Clinical data are especially instructive to linguistics when they show that certain components or functions of the language system may be separately disrupted. In those cases where all functions are equally disturbed, we gain no insight into the hierarchical nature of language organization or mechanisms underlying different language components. However, in those cases where only some elements or functions are disturbed, we can sometimes bring evidence to bear on issues regarding the relative complexity of linguistic units and interaction of different language components. One potential source of clinical data for linguistics comes from the effects of delayed language development.

Up to the present, the bulk of published research on delayed language development had focused on English-speaking subjects. There is a critical need for information about the effects of delayed language development in other languages. Without such information, we cannot determine those features of delayed language development that are common across languages from those that are specific to particular languages. To our knowledge, there are no published data available on delayed language development in Thai, the national language of Thailand. The present study represents an initial effort to fill this information gap.

Because of the wide range of intersubject variability among language-disordered populations (Leonard 1983), it may not always be wise to represent their behavior by reporting only a group mean. Unlike the case of research with normal subjects, one cannot consider the within group variance of the sample of speech/language-disordered subjects as consisting primarily of random error variance but must seriously consider the possibility that a large part of this variance is caused by theoretically important individual differences (cf. Caramazza & Martin 1983). A single subject design eliminates this particular problem. In a single subject design, on the other hand, it is essential that multiple measures across a variety of tasks are taken in order to draw valid conclusions. The present case study of a Thai-speaking subject (LI) is offered as an example of the kind of detail that is required for drawing valid conclusions about selected speech production capabilities of an individual subject.

Because of the clinico-perceptual impression of disturbances in certain aspects of LI's timing and fundamental frequency (F0) control, this paper reports on an acoustic-perceptual investigation of important linguistic distinctions in the Thai language associated with timing and F0. We selected different aspects of timing control that are associated with linguistic units that occur at different levels of linguistic representation.

Thai is a language that has a maximum of three voicing categories of stops in word-initial position: a three-way opposition (voiced unaspirated, voiceless unaspirated, voiceless aspirated) at the bilabial (/b, p, pʰ/) and alveolar (/d, t, tʰ/) places of articulation and a two-way opposition (voiceless unaspirated,
voiceless aspirated) at the velar (/k, kʰ/) place of articulation. Previous studies of the production of voice onset time (VOT) in normal adult speakers of Thai have shown distinct nonoverlapping distribution of VOT for homorganic word-initial stops in isolated words (Gandour 1985; Lisker & Abramson 1964). VOT values for /b, d/ lie in the long voicing lead region, for /pʰ, tʰ, kʰ/ in the long voicing lag region, and for /p, t, k/ at zero or in the short voicing lag region. VOT associated with word-initial stops provides a measure of consonant timing at the syllable level.

In Thai, differences in the duration of short and long vowels are used phonemically (e.g., /hát/ 'to practice' vs. /hát/ 'beach'; /bót/ 'to grind' vs. /bót/ 'temple'; /khun/ 'you' vs. /khun/ 'to multiply'). Although there are concomitant differences in vowel quality for the mid and high vowels, the overriding importance of duration has been amply demonstrated in perception experiments with Thai normal adults (Abramson 1962). Previous studies of the production of vowel length in normal adult speakers of Thai have shown that short and long vowel productions fall into distinct, nonoverlapping regions along the duration continuum (Abramson 1962, 1974). Vowel duration associated with a quantity opposition is a measure of vowel timing at the syllable level.

Rhythm has traditionally been defined in terms of the timing of syllables and the intervals between them. Pike (1945) divided languages into two rhythmic categories: languages in which all syllables are equally spaced in time (syllable-timed) or languages in which only stressed syllables are equally spaced in time (stress-timed). Luangthongkham (1977) concluded that rhythm in Thai has characteristics of both syllable-timed and stress-timed languages. Rhythmic patterns associated with syllables, phrases, and sentences provide a measure of timing control at the extrasyllabic or discourse level.

Thai is a tone language. In a tone language, every syllable or word may have a distinctive pitch pattern as part of its phonemic structure. Thai has five contrastive pitch patterns, or lexical tones, traditionally labeled mid, low, falling, high, and rising (Gandour 1975). The primary acoustic correlate of tone is generally considered to be F₀ states and movements. In prepositional position in Thai, the mid tone can be described as mid level with a final drop, low tone as low falling, falling tone as high falling, high tone as high rising, and rising tone as low rising (see Abramson 1962, 1976 for acoustical description of Thai tones). F₀ contours associated with the five Thai lexical tones provide a measure of F₀ control.

Accordingly, in this paper we report on the findings of four acoustic-perceptual experimental studies of LI's production of VOT of homorganic word-initial stops (Study 1), vowel duration of phonemic short and long vowels (Study 2), durational patterns of syllables, phrases, and sentences in connected speech (Study 3), and F₀ patterns of lexical tones (Study 4).

Case Report

LI was a 16-year-old male boy, who was seen at Ramathibodi Hospital in the summer of 1980, at which time the data for this study were collected. LI was a monolingual native speaker of Central Thai. At the time of testing for this study, LI had been receiving speech therapy at Ramathibodi Hospital biweekly for about a year and a half. When LI was first seen at age 15, audiological testing demonstrated LI's hearing to be normal. His ENT exam was normal. His neurological evaluation was normal. The neurologist's diagnosis was "developmental articulation disorder" with a recommendation for speech therapy. According to the speech pathologist, LI exhibited a "severe articulation disorder". Almost all consonants were produced as glottal stops. Vowels were distorted, including both monophthongs and diphthongs. His tonal production was aberrant. With therapy, his consonant
production improved dramatically; some vowels were still distorted, especially diphthongs; tone production improved slightly. By self report, LI didn’t start speaking until he was about 3 years old. Other than a delay in language development, LI’s medical history was normal. His birth was without complications. He did not suffer from any prolonged childhood diseases. At the time of testing, LI had already completed nine years of formal education.

Study 1: Voicing Contrast in Word-Initial Stops

Perception

Method

Subjects. Data were obtained from LI for the present study. For comparison purposes, data for one normal, male adult subject were taken from a previously published report (Gandour & Dardarananda 1982).

Stimuli. A total of 37 stimuli for each place of articulation were synthesized by means of a computer-controlled parallel resonance synthesizer at Haskins Laboratories (Lisker & Abramson 1970, pp. 563-564). The continuum ranged in VOT from -150 to +150 m sec: from -150 to -10 in 10 m sec steps, from -10 to +50 in 5-m sec steps, and from +50 to +150 in 10-m sec steps.

Each stimulus consisted of three steady-state formants of a vowel of the type /

/. Bilabial, alveolar, and velar stops were made by adding appropriate release bursts and formant transitions to the beginning. For voicing lead, only low-frequency harmonics of the buzz source were used; for voicing lag, the interval between burst and onset of pulsing was excited by hiss alone, the first formant was suppressed. Each stimulus variant had a fundamental frequency of 114 Hertz with a falling contour near the end of the vowel.

For each place of articulation, two test tapes were constructed, each consisting of a separate random presentation of two occurrences of each stimulus.

Listening Procedure. Each subject was tested individually in a quiet room. The test tapes were played on a Nagra IV-S tape recorder and the signal was presented through TDH-39 headphones at a comfortable listening level.

Subjects were instructed to identify each stimulus by pointing to a card displaying the Thai printed letter and picture of its alphabet keyword: /b/ 'leaf', /p/ 'fish', /pʰ/ 'tray', /d/ 'child', /t/ 'turtle', /tʰ/ 'soldier', /k/ 'chicken', /kʰ/ 'water buffalo'.

Results and Discussion

Identification functions for the VOT continua for the normal subject and LI are shown in Figure 1. The curves give the distribution of a subject’s identification of the synthetic speech stimuli as functions of VOT values. As shown in Figure 1, the labeling curves for the normal subject reflect three distinct perceptual categories for the bilabials and alveolars, and two for the velars. His performance replicates the findings of Lisker & Abramson (1970) both in terms of location of the VOT boundaries and steepness of the identification functions. LI’s labeling curves, on the other hand, reflect only two distinct perceptual categories regardless of place of articulation. For the bilabials, there is no sharp perceptual boundary between /b/ and /p/; for the alveolars, there is no sharp perceptual boundary between /d/ and /t/. His labeling curves for /p/ and /t/ and /k/ are similar to those for normals. With the exception of four VOT values in the voicing lead region of the continuum, LI’s labeling curve for /k/ also mirrors that of normals. Thus, LI’s deficit in VOT perception appears to be restricted primarily to the voicing
Fig. 1. Identification functions for VOT contrasting at three places of articulation for a normal Thai adult (N: adapted from Gandour & Bardesanada 1982) and L.I.