Verlag.

Cunningham, J., Nicol, T., Zecker, S. G., Bradlow, A., & Kraus, N. (2001). Neurobiologic responses to speech in noise in children with learning problems: Deficits and strategies for improvement. *Clinical Neurophysiology*, *112*, 758–767.

Dara C, Monetta L, Pell MD.(2008). Vocal emotion processing in Parkinson's disease: reduced sensitivity to negative emotions. *Brain Research* .;1188:100-11. Epub 2007 Oct 22.

Davis, M . H.(1996). Empathy:A Social Psychological Approach. Oxford:Westview Press.

Dawes P, Sirimanna T, Burton M, Vanniasegaram I, Tweedy F, Dorothy, B. V. (2009). Temporal auditory and visual motion processing of children diagnosed with auditory processing disorder and dyslexia. *Ear and Hearing. Dec;30(6)*:675-86.

Day, K. (1985). Psychiatric disorder in the middle aged and elderly mentally handicapped. *British Journal of Psychiatry*, *147*, 660-667.

Dellaert F., Polzin T., and Waibel A.(1996). Recognizing emotion in speech. In Proc. International Conf. on Spoken Language Processing, pages 1970–1973.

Dellaert, F., Polzin, T., Waibel, A. (1996) Recognizing emotion in speech. Spoken Language. ICSLP 96. Proceedings. Fourth International Conference on, Volume: 3, 3-6. Pages: 1970 - 1973 vol.3.

Denes, P. (1959). A preliminary investigation of certain aspects of intonation. *Language and Speech*, 2, 106-110.

De Silva, L. C., Miyasato, T., and Nakatsu, R. (1997) Facial Emotion Recognition Using Multimodal Information. In Proc. IEEE Int. Conf. on Information, Communications and Signal Processing (ICICS'97), Singapore, pp. 397-401.

Deva (1957). Psychophysics of speech melody. Cited in Manjula, R. (1979). Intonation in Kannada: Some aspects. An unpublished Masters dissertation, University of Mysore.

Devillers L. & Vasilescu I. & Vidrascu L. (2004). F0 and pause features analysis for Anger and Fear detection in real-life spoken dialogs. *Speech Prosody.*

Duffy, J.R. (1995). *Motor speech disorders: Substrates, differential diagnosis and management*. St. Louis: Mosby.

Ekman, P. (1992). ‘An Argument for Basic Emotions’, *Cognition and Emotion*. *6(3/4):* 169-200.

Ekman, P. & Davidson, R. J. (1994). ‘Affective Science: A Research Agenda’, in P. Ekman & R. J.Davidson (eds) The Nature of Emotion: Fundamental Questions, pp. 411-30. New York: Oxford University Press.

Ekman, P., & Friesen, W. V. (1975). Unmasking the face. Englewood Cliffs, NJ: Prentice Hall.

Ekman, P., & Friesen, W. V. (1976). Pictures of facial affect. Palo Alto, CA: Consulting Psychologists Press.

Emerson, P. (1977). Covert grief reactions in mentally retarded clients. *Mental Retardation*, *15*, 46-47.

Farmer, M. E., & Klein, R. (1995). The evidence for a temporal processing deficit linked to dyslexia: A review. *Psychonomic Bulletin & Review*, *2*, 460–493.

Fernald, A. (1985). Four-month-old infants prefer to listen to motherese. *Infant Behavior and Development, 8,* 181-195.

Fitzgerald, Michael; Corvin, Aiden (2001). "Diagnosis and differential diagnosis of Asperger syndrome". *Advances in Psychiatric Treatment* (The Royal College of Psychiatrists) 7: 310–318. ISSN 1472-1481.

Freeman, F.J. (1983). *Prosody in perception, production and pathologies.* In W.B. Saunders (Ed), Speech, language and hearing, Vol 2. Nwew Jersey.

Fujisaki, H. (1991). Modeling the generation process of F0 contours as manifestation of linguistic and paralinguistic information. Proceedings XIIth ICPhS, Aix-en-Provence, France, supplement, 1-10.

Fry, D.B. (1968). Prosodic phenomena. In B.Malmberg (Ed.), Manual of Phonetics. Amsterdam: North Holland Publishing Co.

Gioia JV, Brosgole L. (1988).*Visual and auditory affect recognition in singly diagnosed mentally retarded patients, mentally retarded patients with autism and normal young children.* International Journal Neurosciences*;* 43*:* 149–*63.*

Guruprasad, A. (2000) *Evaluation of central auditory processing disorders in children with learning disabilities*. (Unpublished Master's Thesis). Submitted to the University of Mysore, Mysore.

Gunter, R. (1975). *Intonation and relevance.* In D.Bolinger (Ed.), Intonation; Selected Readings. Middlesex , England; Penguin Books Ltd.

Gopal, K.V. & Kowalski J. (1999). Slope analysis if auditory brainstem responses in children at risk of central auditory processing disorders. *Scandanavian Audiology, 28*: 85-90.

Goswami, U., Thomson, J., Richardson, U., Stainthorp, R., Hughes, D., Rosen, S., et al. (2002). Amplitude envelope onsets and developmental dyslexia: A new hypothesis. Proc Natl Acad Sci U S A, 99(16), 10911-10916.

Hallahan, D., & Kauffman, J. (1994). *Exceptional children: Introduction to special education (6th edition).* Boston: Allyn and Bacon.

Hargrove, K.M., & McGarr, N.M. (1994). *Prosody management of communication disorders*. San Diego : Singular Publishing Group, Inc.

Harris, J. A. (1977). Emotion Recognition in Average and Below Average Intelligence Adults, unpublished Master's Thesis, Nashville,TE, George Peabody College.

Hart, J. 't, Collier, R., and Cohen, A. (1990). *A perceptual study of intonation*. Cambridge University Press, Cambridge.

Hayes, E., Tiippana, K., Nicol, T., Sams, M., & Kraus, N. (2003). Integration of heard and see speech: A factor in learning disabilities in children. *Neuroscience Letters*, *351*, 46–50.

Hayes, E. A., Warrier, C. M., Nicol, T. G., Zecker, S. G., & Kraus, N. (2003). Neural plasticity following auditory training in children with learning problems. *Clinical Neurophysiology*, *114*, 673–684.

Heikkinen, J. Jansson-Verkasalo, E., Toivanen, J., Suominen, K., Vayrynen, E., Moilanen, I., & Seppänen, T. (2010). Perception of basic emotions from speech prosody in adolescents with Asperger's syndrome. *Logopedics Phoniatrics Vocology, 35(3):*113-20.

Higuchi, N., Hirai T., and Sagisaka, Y. (1997). *"Effect of speaking style on parameters of fundamental frequency contour".* In: J. P. H. van Santen, R. W. Sproat, J. P. Olive, J. Hirschberg (Eds.) Progress in speech synthesis, Springer-Verslag, New-York, 417-428.

Herba, C. M., & Phillips, M. (2004). Annotation: Development of facial expression recognition from childhood to adolescence:Behavioural and neurological perspectives. *Journal of Child Psychology and Psychiatry, 45*, 1185–1198.

Hobson, R. P., Ouston, J. & Lee, A. (1989). 'Recognition of Emotion by Mentally Retarded Adolescents and Young Adults', *American Journal of Mental Retardation. 93* (4): 434-44.

Holder, H. B., & Kirkpatrick, S. W. (1991). Interpretation of emotion from facial expressions in children with and without learning disabilities. *Journal of Learning Disabilities, 24,* 170-177.

Hollins, S. and Esterhuyzen, A. (1997). Bereavement and grief in adults with learning disabilities. *British Journal of Psychiatry, 170,* 497-501.

Horley K, Reid A, Burnham D.J.(2010). Emotional prosody perception and production in dementia of the Alzheimer's type. *Speech Language and Hearing Research; (5):*1132-46. Epub 2010 Jul 19.

House, David (1994). *Perception and Production of Mood in Speech by Cochlear Implant Users*. International Conference on Spoken Language Processing (ICSLP)1994. Yokohama, Japan.

Iacobbo, M .L. (1978) 'Recognition of Facial Expressions by Retarded and Nonretarded Individuals Across the Life Span', Dissertation Abstracts 38: 08B.

Jean Berko Gleason (2001). *The Development of Language*. Allyn&Bacon.

Jerger, J., & Musiek, F. (2000). Report of the consensus conference on the diagnosis of auditory processing disorders in school-aged children. *Journal of the American Academy of Audiology, 11*, 467–474.

Johnson, K. L., Nicol, T. G., & Kraus, N. (2005). Brainstem response to speech: A biological marker of auditory processing. *Ear and Hearing*, *26*, 424–434.

Johnson, K. L., Nicol, T. G., Zecker, S. G., & Kraus, N. (2007). Auditory brainstem correlates of perceptual timing deficits. *Journal of Cognitive Neuroscience*, *19*, 376–385.

Johnstone T. (1996). Emotional speech elicited using computer games. In Proc. International Conf. on Spoken Language Processing, pages 1985–1988.

Karen S. R. (1995). Perception of emotional affordances by learning disabled students with and without visual-spatial deficits. *Psychology*, *56*, Issue: 3.

Karin Petrini, Frances Crabbe, Carol Sheridan, and Frank E. Pollick ,(2011). The Music of Your Emotions: Neural Substrates Involved in Detection of Emotional Correspondence between Auditory and Visual Music Actions. v.6 (4).

Keller, W.D., Tillery, K.L., & McFadden, S.L. (2006) Auditory Processing Disorder in Children Diagnosed With Nonverbal Learning Disability. *American Journal of Audiology*, *15*, 108-113.

King, C., Warrier, C. M., Hayes, E., & Kraus, N. (2002). Deficits in auditory brainstem encoding of speech sounds in children with learning problems. *Neuroscience Letters*, *319*, 111–115.

Kishan M.H 2007. Some aspects of temporal processing deficits in individual with learning disability. An unpublished Masters dissertation, University of Mysore.

Kirk, S. A. (1962). Educating Exceptional Children. Boston: Houghton Mifflin.

Knapp, M. L., & Hall, J. A. (2002). *Nonverbal Communication in Human Interaction*. Crawfordsville, IN: Thomson Learning.

Kujala, T. & Naatanen R. (2001). The mismatch negativity in evaluating central auditory dysfunction in dyslexia. *Neuroscience and Behavioral Reviews, 25,* 535-543.

Kurath, M. (1971). *A phonology and prosody of modern English*. Ann Arbor: University of Michigan Press.

Kraus, N., McGee, T. J., Carrell, T. D., Zecker, S. G., Nicol, T. G., & Koch, D. B. (1996). Auditory neurophysiologic responses and discrimination deficits in children with learning problems. *Science*, *273*, 971–973.

Kraus, N., & Nicol, T. (2005). Brainstem origins for cortical "what" and "where" pathways in the auditory system. *TRENDS in Neuroscience*, *28*, 176–181.

Ladefoged, P. (1967). *Language and Language learning series- Three areas of experimental phonetics*. London: oxford University Press.

Lado,R. (1961). *Language testing- the construction and use of foreign language tests*. Essex, England: longman Publications.

Lee C. M., Narayanan S.S. (2004). Towards detecting emotions in spoken dialogs. IEEE Trans. on Speech & Audio Processing, in press.

Lee, C. M., Yildirim, S., Bulut, M., Kazemzadeh A., Busso,C., Deng, Z., Lee, S., Narayanan, S.S. (2004). Emotion Recognition based on Phoneme Classes.

Lerner, J. (1993). *Learning disabilities: theory, diagnosis, and teaching strategies*. 5th edition. Boston, Mass: Houghton Miffin.

Lewis, H. (1998). *Body Language: A Guide for Professionals*. Thousand Oaks, CA: Sage

Liberman, P., & Michaels, S.B. (1962). Some aspects of fundamental frequency and envelope amplitude as related to the emotional context of speech. In

D.Bolinger (Ed.), Intonation; Selected Readings. Middlesex , England; Penguin Books Ltd.

Liscombe, J., Venditti, J., & Hirschberg, J. (2003). Classifying Subject Ratings of Emotional Speech Using Acoustic Features. 8th European Conference on Speech Communication and Technology, Geneva, Switzerland.

Lorenzi, C, Wable, L., Moroni, C, Derbert, C, & Belin, F. C. (2000). Auditory temporal envelope processing in a patient with left-hemisphere damage. *Neurocase. 6*.231-244.

Malik, S. (2009). Read more: http://www.articlesbase.com/learning-disabilities-articles/learning-disabilities-awareness-month 608010.html#ixzz1Nx8cWRGp

Manjula, R. (1979). Intonation in Kannada: Some aspects. An unpublished Masters dissertation, University of Mysore.

Marcell, M. M. & Jett, D. A. (1985). 'Identification of Vocally Expressed Emotions by Mentally Retarded and Nonretarded Individuals', *American Journal of Mental Deficiency. 89*: 537-45.

Matson, J. L. and Sevin, J. A. (1994). Theories of dual diagnosis in mental retardation. *Journal of Consulting and Clinical Psychology, 62*, 6 – 16.

McAlpine, C., Kendall, K. A. & Singh, N. N. (1991). 'Recognition of Facial Expressions of Emotion by Persons with Mental Retardation', *American Journal of Mental Retardation*. *96 (I):* 29-36.

McAnally, K. I., & Stein, J. F. (1996). Auditory temporal coding in dyslexia. *Proceedings of the National Academy of Sciences of the United States of America*, *263,* 961–965.

McFarland, D. J., & Cacace, A. T. (1995). Modality specificity as a criterion for diagnosing central auditory processing disorders.*American Journal of Audiology*, *4*, 36–48.

Mchugo, G. J., Smith, G. A. & Lanzetta, J. T. (1982). 'The Structure of SelfReports of Emotional Responses to Film Segments', *Motivation and Emotion*, *6 (4):* 365-85.

McLoughlin, I. (1986). Bereavement in the mentally handicapped. *British Journal of Hospital Medicine*, *36*, 256-260.

McKenzie K., Matheson E., McKaskie K., Hamilton L., Murray G.C. (2008). Impact of group training on emotion recognition in individuals with a learning disability. *British Journal of Learning Disbilities*. *Vol 28* Issue 4.

Mehrabian, Albert (1971). *Silent Messages* (1st ed.). Belmont, CA: Wadsworth.

Mody, M., Studert-Kennedy, M., & Brady, S. (1997). Speech perception deficits in poor readers: Auditory processing or phonological coding?*Journal of Experimental Child Psychology*, *64*, 199–231.

Moncrieff, D. W., & Musiek, F. E. (2002). Interaural asymmetries revealed by dichotic listening tests in normal and dyslexic children. *Journal of the American Academy of Audiology*, *13*, 428–437.

Monrad-Krohn, G.M. (1947). Dysprosody or altered melody of language. Cited in Ross, E.D. (1981). The aprosodias: Functional- Anotomic organisation of the affective components of language in the Right Hemisphere. *Archives of Neurology*, 38,561-570.

Morrison, R. L. & Bellack, A. S. (1981). ‘The Role of Social Perception in Social Skill’. *Behaviour Therapy* 12: 69-79.

Morton, J. B. & Trehub, S. E., (2001). Children’s understanding of emotion in speech. *Child Development, 72,* 834-843.

Most, T., Weisel, A., & Zaychik, A. (1993). “Auditory, Visual, and Auditory-Visual Identification of Emotions by Hearing and Hearing-Impaired Adolescents.” *British Journal of Audiology*, 27, 247-253.

Motley, M. T., & Camden, C. T. (1988). Facial expression of emotion: A comparison of posed expressions versus spontaneous expressions in an interpersonal communication setting. *Western Journal of Speech Communications, 52,* 1-22.

Mozziconacci, S. J. L. (1998). Speech variability and emotion: Production and perception. Ph.D. thesis, Technical University Eindhoven.

Murray I.R. and Arnott J.L. (1993) Toward the simulation of emotion in synthetic speech: A review of the literature of human vocal emotion. *Journal of the Acoustic Society of America*, 93(2):1097–1108.

Murray I.R. and Arnott J.L.. (1996). Synthesizing emotions in speech: Is it time to get excited? In Proc. International Conf. on Spoken Language Processing, pages 1816–1819.

Musiek, F. E. & Chermak, G. D. (Eds.). (2007). *Handbook of (central) auditory processing disorder: Diagnosis (Volume 1).* San Diego, CA: Plural Publishing.

Musiek, Frank; Gail, Chermak (2007). *Handbook of central auditory processing disorder [auditory neuroscience and diagnosis]*. Plural Publishing. pp. 448. ISBN 1597560561.

Nandini, M.M. (1985). Some prosodic aspects in Kannada. An unpublished Masters dissertation, University of Mysore.

Nataraja.N.P. (1982). Intonation in four Indian languages under five emotional conditions. *Journal of AIISH,* 12, 22-29.

National joint Committee on LD, (1988), Letter to NJCLD Member Organisation. Washington, DC: Author.

Nikolova, Z. T, Fellbrich, A., Born, J., Dengler, R., Schroder, C. (2011). Deficient recognition of emotional prosody in primary focal dystonia. *European Journal of Neurology*. *18(2):*329-36.

Nowicki, S. & Duke, M. P. (1994). Individual difference in the nonverbal communication of affect: The diagnostic analysis of nonverbal accuracy scale. *Journal of Nonverbal Behavior, 18,* 9-35.

Nowicki, S. & Mitchell, J. (1998). Accuracy in identifying affect in child and adult faces and voices and social competence in preschool children. *Genetic, Social, and General Psychology Monographs, 124,* 39-59.

Nwe, T. L., Wei, F. S., De Silva, L.C. (2001). Speech based emotion classification. Electrical and Electronic Technology, 2001.TENCON. Proceedings of IEEE Region 10 International Conference on, Volume: 1 , Pages: 297 - 301 vol.1

Osgood, C. E. (1952). 'The Nature and Measurement of Meaning'. *Psychological Bulletin, 49*: 172-237.

Oster, A.M., & Risberg, A. (1986). “The Identification of the Mood of a Speaker by Hearing Impaired Listeners.” *Quarterly Progress and Status Report (QPSR), 4,* 79-90.

Owen, A., Browning, M., Jones, R. S. P., (2001). Emotion recognition in adults with mild–moderate learning disabilities: An exploratory study. *Journal of Intellectual Disabilities*, *5*: 267.

Pant, K. (2001). Perception and Production of Emotive Intonation In Individuals With Right Hemisphere Damage. An unpublished Masters dissertation, University of Mysore.

Pantic, M., & Rothkrantz, L. J. K. (2003). Toward an affect-sensitive multimodal human–computer interaction. *Proceedings of the IEEE, 91*(9), 1370–1390

Parrott, W. (2001). Emotions in Social Psychology. *Psychology*, Philadelphia.

Paulmann, S. & Pell, M.D. (2009). Decoding facial expressions as a function of emotional meaning status: ERP evidence. *NeuroReport, 20,* 1603-1608.

Paulmann, S., Pell, M.D., Kotz, S.A. (2008). How aging affects the recognition of emotional speech. *Brain and Language*;104(3):262-9. Epub 2007 Apr 10.

Paulmann S, Kotz SA.(2008). Early emotional prosody perception based on different speaker voices. *Neuroreport*; 19(2):209-13.

Pearson J. E. (2010). Debunking the 55%, 38%, 7% Rule. La Trobe University. "(C)APD".

Petrushin, V. (1998) “How well can people and computers recognize emotions in speech?” in Proc. AAAI Fall Symposium, pp. 141–145.

Pereira, Ceclie (2000). “The Perception of Vocal Affect by Cochlear Implantees.” *Cochlear Implants 16J,* 343-345.

Phillips, D. P. (1995). Central auditory processing: A view from neuroscience. *American Journal of Otology*, *16*, 338–352.

Phillips, D. P., & Farmer, M. E. (1990). Acquired word deafness and the temporal grain of sound discrimination in the primary auditory cortex.*Behavioral Brain Research*, *40*, 85–94.

Picard, R. W., Vyzas, E., & Healey, J. (2001). Toward machine emotional intelligence: analysis of affective physiological state. *IEEE Transactions on Pattern Analysis and Machine Intelligence,* 23(10), 1175–1191.

Pike, K.L. (1945). General characteristics of intonation. In D.Bolinger (Ed.), Intonation; Selected Readings. Middlesex , England; Penguin Books Ltd.

Purdy, S. C., Kelly, A. S., & Davies, M. G. (2002). Auditory brainstem response, middle latency response, and late cortical evoked potentials in children with learning disabilities. *Journal of the American Academy of Audiology*, *13,* 367–382.

Ramaa, S. (2000).Two decades of research on learning disabilities in India. *Dyslexia,* 6(4):268-283.

Ramus, F. (2003). "Developmental dyslexia: specific phonological deficit or general sensorimotor dysfunction?” *Current Opinion in Neurobiology 13 (2):* 212–8.

Rathan, N., Nataraja, N.P., & Samuel, G. (1976). Identification of context based on intonation of test sentences. A paper presented in the Indian Speech and Hearing Association Conference, 1976.

Rathna, N., Nataraja, N.P., & Subramanyaiah,. (1982). A study of prosodic aspects of Kannada language. *Journal of AIISH*, *12*, 1-6.

Reed, J. and Clements, J. (1989). Assessing the understanding of emotional states in a population of adolescents and young adults with mental handicaps. *Journal of Mental Deficiency Research*, *33,* 229-233.

Renée Bradley; Louis C. Danielson; Daniel P. Hallahan (2002). *Identification of learning disabilities: research to practice*. "National Research Centre on Learning Disabilities (NRCLD)".

Rojahn, J., Kroeger, T. L. & Mcelwain, D. C. (1995a) 'Psychometric Properties and Preliminary Norms of the Penn Facial Discrimination Task in Adults with Mental Retardation'. *Journal of Developmental and Physical Disabilities, 7 (4):* 285-301.

Rojahn, J., Lederer, M. and Tasse, M. J. (1995b). Facial emotion recognition by persons with mental retardation: A review of the experimental literature. *Research in Developmental Disabilities*. *16*, 393-414.

Rojahn, J.,Raybould, D. & Schneider, F. (1995c). 'Emotion Specificity in Mental Retardation'. *American Journal of Mental Retardation, 99*: 477-86.

Rosen, S. (2003). Auditory processing in dyslexia and specific language impairment: Is there a deficit? What is its nature? Does it explain anything? *Journal of Phonetics*, *31*, 509–527.

Ross, E.D., & Duffy, R.J. (1973). Contribution of the lower audible frequencies to the recognition of emotion. Cited in Ross, E.D. (1981). The aprosodias:

Functional- Anatomic organization of the affective components of language in the Right Hemisphere. *Archives of Neurology*, *38*, 561-570.

Roux P, Christophe A, Passerieux C. (2010). The emotional paradox: dissociation between explicit and implicit processing of emotional prosody in schizophrenia. *Neuropsychologia*. *48*(*12):*3642-9. Epub 2010 Aug 27.

Roy, D., Pentland, A. (1996). Automatic spoken affect classification and analysis. Automatic Face and Gesture Recognition, Proceedings of the Second International Conference. Pages: 363 – 367.

Russell, J. A. (1980). 'A Circumplex Model of Affect', *Journal of Personality and Social Psychology 39*: 1161-78.

Russell, J. A. & Mehrabian, A. (1977). 'Evidence for a Three-Factor Theory of Emotion'. *Journal of Research in Personality, 11*: 179-83.

Russo, N., Nicol, T., Musacchia, G., & Kraus, N. (2004). Brainstem responses to speech syllables. *Clinical Neurophysiology*,*115*, 2021–2030.

Ryalls J., Joanette Y., Feldman L.(1987). An acoustic comparison of normal and right-hemisphere-damaged speech prosody. *Cortex*; 23(4):685-94.

Sagisaka, Y. Campbell, N. and Higuchi, N. (1997). *Computing Prosody: Computational Models for Processing Spontaneous Speech*, Springer, New York.

Sato J. and Morishima S. (1996) Emotion modeling in speech production using emotion space. In Proc. IEEE Int. Workshop on Robot and Human Communication, pages 472–477.

Scherer, K.R. (1981). Speech and emotional states. In J. K. Darby (Ed.), Speech evaluation in psychiatry (pp. 189-220). New York: Grune & Stratton.

Scherer, K.R. (1982). Methods of Research on Vocal Communication Paradigms and Parameters. In Scherer, K.R., Ekman, P.E. (Eds.) *Handbook of Methods in Nonverbal Behavior Research.* Cambridge: Cambridge University Press, 136-198.

Scherer, K.R. (1986). Vocal Affect Expression: A Review and a Model for Future Research. *Psychological Bulletin, 99*, 143-165.

Scherer, K.R. (1992). Vocal Affect Expression as Symptom, Symbol, and Appeal. In: Papousek, H., Jurgens, U, Papousek, M. (Eds.) *Nonverbal Vocal Communication*. Cambridge: Cambridge University Press, 43-60.

Scherer K.R. (1996) Adding the affective dimension: A new look in speech analysis and synthesis. In Proc. International Conf. on Spoken Language Processing, pages 1808– 1811.

Schulte-Korne, G., Deimel, W., Bartling, J., & Remschmidt, H. (1999). The role of phonological awareness, speech perception, and auditory temporal processing for dyslexia. *European Child & Adolescent Psychiatry, 8*, 28–34.

Semrud-Clikeman M, Walkowiak J, Wilkinson A, Minne E.P. (2010). Direct and indirect measures of social perception, behavior, and emotional functioning in children with Asperger's disorder, nonverbal learning disability, or ADHD. *Journal of Abnormal Child Psychology; 38(4):*509-19.

Sharma, M., Purdy, S. C., Newall, P., Wheldall, K., Beaman, R., & Dillon, H. (2006). Electrophysiological and behavioral evidence of auditory processing deficits in children with reading disorder. *Clinical Neurophysiology, 117*, 1130–1144.

Shattuck-Hufnagel, S., & Turk, A. E. (1996). A prosody tutorial for investigators of auditory sentence processing. *Journal of Psycholinguistic Research*, *25*, 193–247.

Siegman, A.W., & Feldstein, S. (1987). Nonverbal *Behavior and Communication.* Hillsdale, New Jersey: Lawrence Erlbaum.

Siegwart, H., and Scherer, K. R. (1995). "Acoustic concomitants of emotional expression in operatic singing: the case of Lucia in Ardi gli incensi," *Journal of Voice*, 9 (3), 249-260.

Snowling MJ. (2000). Dyslexia Oxford*:* Blackwell.

Song, J. H., Banai, K., Russo, N. M., & Kraus, N. (2006). On the relationship between speech- and nonspeech-evoked auditory brainstem responses. *Audiology Neurotology*, *11*, 233–241.

Sylvie J.L. Mozziconacci. (2000) The expression of emotion considered in the framework of an intonation model. *Speech and emotion,* sep 5-7.

Tallal, P. (1977) Auditory perception, phonics and reading disabilities in children. *Journal of Acoustical Society of American, 62,* S100-S100.

Tallal, P. (1980). Auditory temporal perception, phonics, and reading disabilities in children. *Brain and Language, 9,* 182–198.

Tallal, P., Stark, R., Kallman, C., & Mellits, D. (1981). A reexamination of some nonverbal perceptual abilities of language-impaired and normal children as a function of age and sensory modality. *Journal of Speech and Hearing. Research, 24, 351–357.*

Tallal, P., Miller, S., Fitch, R. (1993) Neurobiological Basis of Speech: A case for the Preeminence of Temporal Processing, In: Temporal Information Processing in the Nervous System: Special Reference to Dyslexiaand Dysphasia, P. Tallal, A. M. Galaburda, R. R. Llinas and C. von Euler (Eds), Annals of the New York Academy of Sciences, v. 682, pp. 27-47.

Trainor, L. J., Austin, C. M., & Desjardins, R. N. (2000). Is infant-directed speech prosody a result of the vocal expression of emotion? *Psychological Science*,*11*, 188-195.

Walker, M. M., Givens, G. D., Cranford, J. L., Holbert, D., & Walker, L. (2006). Auditory pattern recognition and brief tone discrimination of children with reading disorders. *Journal of Communication Disorders*, *39*, 442–455.

Warrier, C. M., Johnson, K. L., Hayes, E. A., Nicol, T., & Kraus, N. (2004). Learning impaired children exhibit timing deficits and training-related improvements in auditory cortical responses to speech in noise. *Experimental Brain Research*, *157*, 431–441.

Watson, B. U., & Miller, T. K. (1993). Auditory perception, phonological processing, and reading ability/disability. *Journal of Speech and Hearing Research*, *36*, 850–863.

Watson, C. A., & Kidd, G. R. (2002). On the lack of association between basic auditory abilities, speech processing, and other cognitive skills. *Seminars in Hearing*, *23*, 83–93.

Welsh, L. W., Welsh, J. J., & Healy, M. P. (1980). Central auditory testing and dyslexia. *Laryngoscope*, *90*, 972–984.

Werker, J. F., & McLeod, P. J. (1989). Infant preference for both male and female infant directed talk: A developmental study of attentional and affective responsiveness. *Canadian Journal of Psychology, 43*, 230-246.

Wible, B., Nicol, T., & Kraus, N. (2005). Correlation between brainstem and cortical auditory processes in normal and language-impaired children. *Brain*, *128*, 417–423.

Widen, S. C., & Russell, J. A. (2003). A closer look at preschoolers' freely produced labels for facial expressions. *Developmental Psychology*, *39*, 114–128.

Williams, C.E., & Stevens, K.N. (1972). Emotions and Speech; Some acoustical correlates. *Journal of Acoustical Society of America*, 52, 1238-1250.

Wood, Margaret P., Kroese, Stenfert B.. (2007). Enhancing the Emotion Recognition Skills of Individuals with Learning Disabilities: A Review of the Literature. *Journal of Applied Research in Intellectual Disabilities*, v20 n6 p576-579.

World Health Organization (1992). *The ICD-10 Classification of Mental and Behavioral Disorders*. Geneva: WHO.

Yildirim, S., Bulut, M., Lee, C., Kazemzadeh, A., Busso, C., Deng, Z., Lee, S., and Narayanan, S. (2004). An acoustic study of emotions expressed in speech. In 8th International Conference on Spoken Language Processing (ICSLP 04), Jeju Island, Korea.

Yuan, Jiahong, Liqin Shen, Fangxin Chen. (2002). The acoustic realization of anger, fear, joy and sadness in Chinese. ICSLP.

Ziegler, J., Pech-Georgel, C., George, F., & Lorenzi, C. (2009). Speech perception in noise deficits in dyslexia. *Developmental Science*, *12*, 732–745.

Appendix A

Sr No.	Happy 	Sad 	Angry 	Fear 	Surprise 
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					

Appendix B

Perception task

Semantically Loaded Sentences.

HAPPY

1. I feel so glad of being a part of the team.
2. The show ended with their joyful reunion.
3. We were so merry all the way home.
4. I was overjoyed when I saw him after days.
5. I'm just feeling really great.

SAD

1. I was upset to give him my toy.
2. I'm sorry; I seem to have lost it.
3. I'm unhappy with the decision.
4. I feel really depressed about what happened.
5. The movie had such an unhappy ending.

FEAR

1. I am afraid of failing in exams.
2. He was horrified seeing the movie.
3. I am scared of loud noise.
4. He was frightened after seeing the injection.
5. It was dreadful to see the bad man.

ANGRY

1. He got annoyed with the noise children made.
2. She got mad when he spilled colours on the painting.
3. Grandmother scolded Rima for wasting food.
4. Gardener shouted at the children for stealing mangoes.
5. He was furious when he lost his book.

SURPRISE

1. I was amazed to see her in my house.
2. I was shocked when my name was announced for the award.
3. Suddenly she was chosen the leader.
4. Children were amazed seeing the teacher's drawing.
5. The teacher suddenly came to the class.

Semantically Neutral Sentences

HAPPY

1. We had a nice time at the party.
2. This is a perfect dress.
3. I have three box of ice cream.
4. Mom will take me to the zoo today.
5. I got a new puppy today.

SAD

1. They cut down the tree next door.
2. I cannot be with my mom on her birthday.
3. I was stuck in the traffic for over 2 hours.
4. He cannot walk any more.
5. They did not get any birthday gifts.

FEAR

1. I heard the door creak in the middle of the night.
2. I woke up with a snake by my side.
3. I was stuck in the lift when the current went off.
4. A lion appeared out of nowhere.
5. He tried to push me from the second floor.

ANGRY

1. He hurt my little brother.
2. Get out of my house!!
3. She ate all my chocolates.
4. He spoiled my new painting.
5. He hit me for nothing.

SURPRISE

1. All the animals started roaring in the zoo.
2. He jumped from the 3^{rd} floor.

3. Is such a big car yours?

4. Does he know you so well?

5. Is she really my dance partner?

Imitation Task

Semantically Loaded Sentences

HAPPY

1. We would be glad to hear from you.

1. I'm finally feeling good about being here.

2. She was full of joy after receiving the gift.

3. It was a very joyful celebration.

4. We spent a very enjoyable evening.

SAD

1. I'm sorry to disappoint you.

2. I'm very sorry to hear that you failed.

3. I get depressed seeing poor people.

4. I'm upset with your work.

5. I will forever regret about not being in the team.

FEAR

1. I am scared of the strange noise.

2. We were afraid at the sound of crackers.

3. Rohan is scared to go to the doctor.

4. She was scared to see the big snake.

5. Going to that haunted house was a nightmare.

ANGRY

1. Neighbour was outraged when children broke his window.
2. Teacher was shouting at the children.
3. She got mad when he pulled her hair.
4. Father shouted at the child.
5. Dog was mad when its bone was taken away.

SURPRISE

1. It was really unexpected to get the award
2. She suddenly stood in front of me from nowhere.
3. I was amazed to see the gifts I received.
4. I was shocked when I stood 1st in class.
5. All were amazed to see the magic.

Semantically Neutral Sentences

HAPPY

1. I got a big chocolate.
2. It's my parent’s 25th anniversary.
3. I finished my homework.
4. Mom has prepared my favourite dish.
5. Papa gave me a new watch.

SAD

1. I lost my favourite teddy bear.
2. I had to give him a refund.
3. He has no money to buy food.
4. She never saw her family again.
5. No one survived the flood.

FEAR

1. It was pitch dark when I got there.
2. The bomb is going to go off any moment.
3. I was locked up in the room when the lights went off.
4. There was a snake near my feet.
5. A cow came running in our playground.

ANGRY

1. You made me late again.
2. Stop kicking sand in my face.
3. My blood boils at the thought.
4. My neighbour throws his trash in front of my house.
5. I lost the game because of a small mistake.

SURPRISE

1. All the animals woke up in the museum.
2. You sang so well!!

3. What a beautiful flower!!
4. Has he really come?
5. Can't believe you are still studying??

Spontaneous Production task

Semantically Loaded Sentences

HAPPY

1. I am glad you came home today.
2. I'm overjoyed after talking to my friend.
3. I always feel good preparing projects.
4. I attended a joyful gathering last night.
5. I feel good being his friend.

SAD

1. I'm sorry that you lost your cycle.
2. We are unhappy about the cancelled plan.
3. I'm upset for making such a mistake.
4. I am very sorry I can't come for the party.
5. I'm sorry to interrupt the flow of the class.

FEAR

1. I am afraid of dogs.
2. I am scared of the new toy.
3. We are afraid to go in the big old house.

4. I'm scared of my uncle.
5. Everyone was scared on seeing their parents.

ANGRY

1. I was furious so I went back home.
2. She was annoyed when her dress was spoilt.
3. Teacher scolded us when we were making noise.
4. He was shouting when his books were stolen.
5. Teacher got mad at the students.

SURPRISE

1. He was amazed when he actually won the prize.
2. He was totally shocked seeing the painting.
3. I was shocked to see such a big tomato.
4. I was shocked to know he is in town.
5. Getting that award was very sudden.

Semantically Neutral Sentences

HAPPY

1. It's my 10^{th} birthday today.
2. The cake is delicious.
3. I love pizza.
4. Mom got me a new dress.
5. I have two tickets to the cricket match.

SAD

1. I lost my purse.
2. There is no holidays this year.
3. I didn't get the prize.
4. I can’t go to the movies.
5. He had to work late night.

FEAR

1. I saw a shadow in the bushes.
2. A shark appeared when I was swimming.
3. A scream came out of the empty house.
4. A big rat fell in front of me.
5. The branch on which I was sitting broke.

ANGRY

1. He lost my favourite book.
2. She pulled my hair.
3. This is the 4th time the bus is late.
4. He made me do all the work.
5. Kathy won’t let me look at the book.

SURPRISE

1. You finished your home work so fast.
2. You want to go home so early.
3. Can’t believe you drew this picture.
4. Sachin Tendulkar is coming to our school.
5. Is he really out of the team.