INTONATION IN HEBREW-SPEAKING CHILDREN WITH HIGH-FUNCTIONING AUTISM: A CASE STUDY

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ABSTRACT

This paper presents a case study which describes, compares and contrasts the prosodic features of the intonation of two children diagnosed with High-Functioning Autism (HFA) with two children without developmental disorders (WDD), matched for age, school grade and academic achievements. They were all male monolingual speakers of Modern Hebrew. Three prominent components of prosody (intonation units, simple pitch accents and edge tones) were examined in two elicitations tasks (spontaneous speech and reading-aloud). The data were transcribed and described using the Autosegmental-Metrical (AM) theory and the results were analyzed and explained according to the theory of Phonology as Human Behavior (PHB).

Keywords: Intonation, Autism, Phonology as Human Behavior.

1. INTRODUCTION

Prosody plays an important role in diverse communicative functions that enables speakers to construct discourse through expressive language. In spite of the abundant documentation that indicates that prosody is a feature of impaired communication in Autism Spectrum Disorders (ASD) (e.g. [11], [12], [4], [5], [17], [22]), the research of prosody in ASD is limited and has been criticized for:
(a) being severely fragmented, (b) lacking normative data and contrast groups, (c) using poorly defined prosodic categories and (d) employing subjective ratings rather than objective measures [17].

There is general agreement that when atypical prosody is present, it tends to be persistent and show little change over time, even when other aspects of language improve [12], [20]. For those with High-Functioning Autism (HFA), prosody can be one of the main barriers to social acceptance [21].

McCann and Peppé [15], claim that research in the prosody of autism has concentrated on disordered stress patterns described as being excessive, equal or misplaced [4], [14], [3], [9], [21]. Other findings [9], [23] point out that autistic children use grammatical pausing in a way similar to typically developing children. Baltaxe [2] found that the children with autism did not have a significantly different frequency range from the typically developing children but produced either very narrow or very wide frequency ranges. These findings suggest that the mean of the frequency ranges does not adequately capture the atypical nature of intonation in children with autism [15].

At present research into prosody does not provide a full description and explanation for the unusual and odd-sounding prosody produced by many individuals with autism.

2. METHODOLOGY

2.1. RESEARCH OBJECTIVES

We used the phonological approach to intonation -- the Autosegmental-Metrical (AM) theory [18] in order to provide a unified transcription and description of intonation. The results were analyzed and explained according to: (a) the definition that language is a symbolic tool whose structure is shaped both by its communication function and by the characteristics of its users [24], and (b) the principle that language represents a compromise in the struggle to achieve maximum communication through minimal effort as presented in the theory of Phonology as Human Behavior (PHB) [7], [8], [25].

2.2. SUBJECTS

The participants were four children: two children Without Developmental Disorders (WDD) (9:08, 12:09) and two children diagnosed with HFA (9:11, 12:10). The high IQ of the HFA subjects allowed us to select a control group matched for chronological age. The inclusion criteria for the

HFA subjects were (a) diagnosis of DSM-IV [1] for Autistic disorder, (b) tests by an educational psychologist that found them to be within the norm according to their chronological age, both in their performance and verbal IQ and (c) typical language and reading performance in the mainstream class.

The inclusion criteria for the control group were (a) children without developmental disorders, (b) being in the same home classes as the HFA subjects and (c) academic achievements similar to the HFA subjects. All participants were male, monolingual speakers of Modern Hebrew.

2.3. RESEARCH QUESTIONS

Our study addressed the following questions: (1) Is it possible to further distinguish the intonation contours of children with HFA versus children WDD? (2) Will different elicitation tasks influence the intonation of HFA and WDD children and if so, in what way? (3) Will it be possible to explain the results according to the principles of the PHB theory?

2.4. PROCEDURES

The data were gathered from read aloud (RA) and spontaneous speech (SS) elicitation tasks. Each child participated in an introductory meeting followed by a session where language samples were collected:

(1) RA: each subject read a short story considered to be appropriate to the age grade. We analyzed ten sentences of the story: seven complex declarative sentences (181 words) and three simple WH questions (12 words).

(2) SS: natural language samples were collected during interaction between the children and the researcher in response to the question: "I want to get to know you better. Is that OK with you?" After receiving a positive reply, directed, open questions were asked about the school environment and hobbies. The goal was to produce a fluent narrative, preferably a monologue or a series of monologues, from the child. We analyzed the first five minutes of each participant. Meetings took place in the child's room with only the researcher and the child present.

2.4.1. Preparation of material

Three procedures were taken before the actual analyses of the data:

(1) digitalization of the acoustic material: All the language samples were recorded directly onto a laptop computer using Audacity, a software package for recording and editing sound files. The recording was done at a sample rate of 44.1 KHz and at a bit depth of 16 bits.

(2) transcriptions were divided into (a) phonetic transcriptions of the spoken speech segments and (b) prosodic transcriptions of Intonation Units (IUs), simple Phrase Accents (PAs) and Edge Tones (ETs). This step included the division of the data into "large units". The "large unit" for RA is the *sentence*, and the "large unit" for SS is the *turn* which includes everything said by one interlocutor until the second starts to speak.

(3) division of the "large unit" into IUs following the commonly used procedure of parsing an utterance into IUs delimited by their boundaries [6]. Therefore we chose the following working criteria for dividing sentences and utterances into IUs: (a) Perceptual Segmentation (how the hearer judges the units within the fluent narrative) and (b) pitch reset or pauses (using acoustic reanalysis with PRAAT software [19]).

3. RESULTS

The results compare the intonation components of the HFA and WDD groups. In each elicitation task we compare and contrast IUs, PAs and ETs.

3.1. THE *RA* ELICITATION TASK

Using PRAAT we analyzed the IUs, PAs and the tonal events at the edge of prosodic domains (ETs) according to the AM theory.

Intonation Units: The HFA subjects generally produce more IUs than the WDD subjects. When compared with peers of the same age, differences within the HFA subjects were observed: the younger HFA subject produced more IUs than his WDD peer (Case I), while the older subject showed a very similar quantity of IUs (Case II).

Pitch Accents: The HFA subjects produced 22.5% more PAs than the WDD control group. One HFA subject produced 22.6% while the other HFA subject produced 21.6% more PAs than the WDD controls. Differences were also found in the kinds of PAs. All subjects produced the high PA (H*) more frequently, but the HFA participants showed a greater use of H*, as well as a dissimilarity in their use within the group. The use of H* by the two HFA subjects was 70.0% and 81.2% of the total, while the WDD children

produced only 64.2% and 66.1% of H* respectively.

Edge Tones: The corpus contained 169 IUs of which 162 were analyzed. 7 IUs were excluded because the visibility of the ET was unclear or absent. The distribution of the IUs was: Case I - 86 IUs including 8 WH questions and Case II – 76 including 10 WH questions. The results indicate that for all subjects the most frequent use of ETs is a contour pattern of L% final. For declarative sentences, the HFA and the WDD use almost the same patterns at the end of the sentences (H*L¯L%, L*L¯L%): i.e. 79% of the ETs were similar, except that they showed a preponderance of H* (similar to the PA component). HFA have 7% more L% final than their peers. With regard to the ETs patterns in the RA task, the WDD subjects exhibit more similar contour patterns (58.2% and 62.7%) of L% final while the HFA participants exhibit dissimilar patterns. One subject with HFA produced 53.9% of L% final which is more similar to the contour patterns of the control subjects and the other HFA subject used a L% final in 83.7% of his IUs boundaries, far more than all the others. These differences in the falling pattern are even more prevalent when we compare the two groups: In Case-I, the WDD subject has 62.7% of final lowering, and the HFA subject has 53.9%. In Case-II the WDD subject showed 58.2% of final lowering and the HFA subject 83.7%. Comparing the contour patterns, the HFA participants used more final lowering patterns than the WDD controls but with less diversity. In short, the HFA subjects have the same patterns as the WDD controls, but use only two to three favored patterns at the end of IUs (H*L¯L%, L*L¯L% and H*L¯H% in Case I and H*L¯L% and H*H¯L% in Case II).

3.2. THE *SS* ELICITATION TASK

Intonation Units**:** Both groups produced almost the same amount of IUs in five minutes of SS.

Pitch Accents**:** The HFA subjects produced more PAs than the WDD controls with a greater use of H*. The SS analysis of H* by the two HFA subjects was 75.6% and 79.5% of the total number. Differences between the two HFA subjects were smaller, when compared with the RA elicitation task. The PAs of the WDD subjects show that the use of H* is 64.4% and 64.3% and hence similar to the RA elicitation task.

Edge Tones**:** The most frequent use of boundary tones at the ET is a contour pattern of L% final for both groups. Comparing the WDD controls with the HFA subjects, the WDD controls are more similar (58.2% and 62.7%) for L% final while the HFA subjects exhibit dissimilarity. While one HFA subject has 53.9% of L% final and is more similar to the WDD controls, the other uses a L% final in 83.7% of his IU tones boundaries. Comparing the matched cases, the differences are more pronounced. In Case I, while the WDD subject has 62.7% of final lowering, his HFA peer has 53.9%. In Case II the WDD subject produces 58.2% of final lowering and his HFA peer produces 83.7%. When considering the ETs in the contour pattern at the end of the IU, we observed again that the HFA subjects use the final lowering pattern more than the WDD controls with less diversify in their use. For both groups the contour pattern of H* L¯L% at the edge of prosodic domain was the most frequent one.

4. DISCUSSION

Pitch contour differences were found between the HFA subjects and the WDD control group. The HFA subjects produced more IUs than the control group in the RA elicitation task but almost the same number of IUs in the SS elicitation task. The results in the two elicitation tasks showed a similar tendency except that in SS the characteristics were more pronounced. The HFA subjects produced more H* and within the group there is a greater variation than in the control group.

If the causes of the variation in intonation are *differences* in the kinds of PA and *transitions* between the prominent components, then when the prominence exists in a more frequent single PA and there are consequently fewer transitions, a *monotonous accent* is created.

The HFA children exhibited a limited repertoire of prosodic ET patterns within the norm of the language. These patterns are repeatedly used both in the RA and in the SS elicitation tasks. The prosodic patterns found in the control group, showed a greater number and a larger degree of variation for the same tasks.

Both the *monotonous accent* and the *repetitiveness* of ETs produced by the HFA subjects create a stiff sounding prosody.

For the purpose of explaining the results, we use the principles of the theory of PHB [24],[25], and consequently emphasize the traits of Autism. ASD has been defined as a triad of impairments in: (1) reciprocal social interaction, (2) verbal and

non-verbal communication and (3) restricted, stereotyped and repetitive behaviors [1].

In our opinion, the restricted and repetitive use of H* and a limited number of repeated ETs, represents the combination of impairments in communication *and* behavior, i.e. the behavioral impairment of autism influences the linguistic structure of intonation as well as other non-linguistic behaviors.

With regard to communication in ASD, most studies have shown that the prime difficulty is in the area of pragmatic ability (e.g. [15], [17]). In our case studies we found that although the research group primarily use three different contour patterns, they do make limited use of all the other kinds of patterns found in the control group. Our conclusion is that the problem is in the *use* of the range of the available patterns and not their absence. Therefore, the effort required by HFA subjects while attempting to achieve maximum communication is curbed by the "human factor" that attempts to reduce the effort to a minimum.

The result of reducing the effort is the limited use of the intonation components. This leads to the conclusion that the deficit in prosodic features of intonation is the "cost" of the impairment which many HFA subjects pay.

5. REFERENCES

[1] American Psychiatric Association. 1994. *Diagnostic and Statistical Manual of Mental Disorders*, (4th ed.). Washington, DC: Author.

[2] Baltaxe, C. 1984. The use of contrastive stress in normal, aphasic and autistic children. *Journal of Speech and Hearing Research* 27, 97-105.

[3] Baltaxe, C., Guthrie D. 1987. The use of primary sentence stress by normal, aphasic and autistic children. *Journal of Autism and Developmental Disorders* 17(2), 255-271.

[4] Baltaxe, C., Simmons J. 1985. Prosodic development in normal and autistic children. In Schopler, E., Mesibov, G., (eds), *Communication Problems in Autism*. New York: Plenum, 95-125.

[5] Baltaxe, C., Simmons, J. 1992. A comparison of language issues in high-functioning autism and related disorders with onset in childhood and adolescence. In Schopler, E., Mesibov, G., (eds), *High-Functioning Individuals with Autism*. New York: Plenum, 201-225.

[6] Cruttenden, A. 1986. *Intonation.* Cambridge Textbooks in Linguistics.: Cambridge University Press.

[7] Diver, W. 1979. Phonology as human behavior. In D. Aaronson, D., Reiber, P (eds) *Psycholinguistic Research: Implications and Applications*, Hillside NJ: L. Erlbaum.161-186.

[8] Diver, W. 1995. Theory. In Contini-Morava, E, Sussman-Goldberg, B., (eds.), *Meaning as Explanation: Advances in Linguistic Sign Theory*, Berlin/New York: Mouton-De Gruyter, 45-113.

[9] Fine, J., Bartolucci, G., Ginsberg, G., Szatmari, P. 1991. The use of intonation to communicate in pervasive developmental disorders. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 32, 771-782.

[10] Fujisaki, H. 1997. Prosody, models, spontaneous speech. In Sagisaka, Y., Campbell, N., Higuchi, N. *Computing Prosody: Computational Models For Processing Spontaneous Speech.* New York, Springer. 27-42.

[11] Kanner, L. 1946. Irrelevant and metaphorical language. *American Journal of Psychiatry* 103, 242-246.

[12] Kanner, L. 1971. Follow-up of eleven autistic children, originally reported in 1943. *Journal of Autism and Childhood Schizophrenia* 2, 119-145.

[13] Kent, R., Read, C. 1992. The acoustic analysis of speech. San Diego. Singular Publishing Group.

[14] McCaleb, P. and Prizant, B. 1985. Encoding of new versus old information by autistic children. *Journal of speech and Hearing Disorders* 50, 226-230.

[15] McCann, J., Peppé, S. 2003. Prosody in autism spectrum disorder: A critical review. *International Journal of Language and Communication Disorders* 38, 325-350.

[16] Panagos, J., Perlock, P. 1997. Prosodic analysis of child speech. *Topics in Language Disorders* 17, 1-10.

[17] Paul, R., Augustyn A., Klin, A., Volmar , F. 2005. Perception and production of prosody by speakers with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders* 35, 205-220.

[18] Pierrehumbert, J. 1980. The Phonology and Phonetics of English Intonation. MIT. Ph. D. Dissertation.

[19] PRAAT: doing phonetics by computer. http://www.fon.hum.uva.nl/praat visited 5-Jan-05

[20] Simmons, J., Baltaxe, C. 1975. Language patterns in adolescent autistics. *Journal of Autism and Childhood Schizophrenia* 5, 333-351.

[21] Shriberg, L. D., Paul, R., McSweeny, J. L., Klin, A., 2001. Speech and prosody characteristics of Adolescents and Adult with High-Functioning Autism and Asperger Syndrome. *Journal of Speech, Language and Hearing Research* 44, 1097-1115.

[22] Tager-Flusberg, H. 1981b. On the nature of linguistic functioning in early infantile autism. *Journal of Autism and Developmental Disorders* 11, 45-56.

[23] Thurber, C., Tager-Flusberg, H. 1993. Pauses in the narratives produced by autistic, mentally retarded, and normal children as an index of cognitive demand. *Journal of Autism and Developmental disorders* 23(2), 309-322.

[24] Tobin, Y. 1990. *Semiotics and Linguistics.* London/New York: Longman.

[25] Tobin, Y. 1997. *Phonology as Human Behavior: Theoretical Implications and Clinical Applications*. Durham, NC/London: Duke University Press.