

The Speech Prosody Tests: A Narrative Review

Fatemeh Fekar-Gharamaleki¹, Nasrin Dardani², Seyyedeh Maryam Khoddami³, Shohreh Jalayi⁴

Review Article

Abstract

Introduction: Speech prosody is one of the important communication components that describes the paralinguistic features of speech. The tests are suitable tools for quantifying speech and language skills, and of necessary needs for evaluation, screening, describing, diagnosis, and treatment of various aspects. The purpose of present study was to review existing tests in speech prosody recognition, as well as their subtests, implementation and scorings, and ultimately their application in clinical and research fields of children and adults.

Materials and Methods: An electronic search for reviewing common speech prosody tests was performed in Web of Science, PubMed, Scopus, Medline, Scientific Information Database (SID), Google Scholar, Ovid, and Magiran databases to obtain relevant articles published from 1981 to 2019. The keywords used included “Prosody”, “Assessment”, “Test”, “Tool”, “Evaluation”, “Diagnosis”, “Instrument”, and “Measurement”. The articles obtained using the inclusion criteria were studied following as access to the full text of the article and the English or Persian language. From 15 articles found, 8 tests that were adhered to the inclusion criteria were selected for consideration.

Results: 8 speech prosody tests were evaluated which included 5 perceptual tests, 2 expressive tests, and 1 perceptual expressive test. The oldest test was made in 1981, and the latest in 2012.

Conclusion: The literature review shows that some tests have been used more often in recent years due to the specialized expertise of the subtests. A review of speech tests suggests that the Profiling Elements of Prosody in Speech-Communication (PEPS-C) test is more prestigious due to the assessment of perceptual and expression areas, standardization for normal and disabled children, translation into several languages, and high psychometric properties.

Keywords: Test; Speech prosody; Psychometric properties

Citation: Fekar-Gharamaleki F, Dardani N, Khoddami SM, Jalayi S. **The Speech Prosody Tests: A Narrative Review.** J Res Rehabil Sci 2019; 15(1): 58-64.

Received: 04.02.2019

Accepted: 11.03.2019

Published: 04.04.2019

Introduction

Prosody is derived from the Greek word Prosodia, which refers to the rhythm and sound used in poetry. Prosody is one of the important components in communication and is a set of changes in the rhythm and stress of speech which describes the prosodic characteristics of the speech signal and affects the meaning of the message (1). Researchers have considered various functions for prosody at the linguistic and paralinguistic levels that can be categorized into three areas: grammar, function, and emotion-affection. In addition, prosody interacts with other aspects of speech including sound, production, grammar, and vocabulary (1-4). Many of the accepted evidence in infants indicates that prosodic awareness

is the basis of language skills (1,5). Problems in different aspects of prosody are observed in speech and language, which must be carefully evaluated. Given that prosody is one of the most important aspects of speech and language skills, especially in recent years, and through which it is possible to plan a suitable treatment program for speech and language disorders; this area needs to be studied more extensively (1,5).

Contrary to many efforts made by David Crystal in the 1980s and before and after his studies on the area of prosody, prosodic skills have been less well studied in comparison to other aspects of speech and language, and are still a complex subject for speech-language pathologists (1). Instrumental and

1- Instructor, Department of Speech Therapy, School of Rehabilitation Sciences, Tabriz University of Medical Sciences, Tabriz, Iran

2- Department of Speech Therapy, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran

3- Assistant Professor, Department of Speech Therapy, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran

4- Assistant Professor, Department of Physiotherapy, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran

Corresponding Author: Fatemeh Fekar-Gharamaleki, Email: slp.fekar@yahoo.com

perceptual assessment methods are used to evaluate the prosodic skills. Some of the prosodic abilities are provided by the use of acoustic components such as fundamental frequency, acoustic energy, intensity or loudness of sound, and duration of sounds (5), but each of the methods of evaluation of prosody is along with limitations and so far no acceptable method has been presented to specifically evaluate prosody (1,6).

Given the above, one of the most important aspects in evaluation is the study of prosodic skills, through which a suitable treatment program can be designed for the complete treatment of speech and language disorders. Since no study has been conducted to collect and describe speech prosody tests, the present study was conducted with the aim to examine more details about the tests and compare them with each other in order for the increased awareness and easier access for researchers and therapists. Therefore, recognizing existing tests, in addition to increasing awareness and insight, can be used in clinical and research areas in children and adults.

Materials and Methods

This review study was carried out on common prosody tests. To do this, electronic searches were carried out on Web of Science, PubMed, Scopus, MEDLINE, Google Scholar, and Ovid databases in the period of 1982 to 2019. The aim of the study was to collect the existing tests, subtests, implementation methods, scoring, and their application. The search process was performed in two general steps. To achieve a comprehensive list of the prosody tests, a wide search was conducted in the above-mentioned databases using the keyword "Prosody", along with at least one of the words "Assessment, Instrument, Test, Tool, Evaluation, Diagnosis, Measurement". If the above keywords were used in the title, abstract, or keywords sections, the articles would be included in the study. To find out which tests had been translated in Iran and the validity and reliability of which had been confirmed, the SID and Magiran databases were searched with the Persian keywords with the English equivalents of "Tool, Diagnosis, Test, Evaluation and Measurement of Prosody". Thus, a list of prosody tests was extracted, and from a total of 15 research and review articles extracted, 8 tests that met the inclusion criteria, were selected. The inclusion criteria included access to the full text of the article to introduce the test and studies published in English or Persian language. The articles presented at conferences were not considered. In the second step, which was performed with the aim of searching for more complete information, using the name of the test

along with at least one of the words "Accuracy, Reliability, Validity", the above databases were referred to again and the articles containing these words in the title, abstract, or keywords were included in the review. To prevent bias, the articles were extracted by two independent researchers, and if the articles were not included, the reason was mentioned. In cases where there was a disagreement between the two researchers, the article was reviewed by a third party.

Results

After searching various databases, 8 tests were found in this field and then the detailed information of the tests was extracted. The search for this information included the name of the test, the author(s), the publisher, the year of publication, the age range of the test, and the implementation time. The tests are summarized below.

Tennessee Test of Rhythm and Intonation Patterns (T-TRIP): This test consists of 3 sections and 25 subsections that assess the prosody imitation skills. The test sections are expressed by the speakers in the form of meaningless syllables /ma/ with different prosodic patterns and syllable lengths. In the execution process, the examiner expresses each syllable twice and the child imitates it twice, and after recording the sound, the best imitation in terms of accuracy is judged by the examiner. The answer is correct when the stress, speed, and number of syllables are produced correctly, and the answer is considered incorrect when the stimulus is produced incorrectly, and finally, the subject's answer is phonetically examined. The acoustic components in each item are analyzed using the Praat software, and the highest and lowest frequencies, frequency ranges, and duration of syllables are specified and the total score is reported as a percentage (7).

The T-TRIP test is sensitive to differences between different ages. In other words, the results of scores of the 5-year-old children were significantly better than those of the 3-year-old ones. The intra-rater and inter-rater reliability were different for the acoustic components; so that the intra-rater and inter-rater reliability were respectively 85-100% and 73-99%, but the reliability of the intonation was reported weak (7).

Prosody Profile (PROP): This test is the first perceptual assessment method that examines the expressive skills, including pitch, loudness, speech speed, pause, and rhythm, and was developed by Crystal for children and adults in 1982. The PROP test is part of the language proficiency profile and the

oldest test related to the prosody expression, in which a sample of conversational speech is recorded and phonetically investigated, and an agreement is reached. In this test, the melodic phrase is used as the basic unit of prosodic analysis, and it takes a long time to describe prosodic and vocal skills (8).

The test includes age range, manual, and examples of prosody pathology. Although the PROP test has a domestic validity due to its assignments, there is no standard data and reliability data reported for it (1,8). In other words, it has not been officially standardized and only provides some normative information (8).

Voice Assessment Protocol (VAP): This test was first designed in 1987 as a protocol for assessing vocal disorders in children and adults in English. VAP helps speech therapists in the decision-making process regarding sound features. In other words, its main purpose is primarily to identify sound disorders, and evaluating the sound of speech is only part of this analysis. This test is used for sound, neurological, and stuttering disorders and is applicable to individuals aged 8-18 years old. The test prosody section is easy to perform and analyze, and is suitable for a comprehensive evaluation of five components, including "pitch, loudness, respiratory quality, speed, and rhythm". The test uses a variety of tasks, such as vowel lengthening, conversation, and spontaneous speech. The VAP test lacks computer scoring, but the handbook helps the examiner identify the presence or absence of prosodic problems (9).

There is no detailed information on the implementation and scoring method, and the timing of the test varies from person to person. Moreover, no psychometric information has been reported for the test so far.

Prosody Voice Screening Profile (PVSP): This test is a diagnostic method for perceptual evaluation of prosody and sound in the age range of 3 to 81 years and measures only expressive prosodic skills. Using this test, Shriberg et al. evaluated four aspects of sound and three aspects of prosody during sample speech conversations (10). In the PVSP test, the sample speech conversations are recorded and scored with 31 codes about the person's use of prosody. The test uses the cut-off point scores and takes 25 minutes to complete. Acoustic analysis includes the phrasing, speed, stress, duration, pitch, loudness, and the quality of phonation and resonance, which are analyzed in Praat software (10).

The reference data of the PVSP test for comparison of phonemes has been taken from the speech sample of 252 normal 3-19 year old children with speech developmental disorder, but it does not

have standard samples and does not show appropriate age scores. The formal, content, reference, concurrent, and conceptual validity of this test has been confirmed. The reference validity was obtained for four areas of speed, stress, pitch, and quality as 71-84% and for four areas of phrasing, stress, loudness, and quality, an appropriate concurrent validity and internal reliability coefficient were reported (10).

Florida Affect Battery (FAB): This test was designed by Blonder et al. in 1990 to assess the perception of prosodic emotions and faces with a variety of tasks in adults over 17 years of age with neurological and psychiatric disorders (11). The FAB test consists of 10 subtests and 5 subtests of facial expressions, 4 subtests of prosody, and 2 subtests of face mimic-prosody matching. The FAB does not have an expressive part and is a test for functional assessment of pathology that is mostly used for aphasic assessment sets such as Western Aphasia Battery (WAB) and Boston Diagnostic Aphasia Examination (BDAE) as well as for subjects with neurological disorders such as Alzheimer's disease (12). The method of performance and scoring of this test is similar to the prosody comprehension test in Persian. If the answer to the task is correct, score 1 and if the answer is incorrect, the score zero is assigned, but accurate information about the answer correctness is not available and its execution takes 60 minutes (11).

Since 1998, normative data have been collected from about 164 healthy individuals in the age range of 17-85 years. The FAB test has been standardized for different age groups of 8 to 80 years with neurological disorders, with the pre- and post-test reliability reported to be 89 to 97% (11).

Profiling Elements of Prosodic Systems (PEPS): This test was designed in 1998 by Peppe, which differed from the version used for children (PEPS-Children or PEPS-C), but based on the preliminary studies, it is suitable for both groups of children and adults and in other words, for all people over 4 years old. The tasks related to this test measure prosody by the individual's ability to identify compound nouns and noun phrases that differ only in the stress, pitch, and pause features (1). The PEPS test consists of four subtests, the data of which was not available due to the unavailability of the article (13-16). In 1994, the test was standardized on 90 English-speaking people in South Britain with ages 18-52 years old. It is also used for adults with aphasia (14).

Another version of the PEPS test that is used for children 14-5 years old, especially children with autism, is PEPS-C, which is a comprehensive method

for assessing the prosody comprehension and expression skills. The test, which has been designed based on the psycholinguistics model, consists of four subtests in the form of 12 tasks that simultaneously evaluate the perception and expression skills at both the form and application levels, and well demonstrate the relationship between language skills and prosody. The test takes 60-40 minutes, which can be performed by a trained therapist or teacher. The tester examines the individual's responses using a computer and by providing auditory and visual stimuli. In the expressive part, the examiner judges the expressive skills as well or poor without seeing the visual stimulus, and in the perceptual part, the scoring is performed as correct or incorrect. For the expressive part, the stimuli should be culturally appropriate and easily pronounced. The test scoring is conducted automatically and errors are well described. This feature helps the tester to describe the child's performance and compare the score of each person with the scores of the control group (14).

The PEPS-C test was standardized on 80 children aged 5-14 years old between 1995 and 1997. Additionally, in 1998-1999, it was standardized on 180 children with autism, speech impairment, specific language impairment (SLI), hearing loss, and stuttering, and its pre- and post-test reliability was reported to be appropriate. The adult and children version of this scale was performed on English-speaking people and its children version is used in the United States. In addition to English, other versions of the PEPS-C test have been prepared in various languages, including Spanish, French, Norwegian, Dutch, and more recently, the Persian version (17) and it is available in English language in Southern English, Scottish, and North American and Australian dialects (14-16).

Swedish Prosodic Assessment: This test was designed by Samuelsson et al. to examine the language skills of children in Swedish at the word, phrase, and speech levels with 12 subtests. The subtests of the word level include segmental phonology, non-word repetition, vowel lengthening, stress, and word tonal accent. At the phrasal level, there are 4 subtests, 3 of which are related to stress and 1 is specific to questions. At the speech level, there are two subsets related to conversation and storytelling. In this test, various strategies such as direct questioning, sentence completion, and pattern presentation are used to stimulate target structures at the word and phrase levels. All parts of the test except the subtests of conversation and storytelling are described using the subtle phonetics method, but these two subtests are

described by the orthographic method. The test implementation takes about an hour and the scoring is performed very accurately. The child gets a score with each correct production. The total scores of children vary from 31 to 68 and the average score is 56.9. The overall score of the test showed a significant relationship with grammar and language comprehension skills (18).

This comprehensive, valid, and reliable test was designed in Swedish and standardized on 41 children aged 4.4-10 years and its validity and reliability have been reported at a reasonable level. In addition, the internal consistency using Cronbach's alpha coefficient was approximately 79% and the inter-rater reliability for the whole test was 0.75, and 96.1% for some subtests alone (18,19).

Speech prosody comprehension test: is the only comprehension assessment test designed by Torke Ladani et al. following the model implemented in the prosody part of the FAB test in Persian-speaking adults and is used for the 18-60 year old age group. The test consists of four subtests, including "(non-emotional) and emotional prosodic distinction, naming prosody, and naming contradictions". The prosodic distinction, emotional distinction, naming prosody, and naming contradictions sections include 8 pairs of sentences, 16 pairs of sentences, 32 sentences with eight different tones, and 36 sentences, respectively. The scoring method is similar to the FAB test, and if the answer is correct, the task is given a score of 1, and if the answer is incorrect, it is given a score of zero (20).

The speech prosody comprehension test is of a high reliability for the age group of 18 to 30 years and is a valid diagnostic tool for a variety of speech, language, and psychological disorders, with the reliability confirmed on 32 normal people in the age range of 18 and 60 years old. The scale has a content validity of 100%, concurrent reliability of 94%, and correlation coefficient of 89% (20).

Discussion

The objective in this study was to collect and comparatively review the prosody tests so that the reader could more easily access the information of the test needed. Prosody represents paralingual indicators and is one of the signs of social interaction in conversation (5,21-25). Collection, classification, and expression of the features, advantages and limitations of the tests were also considered in the present study. The present review study can be helpful in providing a comprehensive view of the speech prosody tests including the assignments used, target community,

areas of evaluation, performance or grading, etc. for readers and is a good source for familiarity with the most widely used and important tests.

Recent assessments of prosody problems emphasize the simultaneous use of instrumental and perceptual methods. The perceptual screening process, along with instrumental technologies, is required for diagnostic evaluations, research projects, and clinical interventions (20). In the perceptual assessments such as T-TRIP, PVSP, PROP, PEPS, and PEPS-C, the tester's judgment is very important in the test result. Among the prosody tests, PROP is the oldest test designed in 1982. All of these tests have been designed to test comprehension and expression skills. In other words, T-TRIP, PVSP, PROP, VAP, and Swedish Prosodic Assessment tests are employed to assess expression skills, FAB and speech prosody comprehension tests for perceptual skills, and the PEPS-C test for comprehension-perceptual skills (6-14). Most prosody tests are used for assessing expressive skills using multiple assignments. For example, in the PROP test, the conversational speech samples are used, in the VAP test, the vowel lengthening and conversational and automatic speech tasks are utilized, in the PVSP test, the conversational speech is used, and in the T-TRIP test, the syllable imitation procedure is employed (20). The PVSP, PROP, and PEPS-C tests evaluate speech prosody by recording a speech sample, and the examiner can score it (1). The diversity of the analysis protocols is one of the disadvantages of speech analysis and require an expert and speaker specialized in that language. Furthermore, since the content of speech varies from person to person, it makes it harder to compare the referents. These tests have a high environmental validity due to the use of speech samples despite such disadvantages (1). The PVSP and PROP tests are utilized to assess the level of expression (26,27).

Each assessment test is accompanied by advantages and disadvantages, each of which may be selected depending on the goals and conditions of the referents. Although none of the tests introduced are standard, there are norms for the PEPS-C, PVSP, and FAB tests. The T-TRIP and PEPS tests are sensitive to differences between different ages, but no studies have been accomplished on other tests (5). The PROP and PVSP tests are not standard. The speech prosody comprehension test, Swedish Prosodic Assessment, and T-TRIP tests have high validity and reliability and PROP test benefits from domestic validity. The advantages of the PVSP test include the use of the cut-off point scores. The PEPS-C test has many strengths, including categorizing the prosody into

distinct and meaningful groups and allows the examiner to determine if the person has a general problem in understanding and expressing speech prosody in communication, and whether if he has problems in a wide range of communication, or his problems only relate to prosody. Additionally, this test shows the severity of the difference or disorder well and reduces the limitations of previous assessments of prosody such as the time required for analysis (28-30). An important point in the PEPS-C test is the evaluation of prosody in two areas of perception and expression, which is also used for children with high-functioning autism and Down's syndrome and Williams syndrome. Another advantage of PEPS-C is the use of this test in English and six other languages (17).

Limitations

One of the limitations of the present study was the lack of access to the full text of some of the speech prosody tests.

Recommendations

Considering the results of the present study and the need to pay attention to prosody in various disorders, in order to give more importance to this area and achieve better evaluation and treatment outcomes, it is suggested that the tests required in evaluating prosody at different age levels and languages be translated into Persian and their validity and reliability be determined and used. Speech-language pathologists (SLPs) can use the findings of the present study as a source to make knowledge of these tests.

Conclusion

Recently, significant advances have been made in identifying the neurological and causal foundations of prosody disorders, as well as the relationship between prosody and other aspects of speech and language. Preparing and collecting these tests is the first step towards describing and examining problems associated with prosody. Investigating the relevant articles, it is revealed that some tests have been used more in recent years for various reasons such as ease of implementation, appropriate psychometric information, and age range, and the tests that were more comprehensive were more used in articles and have more research value. Examination of the tests indicated that the PEPS-C test was more acceptable due to the evaluation of comprehension-expression areas, standardization for normal and disabled children, translation into several languages, and high psychometric characteristics.

Acknowledgments

All the researchers whose tests were used in the present study are appreciated.

Authors' Contribution

Fatemeh Fekar-Gharamaleki: Study design and ideation, financial resources, support, executive, and scientific services of the study, providing study equipment and samples, data collection, analysis and interpretation of results, specialized statistics services, manuscript preparation, specialized evaluation of the manuscript in terms of scientific concepts, confirmation of the final manuscript to be sent to the journal office, responsibility for maintaining the integrity of the study process from beginning to publication, and responding to the referees' comments; Nasrin Dardani: financial resources, support, executive, and scientific services of the study, providing study equipment and samples, data collection, manuscript preparation, specialized evaluation of the manuscript in terms of scientific concepts, confirmation of the final manuscript to be sent to the journal office; Seyyedeh Maryam Khoddami: Study design and ideation, financial resources, support, executive, and scientific services of the study, manuscript preparation, confirmation of

the final manuscript to be sent to the journal office; Shohreh Jalayi: financial resources, support, executive, and scientific services of the study, specialized statistics services, confirmation of the final manuscript to be sent to the journal office.

Funding

The financial resources of Tabriz University of Medical Sciences, Tabriz, Iran have been used to perform the article.

Conflict of Interest

The authors declare no conflict of interests. Fatemeh Fekar-Gharamaleki conducted the basic studies related to this project and has been working as an instructor at Tabriz University of Medical Sciences since 2016. Nasrin Dardani is a graduate student of speech therapy from Tehran University of Medical Sciences, Tehran, Iran. Dr. Seyyedeh Maryam Khoddami is an Assistant Professor, Department of Speech Therapy, School of Rehabilitation, Tehran University of Medical Sciences and Dr. Shohreh Jalayi is an Assistant Professor, Department of Physiotherapy, School of Rehabilitation, Tehran University of Medical Sciences.

References

1. Peppe S. Why is prosody in speech-language pathology so difficult? *Int J Speech Lang Pathol* 2009; 11(4): 258-71.
2. Raphael LJ, Borden GJ, Harris KS. *Speech science primer: Physiology, acoustics, and perception of speech*. Philadelphia, PA: Lippincott Williams and Wilkins; 2007.
3. Yorkston K M, Hakel M, Beukelman DR, Fager S. Evidence for effectiveness of treatment of loudness, rate, or prosody in dysarthria: a systematic review. *J Med Speech Lang Pathol* 2007; 15(2): xi-xxxvi.
4. Fletcher J. The prosody of speech: Timing and rhythm. In: Hardcastle WJ, Laver J, Gibbon FE, editors. *The handbook of phonetic sciences*. 2nd ed. Hoboken, NJ: Wiley; 2010. p. 521-602.
5. Fekar Gharamaleki F, Shahbodaghi MR, Jahan A, Jalayi S. Investigation of acoustic characteristics of speech motor control in children who stutter and children who do not stutter. *J Rehabil* 2016; 17(3): 232-243. [In Persian].
6. Martinez-Castilla P, Peppe S. Developing a test of prosodic ability for speakers of Iberian Spanish. *Speech Commun* 2008; 50(11-12): 900-15.
7. Koike KJ, Asp CW. Tennessee Test of rhythm and intonation patterns. *J Speech Hear Disord* 1981; 46(1): 81-7.
8. Crystal D. *Profiling linguistic disability*. San Diego, CA: Singular Pub. Group; 1992.
9. Pindzola RH. *VAP, a voice assessment protocol for children and adults*. Austin, Tex.: Pro-ed; 1987.
10. Shriberg LD, Kwiatkowski J, Rasmussen C. *Prosody-voice screening Profile (PVSP): Scoring forms and training materials*. Tucson, AZ: Communication Skill Builders; 1990.
11. Blonder L, Bowers D, Heilman K. *Florida Affect Battery*. Gainesville, FL: Center for Neuropsychological Studies, Department of Neurology; 1998.
12. Mirahadi SS, Khatoonabadi SA, Fekar Gharamaleki F. A review of divided attention dysfunction in Alzheimer's disease. *Middle East J Rehabil Health Stud* 2018; 5(3): e64738.
13. Richmond VP, McCroskey JC. *Nonverbal behavior in interpersonal relations*. Boston, MA: Allyn and Bacon; 1995.
14. Peppe S, McCann J. Assessing intonation and prosody in children with atypical language development: the PEPS-C test and the revised version. *Clin Linguist Phon* 2003; 17(4-5): 345-54.
15. Peppe S, McCann J, Gibbon F, O'Hare A, Rutherford M. Assessing prosodic and pragmatic ability in children with high-functioning autism. *J Pragmat* 2006; 38(10): 1776-91.
16. Peppe S, McCann J, Gibbon F, O'Hare A, Rutherford M. Receptive and expressive prosodic ability in children with high-functioning autism. *J Speech Lang Hear Res* 2007; 50(4): 1015-28.
17. Ghorbani E, Khoddami SM, Soleymani Z, Jalaie S, Khodadadi M. Cross-cultural adaptation of profiling elements of prosody

- in speech communication: Validity and reliability in Persian. *Modern Journal of Language Teaching Methods* 2017; 7(4): 410-21.
18. Samuelsson C, Scocco C, Nettelbladt U. Towards assessment of prosodic abilities in Swedish children with language impairment. *Logoped Phoniatr Vocol* 2003; 28(4): 156-66.
 19. Samuelsson C, Nettelbladt U. Prosodic problems in Swedish children with language impairment: Towards a classification of subgroups. *Int J Lang Commun Disord* 2004; 39(3): 325-44.
 20. Torke Ladani N, Agharasouli Z, Ashayeri H, Mahmoudi Bakhtiyari B, Kamali M, Ziatabar Ahmadi SZ. Development, validity and reliability of the speech prosody comprehension test. *Audiology* 2012; 21(1): 69-75. [In Persian].
 21. Ostendorfy M, Shafranz I, Bates R. Prosody models for conversational speech recognition. *Proceedings of the 2nd Plenary Meeting and Symposium on Prosody and Speech Processing* 2003; 147-154.
 22. Regenbogen C, Schneider DA, Finkelmeyer A, Kohn N, Derntl B, Kellermann T, et al. The differential contribution of facial expressions, prosody, and speech content to empathy. *Cogn Emot* 2012; 26(6): 995-1014.
 23. Tseng SC. Grammar, prosody and speech disfluencies in spoken dialogues [Thesis]. Bielefeld, Germany: Bielefeld University; 1999.
 24. O'Shaughnessy, D. Relationships between syntax and prosody for speech synthesis. In *Proceedings of the ESCA tutorial day on speech synthesis* 1990; 39-42.
 25. Cutler A, Dahan D, van Donselaar W. Prosody in the comprehension of spoken language: A literature review. *Lang Speech* 1997; 40(Pt 2): 141-201.
 26. Diehl JJ, Paul R. The assessment and treatment of prosodic disorders and neurological theories of prosody. *Int J Speech Lang Pathol* 2009; 11(4): 287-92.
 27. Rodriguez RH. Acoustic and perceptual comparisons of imitative prosody in kindergartners with and without speech disorders [MSc Thesis]. Tampa, FL: University of South Florida; 1998.
 28. Munhall KG, Jones JA, Callan DE, Kuratate T, Vatikiotis-Bateson E. Visual prosody and speech intelligibility: Head movement improves auditory speech perception. *Psychol Sci* 2004; 15(2): 133-7.
 29. Pell MD. Cerebral mechanisms for understanding emotional prosody in speech. *Brain Lang* 2006; 96(2): 221-34.
 30. Thompson WF, Schellenberg EG, Husain G. Perceiving prosody in speech. Effects of music lessons. *Ann N Y Acad Sci* 2003; 999: 530-2.