Intonation Patterns in Normal, Autistic and Aphasic Children

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1. Introduction

Current knowledge of prosody and language disordered children remains limited. Studies with normal children show that *first*, early in language acquisition, prosodic development is more advanced than phonological, syntactic, and semantic development. Early prosodic units seem to fulfill a facilitative function perceptually and productively and to constitute 'frames' for other units of language (Bruner, 1975). *Second*, these early prosodic 'frames' appear to be more stable than the segmental dimensions accompanying the prosodic contours (Menn, 1979). *Third*, there is some evidence that control of fundamental frequency develops first, timing second and segmental contrasts last (Allen and Hawkins, 1980). *Fourth*, children's knowledge of the prosodic system is interdependent with their knowledge of other levels of language and may not reach adult refinement until about the age of twelve (Cutler and Swinney, 1980). Prosody may also be an important variable in children with development disorders of language. When prosody is impaired, its facilitative function may be disturbed, affecting other levels of language. Conversely, when phonological, syntactic, semantic or pragmatic development is delayed or disturbed, prosody may also be affected.

2. Experiment

The present study examined the intonation contours in normal, autistic, and aphasic children. The subjects consisted of six normal, five autistic, and six aphasic children, matched as closely as possible for socio-economic class, sex, and mean length of utterances as a measure of psycho-linguistic age (MLU for all groups: 1.45 to 4.46 morphemes). The children ranged in age between 2-0 and 4-0 years for the normal subjects, 4-6 and 12-2 years for the autistics and 4-5 to 12-2 years for the aphasics. Simple, neutral, declarative utterances of the subject-verb-object variety, produced spontaneously under controlled conditions, were examined for the prosodic characteristics and markers listed below. These markers were chosen because they seemed to capture important aspects of the intonation contour and to provide a useful basis for comparison among the groups.

1. *Frequency range*, used to express the intonation contour of the utterances studied;

Table I. Percentage of occurrence for expected markers of intonation contour for simple declaratives in normal, aphasic, and autistic children (group results)

	Numbers of utterances	P_1		P_2		P_3		Terminal fall	Declin. effect		Covariations
		F_0	I	F_0	I	F_0	I	F_0	F_0	I	F_0/I
Normals	N = 38	32	30	26	25	33	37	34	15	14	26
	100%	84%	79%	68%	66%	87%	97%	89%	39%	37%	68%
Autistics	N = 47	31	33	21	21	43	42	36	5	6	16
	100%	66%	70%	45%	45%	91%	89%	76%	11%	13%	34%
Aphasics	N = 43	14 (31)	31 (33)	22	13	23	25	31	17	12	11
	100%	45%	94%	51%	30%	53%	58%	72%	39%	28%	25%

P_1 = Peak$_1$ (subject), P_2 = Peak$_2$ (verb), P_3 = Peak$_3$ (object); F_0 = peak fundamental frequency; I = peak intensity.

2. *terminal fall*, generally associated with the declarative mode in Standard English (O'Shaughnessy, 1979);
3. *intonation contour of the utterance* as characterized by a series of pitch obtrusions expected on the stressed vowels of the utterance in subject-verb-object positions (Martin, 1982);
4. *declination effect* or the tendency of pitch to drift downward over the declarative intonation group (Cooper and Sorenson, 1981);
5. *covariation of frequency and intensity* over the declarative intonation contour (Lieberman, 1967).

The utterances analyzed were processed from an Ampex tape-recorder through a fundamental frequency and intensity meter and an Oscillomink. Results were based on acoustic measurements of Oscillomink tracings, consisting of duplex oscillogram, fundamental frequency, intensity, waveform, and timemarking. Fundamental frequency range was determined by further statistical analysis. Terminal fall, intonation contour, declination, and covariation of frequency and intensity were reported in percentages of actual occurrence of these markers in expected positions (Table I - group results). Five Hz was chosen as the minimum necessary difference to identify the existence of the above markers for speakers with a narrow frequency range. Table II provides mean and standard deviations of values of peak F_0 (Hz) to illustrate declination effect for each of the three key stressed syllables (P1,P2,P3) for each individual subject. Examples of prosodic contours for each subject group are presented in Figure 1.

Table II. Declination effect. Mean and standard deviations of values of peak F_0 (Hz) for each of three key stressed syllables in simple declaratives (S-V-O) in normal, aphasic and autistic children

	Subjects	P_1 (F_0)		P_2 (F_0)		P_3 (F_0)	
		X	S.D.	X	S.D.	X	S.D.
Normals	Subj. 1	248	94.1	230	86.4	232	91.2
	Subj. 2	249	96	232	95	333	132
	Subj. 3	170	147	165	143	167	145
	Subj. 4	257	110	215	79	212	83
	Subj. 5	214	144	195	130	192	129
	Subj. 6	198	111	178	101	170	97
Autistics	Subj. 1	298.1	96.2	252.2	87.2	277.2	99
	Subj. 2	232.5	77	205	70.9	211.1	74.6
	Subj. 3	313.5	115	267	102.7	257.6	166.79
	Subj. 4	208.5	93.88	205.7	91.0	248.7	110
	Subj. 5	217.2	82.5	201.2	81.6	204.4	77.15
Aphasics	Subj. 1	251.6	111.99	262.5	83.89	243.3	77.73
	Subj. 2	256	226.78	200	173	176	153
	Subj. 3	176	72.2	175	77.6	171.6	70.5
	Subj. 4	266	149	244	143.6	280	166.7
	Subj. 5	208	67.5	206	67.4	200	67.0

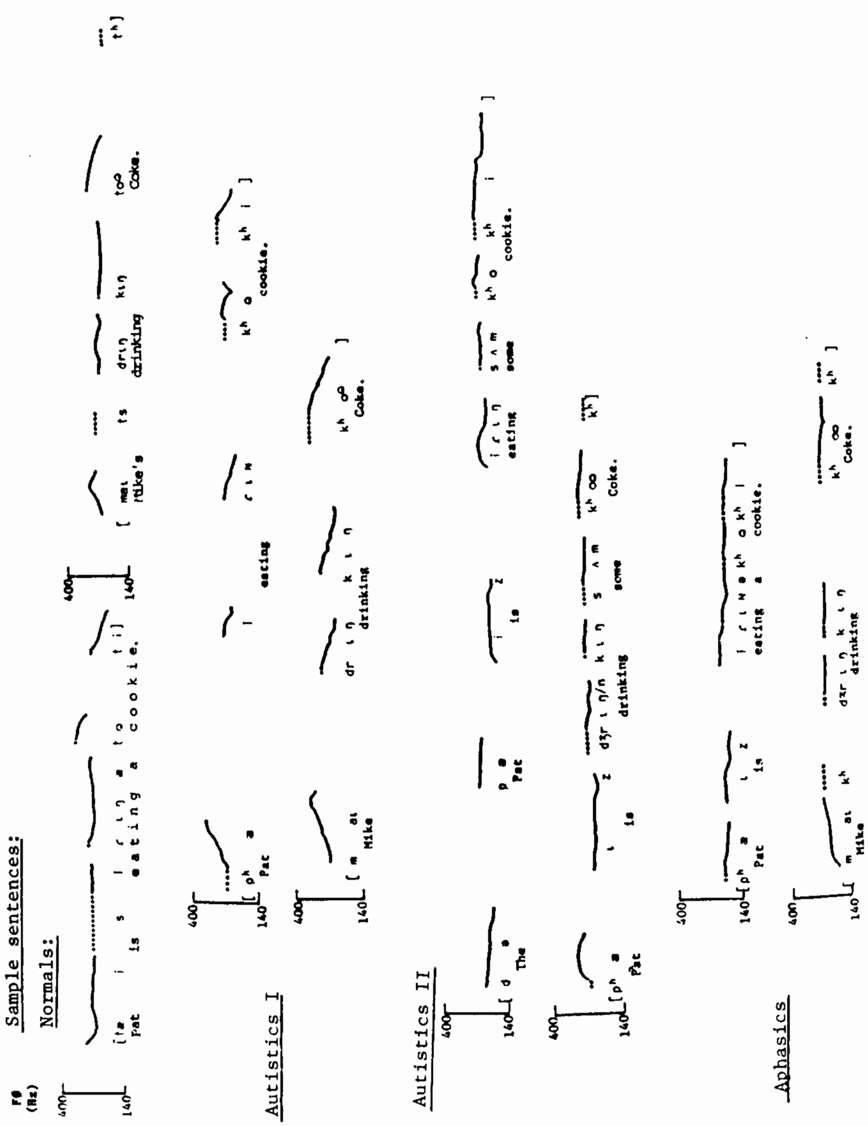

Figure 1. Sample of sentences of normal, autistic and aphasic children.

3. Results

3.1. Frequency range

A comparison of the fundamental frequency ranges across the three groups showed that the normals had the greatest range (122.67 Hz, SD 63.63), followed by the autistics (96.79 Hz, SD 24.78) and then the aphasics (69.69 Hz, SD 25.26). Differences between normals and aphasics, and autistics and aphasics were significant at the .005 level. Frequency ranges for individual

autistic subjects were either highly exaggerated or very narrow. Subjects with a narrow range were not significantly different from the aphasics.

3.2. Terminal fall.

Terminal fall occurred with the highest percentage for the normals, followed by the autistics, and then the aphasics. Individual profiles (Table II) showed terminal fall in all but one of the normal group, while only three autistics and two aphasics produced fall consistently.

3.3. Intonation contour

As defined by expected occurrence of pitch obtrusions on stressed vowels in subject (P1), verb (P2) and object (P3) positions. In all groups the highest percentage of pitch obtrusions occurred on P3, followed by P1, then by P2. The aphasics differed as a group in that P3 was followed by P2. A similar rank order was also seen when intensity perturbation was considered for the normal and the autistic group, while for the aphasics P1 ranked first, P3 second and P2 last. When both frequency and intensity contour were considered, stressed vowels were marked by pitch obtrusion, intensity obtrusion, or both. Table II shows considerable within and between subject variability.

3.4. Declination effect.

Declination occurred with the highest percentage for the normals, second for the aphasics, and third for the autistics (Table I). When considering declination for fundamental frequency and intensity, covariation of the two parameters was not always present in the individual profiles and considerable within and between subject variability was evident. Declination between P1 and P2 was most consistent, while only a few of the subjects showed the expected declination for all three stressed syllables of the utterances (Table II).

3.5. Covariation of frequency and intensity over the declarative intonation contour.

The normals again showed the highest percentage of covariation, followed by the autistics, then the aphasic group. However, individual profiles of the autistics and aphasics showed that some subjects lacked covariation altogether (Table II).

In summary, despite considerable within and between subject variability, some of the markers examined appear more stable and consistent than others. The language deficient subjects generally showed less stability and greater individual variation. Differential impairment was also seen with respect to individual markers, individual groups and individual subjects. Both frequency and intensity thus appear to be important prosodic markers in the speech of young children. The linguistic salience of these parameters may differ for individual children or groups. Covariation of frequency and intensity expected for mature patterns thus may be the result of maturational factors and learned behavior. Although the frequency parameter has been characterized as initially the most stable, when broken down into the individual markers described, some appear more stable than others. It may be that such markers develop earlier, while others, less stable and consistent, might be more dependent on maturational factors, learned behaviors, and other linguistic development. For the abnormal groups, such markers may then exhibit particular vulnerability.

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