ACOUSTIC AND AFFECTIVE QUALITIES OF IDS IN ENGLISH

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ABSTRACT

This study examines modifications to the acoustic and affective qualities of infant-direct speech (IDS) from birth to 12 months. The acoustic analysis of fundamental frequency shows that IDS has the highest level of mean fundamental frequency (F_0) in speech to infants at 6 months, and the highest level of pitch range in speech to infants at 12 months. Sex-based differences were evident with mothers using higher mean-F_0 and pitch range in speech to female than male infants. The mother's speech samples were also rated on five scales of communicative intent. Two factors, labelled 'Affective' and 'Attentional', were extracted from these scales. Analysis of variance of the derived factor scores shows that mothers have the highest scores on the Affective factor at 6 and 12 months, while the maximum on the Attentional factor occurs at 9 months. Mothers also increase their use of both these IDS components more in speech to girls than boys.

1. INTRODUCTION

Acoustic analyses show that infant directed speech (IDS) has higher overall pitch, wider pitch range, slower tempo and longer pauses than adult directed speeach (ADS) [1]. In addition, similar fundamental frequency (F_0) contours tend to be used in the same types of interactional contexts, e.g., rising contours are generally used to gain infant attention or encourage a turn; bell-shaped contours to maintain attention or reward the infant; and falling contours to soothe or comfort [2]. IDS has a distinct affective character, and may play a central role in the development of sound-meaning associations well before speech becomes linguistically meaningful to infants [2]. Similarly infant perception studies show greater affective and attentional preferences for IDS than ADS [3] and for the affective rather than the pitch features in IDS [4]. Further, adults more correctly categorise communicative intent in low-pass filtered IDS than ADS [5]. It is clear then that IDS is capable of conveying a variety of affective and communicative messages to infants.

IDS has three possible functions: attentional, affective and linguistic. However, it is possible that these functions change according to the developmental phase of the infant. For instance, affective and attentional features would be especially important during early socialisation (3-6 months), but these features may be modified in some way in speech to older infants. Research on age-related adjustments to the acoustic qualities in speech to *young* infants is limited [1]. However, longitudinal research on mother's speech patterns is important because it may reveal age-specific functions for speech to infants. In the current study, speech samples were collected from twelve mothers speaking to their infants at birth (0DS), 3 months (3DS), 6 months (6DS), 9 months (9DS), 12 months (12DS) and to another adult (ADS). These were then compared on measures of: (i) fundamental frequency (F_0), and (ii) the affective and communicative intent of the speaker.

2. GENERAL METHOD

The subjects were 12 middle-class, tertiary-educated mothers between 25 and 35 years who were all native Australian speakers. Six mothers had female infants, and six mothers had male infants. All speech samples were recorded in the home using Sony Professional Walkmans. All statistical analyses were planned with a set alpha level set at p=05. Bonferroni adjustments were made to the critical-F value to control for the number of dependent variables and contrasts.

3. STANDARD ANALYSIS OF F_0

Forty utterances from each of the twelve mothers speaking to their infants at each of the five infant ages and to an adult (ADS) were digitised at a sampling rate of 10K Hz, and filtered at 1000Hz using the Kay CSL 4300 package. Pitch was extracted using the CSL function which automatically places impulse markers on amplitude peaks in the waveform, and which calculates pitch as the reciprocal of the difference in time between any two impulse markers. Measures of mean F_0 and pitch range were collected in Hertz. Pitch range, however, was subsequently converted to semitones for easy comparison with other such studies.

3.1 Results

A repeated measures analysis of variance (ANOVA) was conducted on mean-F_0 and pitch range with age of the addressee: 0, 3, 6, 9, 12 and adult as the within subjects factor. Linear, quadratic and cubic age trends were tested on the IDS data (0DS, 3DS, 6DS, 9DS and 12DS), with an additional contrast testing the IDS/ADS difference. The results are plotted in Figure 1a and 1b, and show that mean-F_0 was significantly higher in IDS than ADS (F=439.58). Pitch range was also higher in IDS, but this difference did not quite reach significance. All three age trends were significant for mean-F_0: linear (F=53.99), quadratic (F=61.37) and cubic (F=25.43). These show mean-F_0 reaches its highest level at 6 months, decreases at 9 months, and shows a modest increase at 1 year. For pitch range there is a significant linear increase in pitch modulation from birth to 12 months (F=41.83) complemented by a significant quadratic trend (F=8.26). As shown in Figure 1b, initially range increases dramatically, but then begins to

asymptote.

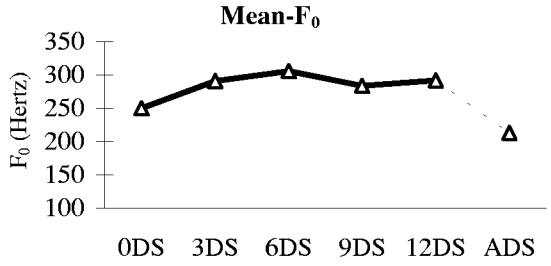

Figure 1a: Age trends for mean-F_0

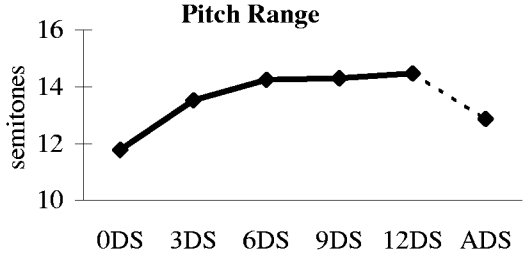

Figure 1b: Age trends for pitch range

4. SPEECH DIRECTED TO MALE AND FEMALE INFANTS

An analysis was conducted in order to ascertain whether there were differences between speech to female infants (female-IDS) and speech to male infants (male-IDS).

4.1 Results

Adjustments were made to IDS mean-F_0 and pitch range for each mother in order to accommodate baseline F_0 differences in speech production. To do this, each IDS utterance was divided by the mother's average adult levels of these measures. An ANOVA on these proportional scores tested linear, quadratic and cubic trends across infants ages (0DS, 3DS, 6DS, 9DS and 12DS), with sex of the infant listener as a between subjects factor. The results are plotted in Figures 2a and 2b, and show that mothers use higher mean-F_0 (F=19.81), and higher pitch range (F=5.53) in female- than male-IDS. Of interest here are the interactions of age trends with the sex of the infant. For these, the quadatric age x sex interaction was significant (F=6.57) for mean-F_0. In male-IDS, peak mean-F_0 is reached between 3 and 6 months but thereafter slowly decreases, whereas in female-IDS, mean-F_0 is high at 6 months, and also at 12 months. With regard to pitch range, the significant linear interaction with sex (F=6.57) shows that in female-IDS the level of pitch modulation continues to increase from birth to 12 months. However in male-IDS, the largest increment is from birth to three months with pitch range thereafter remaining relatively stable. It is evident from Figure 2b that as the infant develops the difference in pitch modulation between female- and male-IDS gradually increases with this difference being greatest at 9 and 12 months of age.

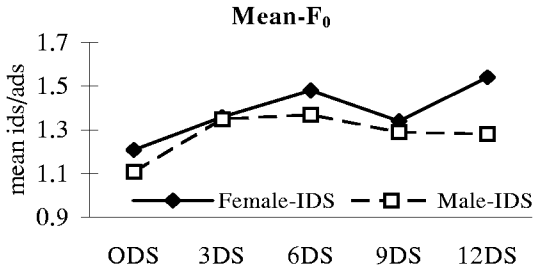

Figure 2a: Age trends for mean-F_0 in male- and female-IDS

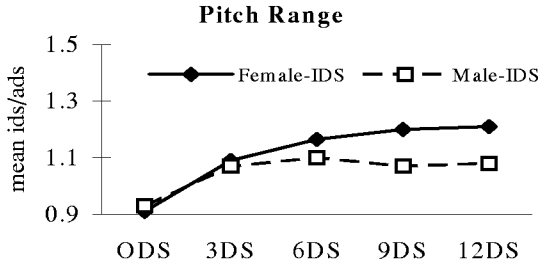

Figure 2b: Age trends for pitch range in male- and female-IDS

5. AFFECTIVE AND COMMUNICATIVE INTENT IN IDS

5.1 Method

Seventy-one undergraduate students from the University of NSW participated in the rating task. Affective intent was measured on five scales: (i) *Positive/negative vocal affect*, on a scale from -4 (very negative affect) to +4 (very high positive affect) and the intention of the speaker to (ii) *express affection*, (iii) *encourage attention*, iv) *soothe or comfort* and (v) *direct behaviour*. The latter were measured on a scale from 1 (not at all) to 5 (extremely). In total, there were 72 speech samples from 12 mothers speaking to listeners at the six ages: 0, 3, 6, 9, 12 and adult. Each speech sample was between 25 and 28 seconds in duration. Speech samples were low-pass filtered with an upper level of 400 Hz, and then recorded in a quasi-random order onto six audio tapes. There were 12 speech samples from two mothers on each tape. The six tapes were played in six quasi-random orders, and each group of subjects was asked to rate each of the 72 speech sample on each of the five scales. The data from the five rating scales were then subjected to (i) an ANOVA, and subsequently (ii) a factor analysis and an ANOVA of the derived factor scores.

5.2 Results of Rating Scales of Affective and Communicative Intent

The repeated measures ANOVA used age of the addressee (0, 3, 6, 9, 12 and adult) as the within subjects factor. Again, trends were tested across infant ages, and the IDS/ADS difference. The results are presented in Figure 3. These show IDS is rated

to have more positive vocal affect on the *positive/negative affect*

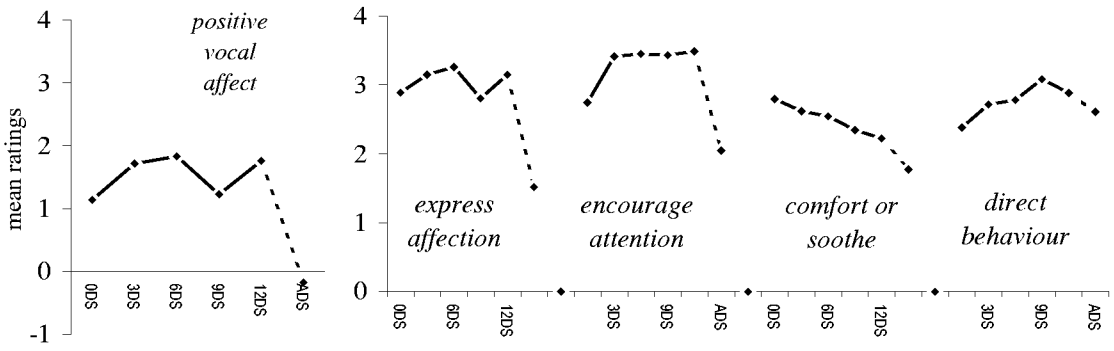

Figure 3: Ratings of positive vocal affect, intention to *express affection*, *encourage attention*, *soothe or comfort* and *direct behaviour* for 0DS, 3DS, 6DS, 9DS, 12DS and ADS.

scale than ADS (F=249.16). Infant directed speech was also rated higher than ADS on the intention to *express affection* (F=512.99), *encourage attention* (F=214.42), and *soothe or comfort* (F=45.55). However, raters perceived no difference between IDS and ADS on the intention to *direct behaviour* scale. The trends across infant ages for the degree of *positive/negative vocal affect* show significant linear (F=15.83), quadratic (F=18.23), and cubic (F=107.92) trends. There is an overall increase in the perception of positive vocal affect from birth to 12 months with the largest increase in 6DS, and a second increase in 12DS. The results for intention to *express affection* show a similar pattern with significant quadratic (F=8.92) and cubic trends (F=108.89), but no significant linear trend. That is, mothers increase their expression of affection from birth to 6 months, decrease it at 9 months, and increase it again when the infant is 12 months. Both these scales appear to be measuring similar parameters of affective intent. With regard to the intention to *encourage attention*, the linear (F=214.76), quadratic (F=115.24), and cubic trends (F=58.35) were significant. Raters perceive an overall increase in the intention to *encourage attention* from birth to 12 months. This characteristic rises steeply from 0DS to 3DS, but becomes more uniform from 3 to 12 months. For the raters' perception of the intention to *soothe or comfort* only the linear trend was significant (F=64.18). Mothers comfort and soothe their infants most when they are newborns. This progressively diminishes over infant ages to reach its lowest level in 12DS. In direct contrast, raters' perceptions of the intention to direct behaviour shows there is a significant linear increase from birth to 12 months (F=97.07). In addition to the linear trend, the significant quadratic trend shows that raters perceive mothers to be most directive in 9DS (F=41.62). These results show that mothers become more instructive as the infant gets older. However, at 9 months, mothers appear to be particularly intent on directing the behaviour of their infant.

5.3 Results of Factor Analysis and ANOVA of Factor Scores

A factor analysis was conducted to investigate the underlying dimensions of the ratings of affective intent. Varimax rotation extracted two factors, labelled 'Affective', and 'Attentional', and Table 1 contains their factor loadings. The results show that the scales, *positive/negative vocal affect*, the intention to *express affection*, and *soothe or comfort* load highly on the Affective factor. The second 'Attentional' factor was most associated with the intention to *encourage attention* and *direct behaviour*. This dimension of IDS may also have didactic features because it not only relates to encouraging attention, but also relates to the way mothers use IDS to direct the attention, and behaviour of their infants .

Scale	Affective factor	Attentional factor
pos/neg affect	.81754	.15121
express affection	.87746	.07856
encourage attention	.45014	.73826
soothe or comfort	.72091	-.15280
direct behaviour	.22329	.85111

Table 1: Factor loadings for the scales: positive/negative affect, intention to express affection, encourage attention, soothe or comfort and direct behaviour

Factor scores derived from the factor analysis were entered into a 2 (factor) x 5 (infant age) x 2 (infant sex) ANOVA. Results for both variates are shown in Figures 4a, 4b and 4c. There were significant main effects for the linear (F=49.84), quadratic (F=24.00), and cubic (F=23.64) age trends; infant sex (F=24.95); and the two factors (F=11.88). These show female-IDS has higher factor scores than male-IDS, irrespective of factor or age; and that scores on the Affective factor are higher than those on the Attentional factor. There were significant interactions between linear age and factor (F=33.59) and

quadratic age and factor (F=7.4). For the Affective factor, scores remain relatively stable from birth to 12 months, but scores on the Attentional factor generally increase over this time. More specifically, scores on the two factors diverge most at birth, and at 9 months. At birth the Affective factor is higher than the Attentional factor; whereas at 9 months, this is reversed, and IDS attentional features are emphasised more than its affective features.

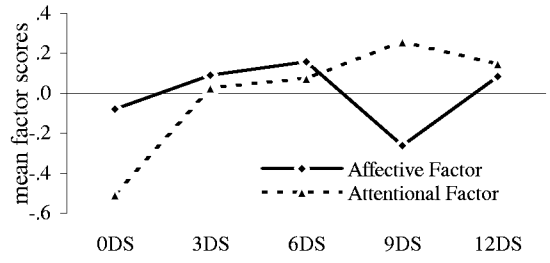

Figure 4a: Age trends for the Affective and Attentional factors

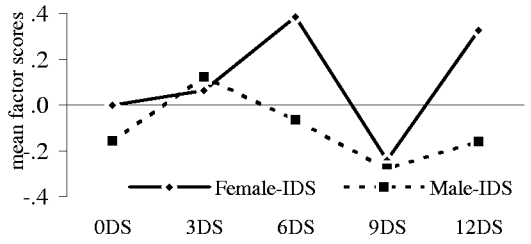

Figure 4b: Age trends for male- and female-IDS on the Affective factor

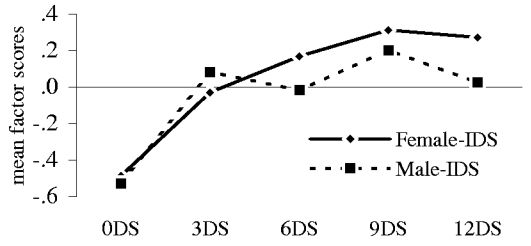

Figure 4c: Age trends for male- and female-IDS on the Attentional factor

When taking the sex of the infant into account, the results show there is a significant two-way interaction between sex and linear age (F=10.18), and significant three-way interactions between factor, infant sex and the linear (F=7.53), quadratic (F=6.65), and cubic (F=48.1) age trends (see Figure 5b). The sex x linear age trend shows that there is a larger increase in factor scores over age in female- than male-IDS. Regarding the three-way interactions, the largest differences between female- and male-IDS are found at 6 and 12 months on the Affective Factor. This divergence between female- and male-IDS is similarly shown on the Attentional Factor in Figure 4c. However, at 9 months, the difference between factor scores for male- and female-IDS is greater on the Attentional than Affective factor. These interactions suggest there are quite distinctive differences in the registers mothers use with girls and boys depending on age.

6. CONCLUSION

The affective and attentional features of IDS appear to be quite sensitively attuned to the infant's needs and abilities during the first year. At birth mothers' primary intention appears to be to comfort and soothe the infant. Both attentional and affective features are considerably lower in 0DS, although the Affective factor is more evident than the Attentional factor. Between 3 and 6 months both factors, and pitch measures increase markedly, and appear to act mainly to facilitate social and emotional development. Around 9 months, mothers' speech changes quite dramatically, its attentional features increase, and affective features decrease. This particular combination of IDS qualities possibly acts as an instructive tool to facilitate the infant's acquisition of phonological representations of speech. The steep increase in affective qualities around 12 months may be intended to offer encouragement and reward for an infant who is now consolidating crucial new language and other competencies

The factor analysis revealed two independent functions: Affective and Attentional. These appear to be related to mean-F_0 and pitch range respectively (compare Figures 1a, 1b and 4a). Thus, it seems that mothers may be able to use mean-F_0 and pitch range relatively independently to convey affective and attentional features, respectively. The expression of these features is dependent on the age of the infant. Thus, it seems different configurations of the affective and attentional features are used at different ages. In the first six months, infant directed intonation is possibly used to encourage interaction and socialisation, but by 9 months, the elevation of attentional features suggests it has a more didactic purpose.

7. REFERENCES

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