TEN-MONTH-OLDS' CATEGORIZATION OF INFANT-DIRECTED SPEECH ACROSS LANGUAGES

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This is dedicated to my loving family. Todos.

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The study investigated the ability of 10-month-old infants, from monolingual English speaking environments, to categorize comforting and approving infant-directed speech (IDS) utterances across languages. Infants participated in an infant-controlled habituation procedure, in which they heard up to 12 different exemplars, in 12 different languages, from one class of ID utterance, either comforting or approving. Following habituation, the test phase consisted of two novel exemplars from either the same (control condition) or a novel (experimental) category in two different languages. The results did not support the hypothesis that infants categorize approving and comforting utterances across languages. In the experimental group infants did not increase looking time to novel category test trials, indicating they did not categorize approving and comforting utterances across languages. The researcher discusses factors such as the large amount of variability across languages, which may have contributed to infants' failure to categorize comforting and approving IDS across languages.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

One can always tell when an infant is near. It is in the manner an adult says “Hey, sweetie?” Some clues that this phrase is being directed to an infant rather than to an adult lie in the phrase length (i.e. the number of words per sentence), the pitch patterns and the affect communicated. Adults use particular types of prosodic patterns that differ from adult-directed speech (ADS) to communicate different messages to infants (Fernald, 1993; Fernald, Taeschner, Dunn, Papousek, Boysson-Bardies & Fukui, 1989; Greiser & Kuhl, 1988). The important difference in the linguistic properties of ADS and IDS is the prosody. The linguistic and acoustic properties of infant-directed speech (IDS) include fewer words in the phrase, longer pauses, hyperarticulated vowels, slower tempo, are more rhythmic, and have exaggerated fundamental frequency contours in comparison to adult-directed speech (Moore & Spence, 1997; Trainor, 1996; Greiser & Kuhl, 1988; Fernald & Simon, 1984). It has also been well documented that infants prefer ID speech over AD speech from birth and throughout the first year of life. Infant-directed speech elicits more attention from the infant (Fernald, 1991; Cooper & Aslin, 1990). This preference may aid pre-verbal infants to learn about their world. I am interested in investigating if infants can abstract commonalities in IDS across languages.

Infant-Directed Speech

Infant-directed speech serves many important roles. It attracts and maintains the infant's attention, conveys positive affective information from the vocal intonation and aids the infant in language acquisition (Fernald & Mazzie, 1991; Werker & McLeod, 1989; Fernald & Simon, 1984). Fernald (1993) suggested that infant-directed speech consists of unique pitch patterns that may serve as communication signals between the caregiver and the infant. It has been shown that adults modify infant-directed speech prosody as a function of numerous contexts and intent when interacting with their infants (Spence & Moore, 2003; Fernald, 1989; Papousek, Papousek, & Symmes, 1991; Stern, Spieker, & MacKain, 1982) and that infant-directed speech regulates infants' arousal and attention (Fernald, 1989; Werker & McLeod, 1989). These functions of IDS have been proposed to help facilitate socialization and language acquisition in the infant (Snow, 1977).

Categorization of Infant-Directed Speech

Infants are constantly receiving a wealth of information from their environments. Categorizing information facilitates the ease of being able to process and work with large amounts of information. Since verbal communication is a large part of the interaction between an infant and its caregiver, categorization of the most common ID utterances may be required. This aids in building the foundation that leads to learning and comprehending a variety of utterances later in life. In order for infant-directed speech to serve a communicative function infants must be able to categorize various types of ID speech (Spence & Moore, 2003). Fernald et al. (1984) found that caregivers vary the prosodic nature of ID speech based on the infant's behavior and context of the

caregiver-infant interaction. There are numerous situations which include play, feeding, bathing, encouraging motor movements, bedtime and showing compassion if an infant is hurt. This results in different categories of ID speech which are defined by characteristic prosodic properties such as frequency, rhythm and intensity (Fernald & Morikawa, 1993; Fernald & Mazzie, 1991; Fernald & Simon, 1984).

There are two types of IDS utterances that are of special interest, because it seems that caregivers express them more towards infants. Two classes of IDS utterances that have been studied are comforting and approving utterances. Comforting utterances, such as “Ah, it’s okay”, are produced by caregivers in order to soothe a fussy or distressed infant and are characterized by low frequency vocalizations with falling frequency contours and lower mean fundamental frequency (F_0) and variability (Moore, Spence, & Katz, 1997; Stern et at., 1982). The approving utterances are characterized by a higher mean fundamental frequency and variability, are longer in duration and have a characteristic bell-shaped frequency contour (Moore & Spence, 2003; Katz, Cohn & Moore, 1996; Fernald, 1989). An example of this is when a caregiver successfully teaches a game to an infant and praises them by saying “Good Girl”.

Infants have been shown to prefer approving utterances and to categorize various types of infant-directed speech. It has been shown that 4-months-olds respond with more visual attention to naturally approving rather than to naturally disapproving ID speech (Papousek, Bornstein, Nuzzo, Papousek & Symmes, 1990) and that 5-month-olds respond with more positive affect (i.e. smiled more) to approving rather than disapproving ID speech (Fernald, 1993). It has been shown that 6-month-olds

categorize across multiple examples of natural approving and comforting infant-directed speech across multiple talkers that were female, while viewing a black and white checkerboard (Spence & Moore, 2003; Moore et al., 1997). In addition Spence, Chuang and Sokolsky (2004) found that 4-month-olds categorized unfiltered comforting and approving infant-directed speech when spoken by a single female talker, when presented in synchrony with a static female face.

Infant-Directed Speech in Different Languages

Even though infant-directed speech is produced in a plethora of language environments, the basic acoustic features of ID speech are constant across the languages. Previous research has shown that similar prosodic characteristics of infant-directed speech occur in numerous languages, such as French, Italian, German, Spanish, Chinese, Cantonese, Japanese, Thai and English (Werker, Pegg & McLeod, 1994; Fernald & Morikawa, 1993; Papousek et al. 1991; Fernald et al. 1989). The prosody varies for different types of ID speech, such as approvals and comforts, but the differences in these patterns are consistent across languages. For example, ID speech patterns were evaluated for the tonal language Mandarin Chinese by Grieser and Kuhl (1988). It was found that the fundamental frequency shifted upward, the pauses were lengthened and the speaking rate was slower and there were fewer words per unit time. There are similar characteristics of infant-directed speech in non-tonal languages, such as English and German (Fernald et al. 1989). Taken together these studies support the suggestion that these particular characteristics of ID speech are not language specific.

Prosody consists of pitch, tempo, stress and intonation and rhythm of a word or phrase. The prosodic cues relate meaning, word stress, speaking styles and emotion of

the speaker (Kuhl, 2004). It plays a crucial role in preference of the gender of the voice and the language acquisition of infants, due to the fact that infants do not comprehend the lexical content (Morgan & Demuth, 1996). It has been demonstrated that prosody may play a role in the preference of an infant's native language when compared to non-native languages throughout the first year of life (Moon, Cooper and Fifer, 1993; Mehler, Jusczyk, Lambertz, Halsted, Bertoncini and Amiel-Tison, 1988). It has also been shown that prosody helped French newborn infants to perceive acoustic correlates of phonological phrase boundaries in Spanish (Christophe, Mehler & Sebatián-Gallés, 2001). Dehaene-Lambertz and Houston (1997) found that French and American 2-month-old infants oriented faster to their native language. When prosodic cues were eliminated the effect was neutralized. Research has also evidenced that 6-month-olds use prosody to parse clauses embedded in continuous speech (Nazzi, Nelson, Jusczyk, and Jusczyk, 2000). In another study conducted by Jusczyk, Friederick, Wessels, Svenkerud, and Jusczyk (1993) it was shown that American 6-month-old infants listened longer to English words than to Norwegian words. The words were low-pass filtered to diminish the phonetic and phonotactic properties of the language and preserve the prosodic features. These studies highlight many important roles of prosody for pre-verbal infants.

Infants' Ability to Discriminate Different Languages

Previous studies have shown infants' abilities to discriminate various languages when presented in adult-directed speech. Empirical evidence shows that infants can discriminate between their native language and a foreign language as well as between two foreign languages. Nazzi et al. (1998) showed that 5-day-old French infants,

listening to low-pass filtered ADS, discriminated languages belonging to different rhythmic classes. The newborns discriminated between syllable-timed French versus stress-based British English and stress-based British English versus mora-based Japanese. Mehler et al. (1988) suggested that infants' ability to discriminate between sentences in different languages depends on a familiarity with one of the languages presented. They demonstrated this with 4-day-old infants from French-speaking families. Infants had a higher sucking rate for the French phrases than the Russian phrases and an asymmetrical pattern was found. Infants only dishabituated when tested with Russian phrases and switched to French phrases, not when tested with French phrases and switched to Russian phrases.

Mehler et al. (1988) also found that 2-month-olds, from monolingual English-speaking families discriminated between sentences belonging to two different languages. The ADS utterances were low-pass filtered to preserve prosodic cues. The infants could discriminate between sentences in their native language, English, and sentences in a foreign language, Italian. Nazzi, Jusczyk and Johnson (2000) studied 5-month-old English-learning infants' ability to discriminate languages. They found that infants discriminated languages from different rhythmic classes, such as stress-based British English versus mora-based Japanese and syllable-based Italian versus mora-based Japanese. The infants discriminated languages within a native rhythmic class, only when the native language or a variant of the native language was present. For example, the infants discriminated American English versus British English and British English versus Dutch. In addition, infants did not discriminate two languages within a foreign rhythmic class, such as syllable-based Italian versus syllable-based Spanish. A

study that has examined infant's abilities' to discriminate different languages when presented in IDS or child-directed speech was conducted by Bosch and Sebastian-Galles (1997). They demonstrated that 4-month-olds, born in Barcelona, Spain, are able to discriminate between Spanish and Catalan. These languages belong to the syllable-time rhythmic class. The infants recognized their maternal language, Spanish or Catalan, when contrasted with English. These studies support the idea that infants can discriminate their language from another language and it will be interesting to investigate how they abstract IDS utterances when presented in languages other than their native language.

In general, infants that are 6 months of age and younger can discriminate the consonantal and vocalic phonetic units used by most languages even if the units do not appear in their native language. Between 6 and 12 months of age this ability considerably declines and infants begin to focus more on their native language sound characteristics (Kuhl, 2004; Nazzi et al., 2000; Eimas, 1975). By 9 months infants have learned a great deal about the regularity of their native language and begin to pay more attention to the characteristics of their native language rather than to characteristics of a non-native language. In a study by Houston, Jusczyk, Kuijpers, Coolen, and Cutler (2000), 9-month-old infants from monolingual Dutch and monolingual American families showed their ability to segment words, spoken in child-directed speech, in an unfamiliar language with the same rhythmic structure as their native language. Nine-month-olds also possess the ability to distinguish their language from another language using phonetic and phonotactic patterns without depending on the language's unique prosodic characteristics (Jusczyk, Friederici, et al. 1993). Since infants' attention may be geared

more toward their native language, it suggests that infants may be devoting more attention to the prosodic characteristics of a type of utterance in a non-native language rather than the phonetic and phonotactic pattern characteristics of the non-native language.

The current study focuses on 9.5 to 10.5-month-old infants' ability to categorize different classes of recorded natural infant-directed speech, specifically comforts and approvals, regardless of the language spoken by different talkers of the same gender (Jerger, Pirozzolo, Jerger, Elizondo, Desai, Wright & Reynosa, 2003; Houston & Jusczyk, 2000). Infants may be exposed to more than just their native language, therefore it is important to test infants' ability to discriminate between different types of ID utterances across languages. Despite differences in the phonetics of a language, IDS has similarities in intonation in many languages (Papousek, 1991Fernald, 1989). For example, Werker et al. 1994 have shown that English and Cantonese ID speech have similar characteristics.

Of interest is the study that demonstrated 4- and 6-month-old infants' ability to categorize comforts and approvals when the utterances were presented in English IDS (Spence, Chuang & Sokolsky, 2004; Spence & Moore, 2003; Moore et al., 1997). The current study will expand on this idea and shed light onto whether infants are extracting the commonalities of the prosodic patterns of two types of IDS utterances (i.e. approving and comforting) across languages. If the infants are able to categorize the two utterances despite the numerous differences in the languages, then this may support the idea that IDS plays an important role in pre-verbal infants' language learning.

To test this hypothesis, samples of two different types of ID speech, comforts and approvals were gathered from female talkers in 14 languages. A habituation paradigm was used to test infants. They were habituated to one class of ID speech in up to 12 languages. Then they were tested with either a novel ID stimulus of the same class or a novel ID stimulus from a different ID class in 2 languages. If the infants, at test, show increased looking time towards the novel class that portrayed the other class of IDS utterance, not heard during habituation, then it lends some evidence to infant's abilities' to categorize comforting and approving IDS spoken across different languages. To ensure that the presented languages were equally unfamiliar and to decrease the effect of preference for familiar words and the preference for the stress patterns of English words (Houston et al., 2000; Jusczyk, et al. 1993) the infants were from predominantly English speaking families.

CHAPTER 2

METHOD

In order to initiate this study, IDS samples in different languages were needed. Before the infant-directed speech study began, infant-directed speech utterances were gathered in fourteen different languages. These samples were then rated by native speakers of those particular languages. The highest rated samples in each language were then used in the infant-directed speech study. The methods for all three parts are described below.

Adult Voice Sample Study

Participants

Adult male and females were recruited to provide the speech stimuli that were used in the familiarization and categorization phases of the infant-directed speech study. The participants were university students that were recruited through the UTD SONA System. The recruitment management system allows psychology students to participate in studies for class credit. Thirty-six females and 8 males participated in the study (n=44). Infant-directed speech samples in 14 languages were collected and included French, Spanish, Portuguese, Hindi, Mandarin, Japanese, Bengali, Urdu, Greek, Shona, Gujarathi, Telugu, Hungarian and Vietnamese. For the purposes of this study, only the non-English female voices (n=30) were analyzed. Fourteen of these female voices were segmented into utterances. These utterances were rated and used in the Infant-Directed Speech study.

Procedure

At the time of the study the participant provided consent, basic information about their native language and any other languages they might have spoken and informed that their voices would be used in future infant studies. Participant's native language had to be one of the 14 named above. The participants were assigned to one of two conditions, an approval or comfort condition. The conditions were counterbalanced across participants. The participants viewed two short videos, each approximately 15 minutes in length, which were developed by the researcher. The approval condition consisted of a video that contained various clips of infants performing actions that elicited approving infant-directed speech. The comforting condition consisted of a video that contained clips of infants in situations that elicited comforting infant-directed speech. The participant viewed the videos on a 51" Sony plasma television in a dimly lit room. They sat five feet in front of the screen and spoke into a microphone that was connected to a Dell Optiplex GX270 desktop computer which recorded each participant's voice using the program Adobe Audition 2.0. Each voice was recorded with a sample rate of 22050, in mono channel mode, and 16-bit resolution.

Participants were instructed to react and speak towards the videos in infant-directed speech in the language in which they were most comfortable. Comforting and approving IDS was defined by providing examples of situations when comforting and approving phrases are used. No auditory examples of comforting or approving phrases were given during instruction. They were asked if they understood the procedure and if they had any questions. Once all their questions were answered and they felt comfortable they began the procedure. The videos contained some typed phrases in

English, of comforting and approving phrases, such as “It’s okay” and “Good Boy” that participants could say in their respective language. They were allowed a 90 second break in between videos.

Results

The recordings from each participant were segmented into distinct audio samples. The audio samples were analyzed using the audio program Wave Surfer. They were analyzed for amplitude and clarity. These audio samples were the ones with the least background noise, least noise produced from the microphone, the least static, and that were clear after amplification. The clearest recordings of comforting and approving infant-directed speech were selected for an online rating survey. The segments were analyzed for number of syllables, standard F_0, average fundamental frequency (F_0), maximum F_0, minimum F_0 and length. The approving audio samples had a mean F_0 of 244.39 (*SD*=17.35). The F_0 range for these samples was 147.70 – 351.30 (*M*=202.50, *SD*=36.13). The comforting audio samples had a slightly lower mean F_0 of 235.26 (*SD*=34.50). The F_0 range for these samples was 162.38 – 315.74 (*M*=152.43, *SD*=41.27). See Table 1 and Table 2 for the acoustic dimensions of non-English audio samples, spoken by a female, selected for the IDS online rating study.

Table 1. Acoustic Dimensions of the Non-English Female Approving Audio Samples Chosen for the IDS Online Rating Study

Language	# syllables	F0 ave	SD	Fmax	Fmin	length
Bengali	6	205.81	68.49	364	140	2.47
	5	230.73	230.73	364	110	2.65
	5	196.56	57.08	354	155	1.51
French	4	249.51	48.32	346	109	1.86
	7	229.72	63.17	362	135	1.40
	6	241.81	54.74	358	184	2.07
Greek	8	237.18	39.71	357	185	2.70
	4	219.62	29.63	346	184	1.05

TABLE 1. CONTINUED

Language	# syllables	F0 ave	SD	Fmax	Fmin	length
	8	213.32	57.84	354	104	2.40
Gujarathi	4	266.41	41.36	352	214	1.84
	9	227.13	25.03	261	178	1.81
	11	191.69	51.14	351	88	2.30
Hindi	12	252.00	60.15	358	182	3.26
	9	240.37	72.74	354	63	3.10
	3	298.87	41.61	358	175	1.01
Hungarian	4	202.49	31.92	359	165	1.74
	5	222.18	43.41	357	164	2.60
	7	217.28	44.79	359	96	2.30
Japanese	10	254.67	67.57	364	117	2.71
	6	228.47	64.44	362	131	1.60
	6	215.88	37.51	347	177	2.80
Mandarin	2	297.83	57.36	362	182	0.87
	7	263.99	64.67	365	104	2.60
	8	264.78	61.01	363	111	3.13
	7	226.97	38.97	329	118	2.50
Portuguese	10	243.22	57.45	362	169	3.00
	4	261.42	34.63	358	190	2.40
	7	274.69	54.44	363	180	2.20
Spanish	3	272.42	43.54	358	171	1.63
	4	224.59	49.32	360	140	1.24
	4	236.06	52.41	360	179	1.26
Shona	9	243.70	46.69	339	170	2.62
	11	301.92	41.34	364	180	2.61
	14	203.08	36.69	276	109	3.51
Telugu	3	266.82	44.75	365	151	1.40
	3	257.59	48.21	361	135	0.95
	6	248.24	53.83	361	117	2.19
Urdu	10	252.00	60.15	359	182	2.40
	10	272.45	40.18	357	164	2.80
	8	261.48	58.52	362	134	2.70
Vietnamese	11	254.46	63.61	316	99	2.54
	11	264.24	56.36	320	124	4.15
	8	274.94	47.14	360	185	3.80

Table 2. Acoustic Dimensions of the Non-English Female Comforting Audio Samples Chosen for the IDS Online Rating Study

Language	# syllables	F0 ave	SD	Fmax	Fmin	Length
Bengali	8	182.43	12.66	210	87	2.53
	7	197.06	23.48	225	146	3.50
	7	169.86	24.60	214	82	1.83
French	2	265.82	42.67	363	185	0.85
	6	200.21	31.17	265	103	2.23
	5	186.01	25.01	261	144	2.63
Greek	8	247.27	28.99	324	134	3.55
	7	204.26	68.34	356	85	2.13
	2	246.02	39.31	307	184	1.50
Gujarathi	4	254.95	47.42	319	127	1.50
	2	245.33	33.94	278	193	1.01
	9	293.35	58.89	361	183	2.19
Hindi	3	264.07	23.32	354	188	1.70
	3	308.67	42.88	365	182	1.25
	5	291.19	41.06	364	186	1.50
Hungarian	7	232.29	37.08	352	182	2.70
	9	218.13	47.04	363	108	2.45
	10	158.32	60.39	347	83	2.96
Japanese	7	191.30	37.60	244	64	1.62
	4	260.11	65.96	363	125	1.84
	4	263.89	37.03	348	227	1.74
Mandarin	6	256.02	25.17	317	212	2.80
	4	305.10	8.95	334	280	1.80
	5	242.36	14.78	300	227	1.67
Portuguese	7	192.09	44.51	347	132	2.36
	9	202.95	202.95	339	131	2.55
	4	294.45	17.96	345	281	1.60
Spanish	2	199.79	32.35	267	154	1.20
	3	221.96	39.46	362	183	1.40
	3	268.68	31.21	355	220	1.30
Shona	9	186.67	38.62	263	91	3.00
	6	186.17	36.41	238	86	1.75
	5	210.80	22.96	260	184	1.60
Telugu	5	203.39	16.16	260	182	1.21

TABLE 2. CONTINUED

Language	# syllables	F0 ave	SD	Fmax	Fmin	Length
	3	241.91	37.00	301	168	0.84
	12	252.28	36.32	354	197	3.14
Urdu	7	275.06	41.43	369	180	2.10
	12	225.46	49.28	327	83	3.04
	6	205.52	59.26	353	83	1.77
Vietnamese	7	255.86	27.14	331	207	4.00
	6	281.31	22.27	331	241	4.50
	8	292.39	23.32	325	300	5.50

Adult Infant-Directed Speech Rating Study

The comforting and approving IDS utterances were rated by adult native speakers of those particular languages. For example, if they were a native speaker of Japanese, they only rated Japanese IDS utterances. The samples that were rated the highest as characteristic examples of an IDS utterance of an approval and comfort in each language was used in the infant-directed speech study.

Participants and Procedure

The participants were recruited through the UTD SONA System and through various online resources. The website www.SurveyMonkey.com was used to gather the information from the participants. It contained a description of the study, the main objectives of the study, previous IDS findings and participation instructions. Participants provided their consent by giving their basic information and contact information. Participants first filled out a Native Speaker Survey, which provided information about their native language experience. It consisted of 31 questions (see Appendix I for the Native Speaker Survey Questions). This survey was used to screen the participants in order to ensure that only native speakers were rating the IDS utterances in their native language. The IDS utterances were rated by answering 3 questions: a forced choice

question, a confidence interval question on a 3-point scale and a typicality question on a 5-point scale (see Appendix II for the Infant-Directed Speech Rating Study Questions).

Native Speaker Survey Questions and Criterion

The online raters were screened in order to ensure that they were native speakers of the language in which they were rating the IDS utterances. This survey consisted of 31 questions and seven were chosen as criteria to screen the raters. The following 7 questions were the screening criteria and were required to have particular responses.

Question 1

The first question was, “In what country were you born?” The response was preferably a country in which their native language is used daily.

Question 2

The second question was, “Throughout your life how many years did you live in that country?” The response was preferably all their life or the first 5-10 years of their life.

Question 3

The third criterion question was, “What was your first/primary language you learned? This would be the language that was spoken in your home while you were growing up.” The rater had to choose one of the languages in the survey or they could choose ‘other’ as long as the language they were rating was one that they learned from birth. For example, most people in India will learn their regional language as well as Hindi, therefore they could have chosen ‘other’ and state they learned Hindi at the same time. This qualified them to rate Hindi.

Question 4

The fourth question was, “How long have you been speaking this particular language?” The preferred response was all their lives or the same number of years as their age.

Question 5

The fifth question was, “How often do you speak this particular language in your daily life?” The preferred response was ‘daily’.

Question 6

The sixth question was, “Can you understand this particular language when it is spoken to you?” The preferred response was ‘yes’.

Question 7

The seventh question was, “What language do you speak throughout a typical day?” Their response had to include their native language in which they are rating the IDS utterances.

Results

Native Speaker Survey Questions

A total of 162 participants responded to the online survey. There were 114 females and 48 males. Six raters were excluded for failure to complete the survey. After all the participants were screened the total number of raters was 156. There were a total of 10 raters for the infant-directed speech utterances in following languages: Bengali, French, Greek, Gujarati, Hindi, Hungarian, Shona (ChiShona), Telugu, Urdu, and Vietnamese. There were a total of 12 raters for the Japanese IDS utterances. Mandarin and Portuguese had a total of 11 raters and Spanish had total of 22 raters.

Infant-Directed Speech Rating Study Questions and Criterion

After the Native Speaker Survey participant rated the audio samples. The criteria for choosing the comforting and approving IDS utterances that were rated, from each language, are described below. Raters answered three questions about each audio sample.

Question 1

The first question, a forced choice question, asked, “Does this sound like a comforting phrase, an approving phrase or neither?” The respondents were instructed to listen to the audio sample a maximum of 2 times. Then they were asked to choose whether the phrase was a typical example of a comforting or approving phrase in their language. If the phrase was not a typical example they could choose “neither”. It was required that 100% of the respondents that rated a particular audio sample choose the same answer in order for the sample to qualify as top rated and used in the IDS study.

Question 2

The second question measured the respondent’s confidence rating of the answer to the first question. It was on a three point scale and asked, “How confident are you about your answer to question #1?” The rater could chose between 1 which meant not confident, 2 which meant somewhat confident and 3 which meant they were very confident. The sample that was chosen out of all the samples in that particular language had the highest percentage of respondents, 90-100%, that picked 3 on the scale.

Question 3

The third question measured how typical the phrase was of a comforting or approving phrase in their native language. It was on a five point scale and stated, “Use

the scale below to rate how typical the phrase is of a comforting or approving phrase in your language?" If the rater chose 1 it meant that the phrase was not at all typical, 2 meant slightly typical, 3 meant typical, 4 meant more typical and 5 meant extremely typical. Each phrase was analyzed by first calculating the percentage of respondents that picked 4 and 5 on the scale. For each phrase the percentage of respondents that chose 4 and 5 were summed. If this summed to 100% then, out of these respondents, the phrase that was chosen was the one that had the highest percentage of respondents that picked 5 on the scale.

Results

Infant-Directed Speech Rating Study Questions

The top rated utterances, from the online rating survey, were used in the infant-directed speech study. See Table 3 for the rating results of the top rated utterances in the online rating study. The audio samples were analyzed for number of syllables, standard F_0, average fundamental frequency (F_0), maximum F_0, minimum F_0 and length. Student t-tests were performed on the mean F_0 and mean F_0 range to show that the distributions of comforting and approving utterances were significantly different. The approving audio samples had a mean F_0 of 247.56 (*SD*=17.35). The mean F_0 range for these samples was 202.50 (*SD*=36.13, range 151.64 – 354.14). The average length of these audio samples was 2.46 seconds. The comforting audio samples had a slightly lower mean F_0 of 223.37 (*SD*=34.50). The mean F_0 range for these samples was 152.43 (*SD*=41.27, range 148.86 – 301.29). The average length of these audio samples was 2.35 seconds. Fundamental frequencies for the approving and comforting distributions were significantly different ($t(13)=2.70$, $p=0.02$). The mean F_0 ranges for the

approving and comforting distributions was also significantly different ($t(13)=2.66$, $p=.02$). See Table 4 and Table 5 for the acoustic dimensions of the top rated approving and comforting utterances, for each language, from the IDS online rating study. These audio samples have similar acoustic properties that have been reported in previous research (Katz et al. 1996).

Table 3. IDS Rating Results: Average Ratings of the Top Rated Approving and Comforting Utterances for Each Language

Language	# of raters	Q1: Does this sound like a comforting phrase, an approving phrase or neither? % of raters that chose utterance type	Q2: How confident are you about your answer to Q1?	Q3:Use the scale below to rate how typical the phrase is of a comforting phrase or an approving phrase in your language.
Bengali	10	100% - approving	3	5
	10	100% - comforting	3	5
French	10	100% - approving	3	5
	10	100% - comforting	3	5
Greek	10	100% - approving	3	4.9
	10	100% - comforting	3	4.8
Gujarati	10	100% - approving	3	5
	10	100% - comforting	3	4.9
Hindi	10	100% - approving	3	4.9
	10	100% - comforting	3	4.9
Hungarian	10	100% - approving	3	4.9
	10	100% - comforting	3	4.9
Japanese	12	100% - approving	3	4.67
	12	100% - comforting	3	4.75
Mandarin	11	100% - approving	3	4.91
	11	100% - comforting	3	4.55
Portuguese	11	100% - approving	3	5
	11	100% - comforting	3	5

TABLE 3. CONTINUED

Language	# of raters	Q1: Does this sound like a comforting phrase, an approving phrase or neither? % of raters that chose utterance type	Q2: How confident are you about your answer to Q1?	Q3:Use the scale below to rate how typical the phrase is of a comforting phrase or an approving phrase in your language.
Spanish	22	100% - comforting	3	4.32
	22	100% - approving	3	4.23
Shona	10	100% - approving	3	4.8
	10	100% - comforting	3	5
Telugu	10	100% - approving	3	4.9
	10	100% - comforting	3	4.9
Urdu	10	100% - approving	3	5
	10	100% - comforting	3	5
Vietnamese	10	100% - approving	3	5
	10	100% - comforting	3	5

Table 4. IDS Rating Results: Acoustic Dimensions of the Top Rated Approval Infant-Directed Speech Utterances

Language	# syllables	F0 ave	SD	Fmax	Fmin	length (s)
Bengali	6	205.81	68.49	364	140	2.47
Hungarian	5	222.18	43.41	357	164	2.6
Greek	8	237.18	39.71	357	185	2.7
Portuguese	10	243.22	57.45	362	169	3
Shona	9	243.70	46.69	339	170	2.62
Telugu	6	248.24	53.83	361	117	2.19
French	4	249.51	48.32	346	109	1.86
Hindi	12	252.00	60.15	358	182	3.26
Urdu	10	252.00	60.15	359	182	2.4
Vietnamese	11	254.46	63.61	316	99	2.54
Japanese	10	254.67	67.57	364	117	2.71
Mandarin	7	263.99	64.67	365	104	2.6
Gujarathi	4	266.41	41.36	352	214	1.84
Spanish	3	272.42	43.54	358	171	1.63

Table 5: IDS Rating Results: Acoustic Dimensions of the Top Rated Comforting Infant-Directed Speech Utterances

Language	# syllables	F0 ave	SD	Fmax	Fmin	length (s)
Bengali	8	182.43	12.66	210	87	2.53
Shona	9	186.67	38.62	263	91	3
French	5	186.01	25.01	261	144	2.63
Japanese	7	191.30	37.60	244	64	1.62
Portuguese	7	192.09	44.51	347	132	2.36
Spanish	2	199.79	32.35	267	154	1.2
Telugu	5	203.39	16.16	260	182	1.21
Hungarian	7	232.29	37.08	352	182	2.7
Greek	8	247.27	28.99	324	134	3.55
Gujarathi	4	254.95	47.42	319	127	1.5
Vietnamese	7	255.86	27.14	331	207	4
Mandarin	6	256.02	25.17	317	212	2.8
Hindi	3	264.07	23.32	354	188	1.7
Urdu	7	275.06	41.43	369	180	2.1

Infant-Directed Speech Study

A pilot study was conducted to test if the testing procedure was appropriate for 10-month-olds. The participants included infants (*n*=18) that were from multi-language environments; therefore the data was not analyzed and is not presented here. Following the pilot study participants were from predominantly English speaking environments.

Participants

The participants were obtained by mailing recruitment letters to new parents and distributing brochures at the university and appropriate locations throughout the (University of Texas at Dallas) neighborhood. A caregiver brought each infant into the laboratory and accompanied the infant for the entirety of the procedure. If there was verbal contact with the parent before the study, they were asked questions about the infant's language exposure. At the time of the study the caregiver provided basic information about the infant, informed consent for the infant's participation and

information about the infant's language exposure. The participants (*n*=41) consisted of healthy 10-month-old male (*n*=25) and female (*n*=16) infants, ranging in age from 9 months and 14 days to 10 months and 14 days (mean age = 285 days). The data from 23 infants was excluded due to predominant exposure to a bilingual environment (*n*=15), fussiness (*n*=3), and failure to habituate (*n*=5). The final sample of infants (*n*=18) that was used for data analysis, consisted of 12 males and 6 females. The mean age of these infants is 286 days (*SD*=16.39, range=262-320 days).

Equipment

The habituation procedure was executed using the Habit 2000 program, developed by Cohen, Atkinson and Chaput (2000), on a Macintosh G4. Habit 2000 presents auditory and visual stimuli, and collects and stores looking time data received from a researcher-operated keyboard. The researcher was in a control room that was separate and adjacent to the experiment room in which the infant participated. The infant sat on their caregiver's lab approximately 1 meter from a 15" computer monitor that was placed on a table. There was black fabric that extended approximately 4' on each side of the monitor. The main lights in the experiment room were turned off and two tall lamps, each 7' feet to the right and left were turned on. This did not distract the infant. It helped the infant focus on the computer monitor. The visual stimulus was shown on a 15" computer monitor. The auditory stimuli were presented through a speaker that was centered behind the 15'' computer monitor. Headphones were placed on the caregivers to mask the auditory samples. Caregivers were instructed to hold their infant and look down at the top of the infant's head for the entirety of the study. When the researcher established a corneal reflection of the monitor on the infant's eyes, the

stimuli was presented which began the trial. The recorded video was shown to the caregivers immediately following the study.

Stimuli

Auditory: The top rated infant-directed speech samples, spoken by a female, of comforting and approving utterances were used. The auditory stimuli, from the rating study, averaged approximately 68-70 dB, which was measured with a sound level meter. During the habituation phase the infant heard a maximum of 12 different utterances from one class, either comforting or approving. The order of the utterances in the habituation phase was randomly presented. Each utterance was spoken by a different female and was in a different language. During the test phase the infants in the control group heard two utterances of the same class, either comforting or approving. During the test phase the infants in the experimental group heard 2 utterances of the different class. Each of the utterances in the test phase was spoken by a novel female talker in a novel language.

Visual: The visual stimulus for the pre-test phase was a colorful polka-dot picture. This pre-test was used to show the infant that pictures and sounds were going to be used simultaneously. The visual stimulus in the habituation phase, for the infant habituation procedure, was a colorful bullseye. The bullseye was used to sustain the infant's attention to the screen in order to hear the auditory stimuli.

Procedure

Ten-month-old infants were run in a between subjects design infant-controlled habituation procedure. There was a control group and an experimental group of infants. Each group contained 2 conditions, an approving and a comforting condition. In the

control group (*n*=9), four of the infants were habituated to different approving utterances in different languages and tested with novel approving utterances in novel languages. The other five were habituated to different comforting utterances in different languages and tested with novel comforting utterances in novel languages. In the experimental group (n=9), five of the infants were habituated to different approving utterances in different languages and tested with comforting utterances in novel languages. The other four were habituated to different comforting utterances in different languages and tested with approving utterances in novel languages. Males and females were equally distributed throughout the groups.

An attention getter, a moving green circle, was presented on the monitor until the infant looked at the monitor and the researcher could see the corneal reflection of the monitor on the infant's cornea. This was the criteria for establishing the infant's attention. At this point one pre-test trial was presented for maximum time of 15 seconds. After the pre-test trial the habituation phase of the procedure began. When infant's attention was established the first habituation trial was presented.

During each habituation trial infants were presented with a comfort or approval IDS utterance in synchrony with a colorful bullseye on a computer monitor. Habit 2000 recorded the looking times for each trial. The trials started when the infant's attention was established and terminated if the trial reached its maximum length of 30 s or when the infant looked away for 1.5 seconds. The trial was repeated if it was less than one second. The infants were presented with a maximum of 12 habituation trials. Habit 2000 determined the number of habituation trials that were presented by calculating a habituation criterion. It was reached when the infants' averaged looking time for three

consecutive trials decreased by 50% or more of the averaged looking time of the first three habituation trials. At this point two test trials were presented. For the control group, the two test trials, which are the two control trials (within category trials) consisted of two novel tokens of the same class of IDS utterance heard during habituation, spoken in two novel languages. For the experimental group, the two test trials, which are the two experimental trials (between category trials), consisted of novel tokens portraying the other class of IDS utterance in two novel languages.

CHAPTER 3

RESULTS

The infants that reached the habituation criteria during the habituation phase of the experiment were included in the final data analysis. The dependent variable that was analyzed is the total looking time (TLT) at the visual stimuli during particular trials. The data from all infants was divided into three trial blocks. Trial block 1 (FirstHab) consists of the mean average of the first three habituation trials. Trial block 2 (EndHab) consists of the mean average of the last 3 habituation trials. Trial block 3 (TestTrials) consists of the mean average of the two test trials.

We tested the infant's responses between the experimental and control groups. A mixed ANOVA was performed where utterance type (approval and comfort) and group (experimental and control) were the between subject factors. The Trial Blocks 2 and 3 served as the levels for the repeated factor. There we no main effects or interactions of any of the factors.

Paired two sample t-tests were performed to analyze if infants increased or changed looking time from Trial Block 2 and Trial Block 3. If there is a significant increase between trial block 2 and trial block 3 in the experimental group, it is interpreted as the infant's discriminating between the two classes of utterances (comforts and approvals) and categorizing them as different classes of ID speech. If infants do not increase looking between trial blocks 2 and 3 in the control group, it is interpreted as the infant categorizing the utterances as the same class of ID speech.

The experimental group minimally increased looking from the end of habituation (*SE*=1.26) to the novel IDS utterance in the test phase (*M*=0.17, *SD*=1.94, *SE*=1.08). This was not statistically significant *t*(8)= -0.14, *p*=0.44. The control group showed a slight increase in looking times from the end of habituation (*SE*=0.80) to the novel IDS utterance in the test phase (*M*=1.99, *SD*=4.07, *SE*=1.58). This was not statistically significant *t*(8)= -1.50, *p*=0.086. See Figure 1 for means of total looking times of the experimental and control groups for the last three habituation trials and the test trials.

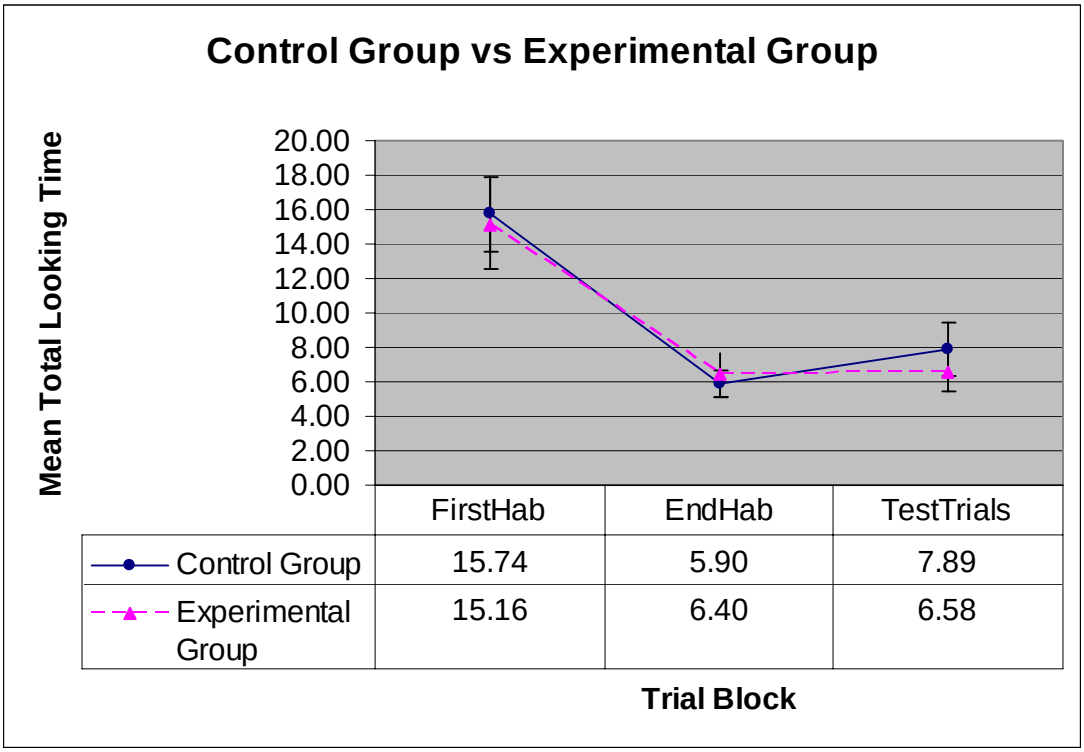

Figure 1. Ten-month-olds' Mean Total Looking Times of the Trial Blocks of the Control Group versus the Experimental Group

CHAPTER 4

DISCUSSION

The present study demonstrated that 10-month-old infants, from mono-English speaking families, did not categorize comforting and approving infant-directed speech utterances across languages. In the control group (*n*=9) the infants minimally increased looking to the novel IDS test trials. This was not statistically significant. In the experimental group (*n*=9) the infants failed to recover looking to the novel IDS test trials. Based on previous research the opposite was hypothesized. It was hypothesized that the control group would not show recovery when presented with novel IDS test trials from the same category. It was hypothesized that experimental group would show recovery when presented with novel IDS test trial from the other category (Moore, Spence and Katz, 1997).

A factor that could have affected the results is simply the number of participants. The number of infant participants (*n*=18) was low. Twice as many males (*n*=12) than females (*n*=6) participated in the study. It could be that the results are skewed to show how male infants process these IDS categories across languages and that a general view could not be concluded. Recent literature has highlighted gender-related differences in language acquisition and in infant behavior. Nagy, Kompagne, Orvos and Pal (2007) found that girls were more responsive than boys in an imitation task. The experimenter extended an index finger and evaluated the imitations of the infants. It was found that the girls imitated more and imitated faster than the boys. Boatella-

Costa,Costas-Moragas, Botet-Mussons, Fomieles-Deu, and Caceres-Zurita (2007) showed that boys are more irritable and less attentive than girls, whereas girls responded faster to the experimenter's voice. A significant effect could have resulted with a greater number of infants and help balance the gender of the participants.

An alternative hypothesis for the lack of categorization may have to do with the large number of languages (*n*=14) that were presented to the infant. Since each trial was in a different language, the infant was hearing large amounts of variability throughout the procedure which may have added a level of complexity to the task. It may have been difficult for the infants to pull out the commonalities in the speech properties of the IDS utterances which included mean F_0, mean F_0 range and frequency contours. Presenting many languages could pose the obstacle of a particular language eliciting more attention from certain infants. The infants could have also been extremely interested in one particular utterance over the other. To minimize the variability due to the number of languages, one could test infants with only one non-native language. For example, one could do the same study with infants from mono-English speaking families with two to four languages.

A third explanation for the lack of categorization may be due to the large variability in the rhythmic classes of the languages presented. Three main rhythmic classes were heard by the infants. One was stress-timed which includes the languages such as English, Hindi and Urdu. The other rhythmic class was syllable-timed which include languages such as Spanish, Italian and French. The third was mora-timed which included Japanese and Mandarin (Nazzi et al., 1998; Fernald et al., 1989). This could have added a level of complexity to the procedure beyond the number of languages that

the infants heard. English belongs to the stress-timed rhythmic class and therefore presenting infants with languages within their native rhythmic class may have interrupted further processing of more specific speech properties in the IDS utterances. Nazzi et al. (1998) have demonstrated that 5-month-old infants were able to discriminate languages based on rhythmic classes. One could extend this idea to this study and minimize the variability in the rhythmic classes presented to the infant. This could be performed by testing infants with languages belonging to one non-native rhythmic class. For example, one could do the same study with, comforting and approving IDS utterances, spoken only in the syllable-timed languages such as Spanish, Italian and French.

A fourth hypothesis for the lack of categorization of comforting and approving IDS involves fundamental frequency. Paired two-sample t-tests performed showed that the mean F_0 and the mean F_0 range of the comforting and approving distributions were significantly different, yet there existed an overlap in the actual values of the individual comforting and approving utterances. The comforting utterances had a mean F_0 range of 152.43 (range=148.86-301.29). The approving utterances had a mean F_0 range of 202.50 (range=151.64-354.14). Refer to tables 4 and 5 above for the individual F_0 and F_0 range of each top rated comforting and approving utterance for each language. The majority of the comforting utterances fall within the range of the approval category. The infants may have heard the overlap in individual exemplars and perceived the exemplars as being from the same class and therefore this information might have fallen secondary to the differences in the languages.

Another factor that might have played a role in the final results is infants' attention to the utterances. The infants were allowed to listen to each utterance for a maximum of 30 seconds each. Due to the complexity of including a large number of languages, it might be beneficial to increase the presentation of the utterance to 60 seconds and maybe decrease the number of languages presented. As a first step the infants may have classified all 14 non-native languages as foreign. They may stop at this step since there isn't extra time for analysis of the speech properties of the utterance. The extra time might allow the infant to go a step further and analyze the utterances and maybe allow for the categorization of approving and comforting IDS utterances across languages.

The factors above, alone or combined, could have prevented the infants' categorization of comforting and approving infant-directed speech across languages. The results of this study may imply that more variability exists in IDS in different languages than previously reported. This could be due to the prosodic characteristics of the languages interplaying with the prosodic characteristics of infant-directed speech. Results demonstrated 10-month-olds' failure to categorize ID speech across languages, yet we cannot state this as an absolute, and conclude that they cannot succeed at this task. The current study was complex, in the sense that there was large variability in the number and types of languages that were presented. The infants may have been overwhelmed with information and therefore not able to perform the task at hand. Infants' categorization abilities may have been observed if the task was presented in a simpler form. For example, the procedure can be altered to present the infants with three languages from one non-native rhythmic class. It is important to know at what

level of complexity an infant is processing particular information. This may help enlighten us about how to best present information to infants for more efficient learning. Future studies will be needed to help address these factors.

APPENDIX I

Native Speaker Survey Questions for the online rating study

1. How old are you?
   (drop down menu choice: 14 or under, 15-20 years, 21-25 years, 26-30 years, 31-35 years, 36-40 years, 41-45 years, 46-50 years, 51-55 years, 56-60 years, 57-65 years, 66-70 years, 71-75 years, 76-80 years, 81-85 years, 86-90 years, 91 or older)

2. Sex? (radio button: choice between male and female)

3. Are you a parent? (drop down menu choice: Yes or no)

4. If yes, how many children do you have?
   (drop down menu choice of: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 or more)

5. How old and what sex are your children? (free fill in)

6. If no, do you have regular contact with children or infants (nieces, nephews, siblings…etc.)? (radio button: Yes or No)

7. If yes, explain your relationship and how often you interact? (free fill in)

8. How old and what sex are these children? (free fill in)

9. In what country were you born? (free fill in)

10. Throughout your life how many years did you live in that country?
    (drop down menu choice: all my life, 1-3 years, 4-6 years, 7-9 years, 10-12 years, 13-15 years, 16-18 years, 19-21 years, 22-24 years, 25-27 years, 28-30 years…and so forth)

11. Have you lived in another country besides the country in which you were born?
    (radio button: Yes or no)

12. If yes please list all? (free fill in)

13. In what country do you currently live? (free fill in)

14. What was your first/primary language you learned? This would be the language that was spoken in your home while you were growing up.
    (drop down menu had the 14 languages collected)

15. How long have you been speaking this particular language?
    (drop down menu choice: all my life, 1-3 years, 4-6 years, 7-9 years, 10-12 years, 13-15 years, 16-18 years, 19-21 years, 22-24 years, 25-27 years, 28-30 years…and so forth)

16. How often do you speak this particular language in your daily life?
    (drop down menu choice: daily, weekly, monthly, yearly, never)

17. Can you read in this particular language? (radio button: Yes or No)

18. Can you write in this particular language? (radio button: Yes or No)

19. Can you understand this particular language when it is spoken to you?
    (radio button: Yes or No)

20. Do you know other languages? (radio button: Yes or No)

21. How many? (drop down menu choice: 1, 2, 3, 4, 5, 6, 7, 8, 9 , 10 or more)

22. If yes please list the languages and how often (daily, weekly, monthly, yearly) you speak them? (free fill in)

23. What language(s) do you speak throughout a typical day? (free fill in)

24. How often are you exposed to other languages that you do not speak?
    (drop down menu choice: daily, weekly, monthly, yearly, never)

25. If you are exposed to other languages, what are these languages? (free fill in)

26. In regards to English, do you consider yourself fluent? Please check all that apply.
    (radio button: speak, read, write)

27. At what age did you learn to speak English?
    (drop down menu choice: 3 years, 4-6 years, 7-9 years, 10-12 years, 13-15 years, 16-18 years, 19-21 years, 22-24 years, 25-27 years, 28-30 years, 30 or more years)

28. At what age did you learn to read English?
    (drop down menu choice: 3 years, 4-6 years, 7-9 years, 10-12 years, 13-15 years, 16-18 years, 19-21 years, 22-24 years, 25-27 years, 28-30 years, other-specify--)

29. At what age did you learn to write English?
    (drop down menu choice: 3 years, 4-6 years, 7-9 years, 10-12 years,
    13-15 years, 16-18 years, 19-21 years, 22-24 years, 25-27 years, 28-30 years,
    other-specify--)

APPENDIX II

Infant-Directed Speech Rating Questions for the online rating study

1. Does this sound like a comforting phrase, an approving phrase or neither?
    a. Please choose your answer.
    (drop down menu: comforting, approving, neither)

2. How confident are you about your answer to question #1?
    a. Please choose your answer. (a 3-point scale)
    (drop down menu: 1=not confident, 2=somewhat confident, 3=very confident)

3. Use the scale below to rate how typical the phrase is of a comforting phrase or an approving phrase in your language. (a 5-point scale)
    1=Not at all typical, 2=Slightly typical, 3=Typical, 4=More typical, 5=Extremely typical

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VITA

Elvalicia Granado was born in Terrell, Texas on April 10, 1978. She is the daughter of the enchanting Elva Gomez and the magical Reyes Reynoso and sister to the suave Isaias Reynoso. While attending the magnet program at Polytechnic High School for Finance and Communications in Fort Worth, Texas, she was enrolled in English and math college courses at Texas Wesleyan University. She thrillingly entered Brown University at Providence, RI, after graduating high school with summa cum laude honors. During the summer of 1997 she attended Tarrant County Junior College. She earned her degree of Bachelor of Science in neuroscience, with academic honors, from Brown University in May 2001. She has been a member of Sigma Xi since 2001. She moved to Göteborg, Sweden, and participated in the MIRT Global Health Promotion Research Program, as a research assistant, in the Department of Rehabilitation Medicine at the Sahlgrenska University Hospital. When she moved back to the USA, she first worked as a teacher and later as a research assistant at Harvard Medical School's AIDS Research Center at the Massachusettes General Hospital. This led to a successfull publication in the Journal of Virology: "Migration of Antigen Specific T-Cells Away From CXCR4 binding HIV-1 gp120". She decided to enter the graduate School of Behavioral and Brain Sciences at the University of Texas at Dallas in July 2004.