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Latency and slope values of evoked responses in children in brain stem audiometry

Brenda S. Schick

LATENCY AND SLOPE VALUES OF EVOKED RESPONSES IN CHILDREN IN BRAIN STEM AUDIOMETRY

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A sequence of potential waves can be identified in the summed responses recorded from the surface of the human scalp following auditory stimulation. This study concerns itself with the sequence of 6 or 7 waves appearing during the first twelve milliseconds. These early waves apparently reflect the progressive activation of the auditory nerve and the brainstem tracts and nuclei (Hecox and Galambos). More specifically they have been ascribed to the inferior colliculus (Davis, 1976b).

The audiometric usefulness of the fast responses at frequencies of 2000 Hz and above has been establihed (Davis, 1976a). However, much of the research has been done using clicks as stimuli. Since brainstem responses are onset responses, they are best elicited by a clear sharp waveform with close synchronization of the responses (Davis, 1976b). The production of any short duration signal produces considerable spectral dispersion of energy, so that a larger extent of the basiliar membrane becomes activated the shorter the signal's duration. The spread of the excitation pattern away from the region of the center frequency of the stimulus may be limited by presenting low intensity signals. However low intensity stimuli exhibit greater variability than intense stimuli.

This study utilized tone pips with a rise and fall time of two cycles or more and a plateau of 4 to 6 cycles. It attempts to quantify the latencies of these early evoked responses as seen in young children and compares these latencies with those of adults.

METHOD

Fifteen children aged two weeks to four and a half years participated in this study. They were considered "high-risk" infants and referred for Electric Response Audiometry at Central Institute for the Deaf. All had hearing with normal limits as measured by the testing. Three adults (one male, two female) also participated in the study.

Standard EEG disc electrodes were attached to the vertex, forehead, and both mastoids of all subjects. The electrodes were led to a pre-amplifier, and the signals, after further amplification were averaged. The onset of averaging was synchronized to the stimulus onset. Each summed recording was printed out on an X-Y Plotter.

The majority of the children had recordings at 60 and 30 dB SPL re SKH) at 4000 and 2000 Hz. All subjects slept during the testing.

The mean results for 2000 Hz plotted in Fig. 4 show a scatter of mean latencies similiar to 4000 Hz. The standard deviations are larger for 2000 Hz with values of .65 (60 dB SPL) and .75 (30 dB SPL) as seen in Fig. 5. The latencies for only one adult are given since the other adults were not tested at equal intensities.

It may be noted that the absolute values of the mean latencies are little indication of the actual threshold level. A latency of 7.1 msec. is within one standard deviation for both 60 and 30 dB SPL at 4000 Hz.

A more stable feature of the latencies is their slope from 30 to 60 dB SPL. A measure of the mean slope was computed by subtracting each individual mean latency at 60 dB SPL from the latency at 30 dB SPL.

The mean difference at 4000 Hz was 1.22 msec. with a standard deviation of .26 msec. This averaged slope and standard deviation are shown in Fig. 6. The absolute values used are derived from the mean latency measures. One can see that there is a much smaller deviation when the slope is considered. The mean adult latencies are shown to illustrate the similiarity in slope although the actual latencies are shorter.

The longer latencies reflect the increased traveling wave time on the basiliar membrane. The greater variability may be a result of decreased synchronization of the stimulus due to the increased separation and longer length of the waveform. That is at lower frequency the elicited response may be due to separate waveforms rather than a single clear stimuli.

An interesting result was the lack of correlation concerning age dependency. Hecox and Galambos (no date) found a systematic dependency of latency upon age for very young children. They report other research that confirms their results (Lieberman it al, and Jewett and Romano).

This study showed very low correlation (.17 and .37) of latencies as a function of age. However it must be noted that the sample was small (15) and involved a wide range of ages (0-2 to 4-6). Hecox and Galambos stated that latency shortens during infancy to attain the adult value somewhere between 12 and 18 months of age. No correlation of age with the slope of the latencies was found either.

A major feature of this study was the reliability of the slope of the latency curve as measured by computing the mean dB difference between 60 and 30 dB. The range of absolute values for the latencies varied considerably at

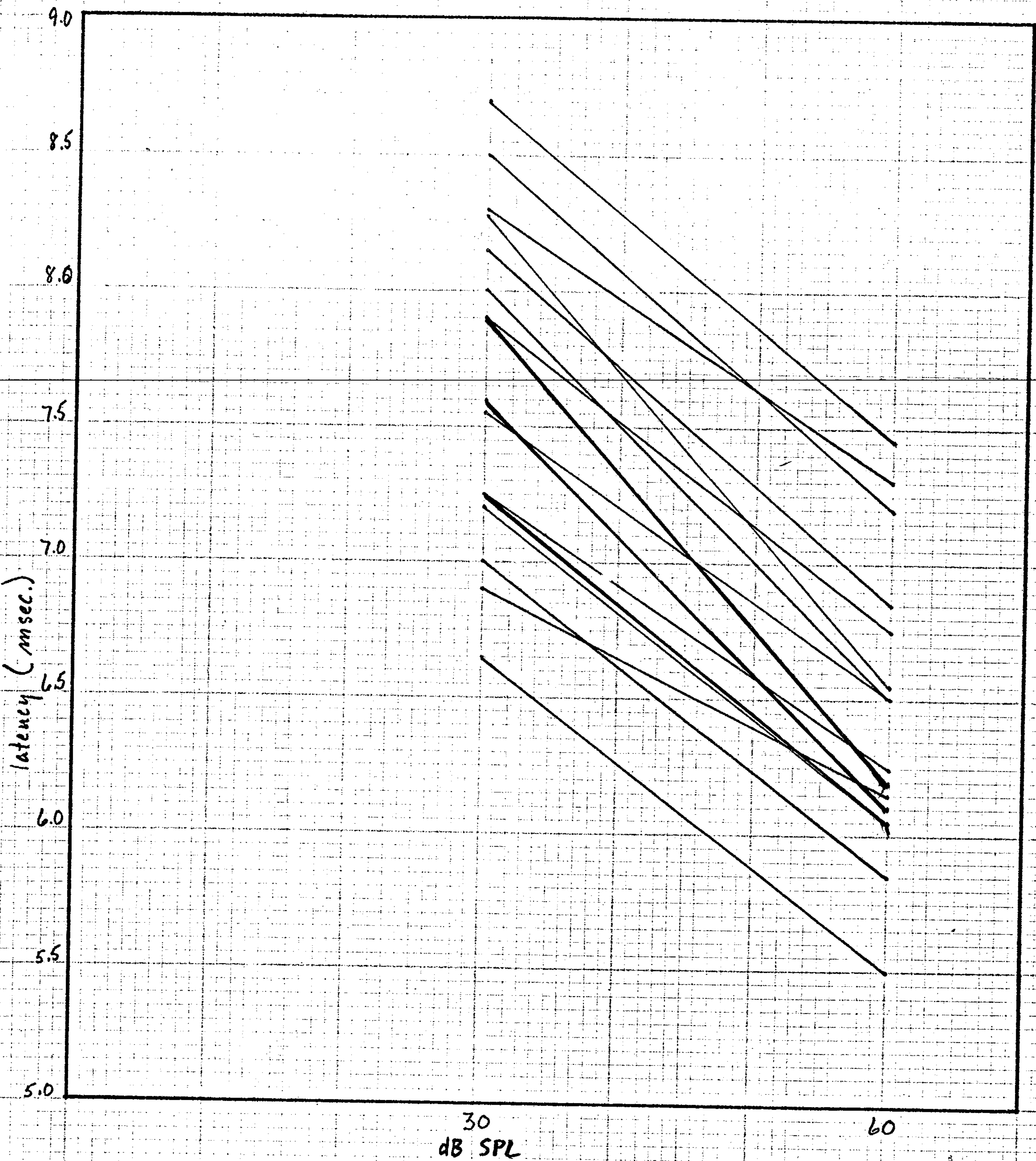

Fig. 2. 4000 Hz. The Relationship between Intensity and Wave P_6 latency. Black lines: means between ears on each of 15 children. Red lines: Data from 3 adult subjects.

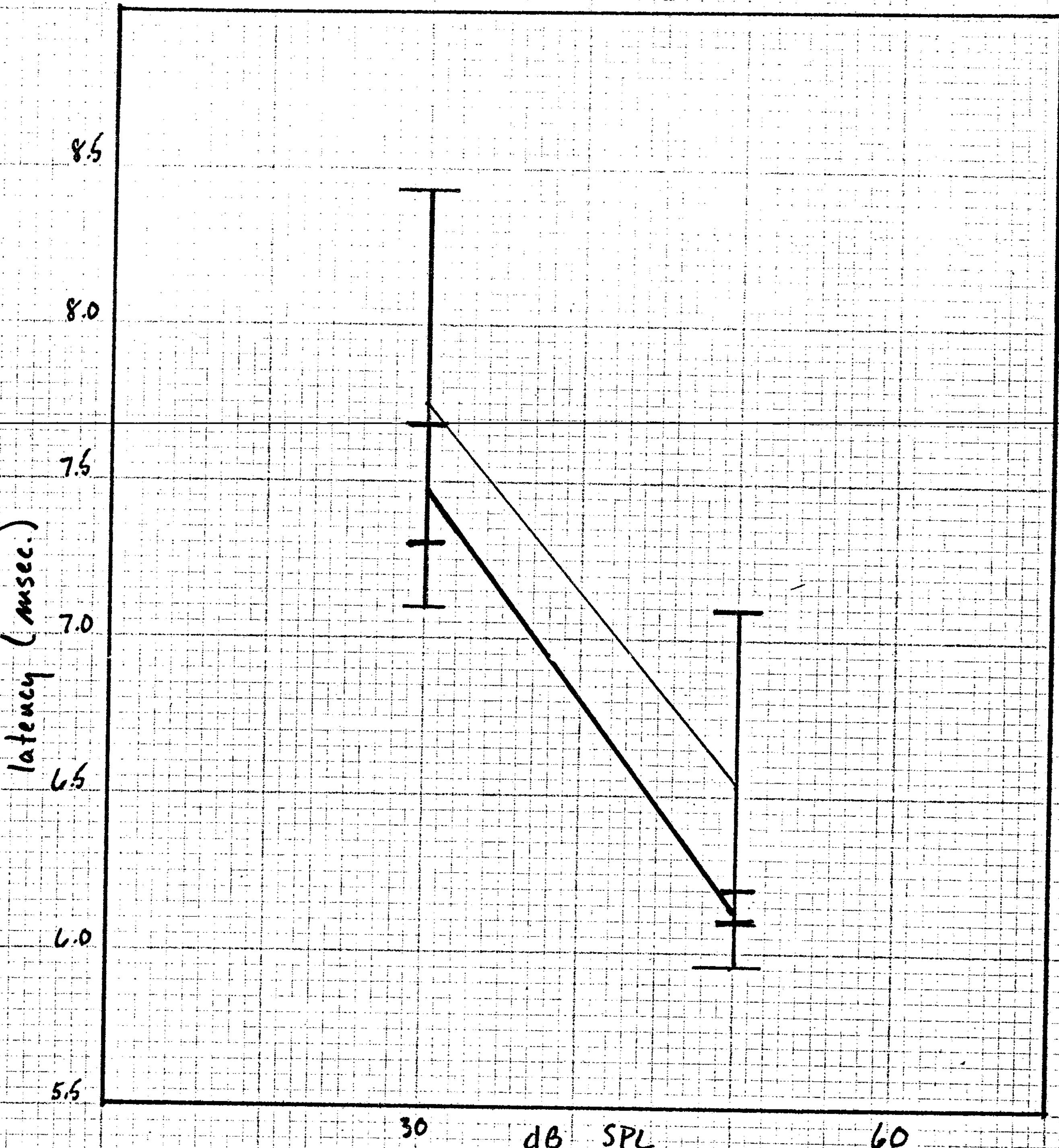

Fig. 3. 4000 Hz. Average Relationship between Intensity and Wave P_6 latency. Black Lines: Mean latency values for 15 children. Red lines: mean latency values for 3 adults. Vertical bars show ± one standard deviation.

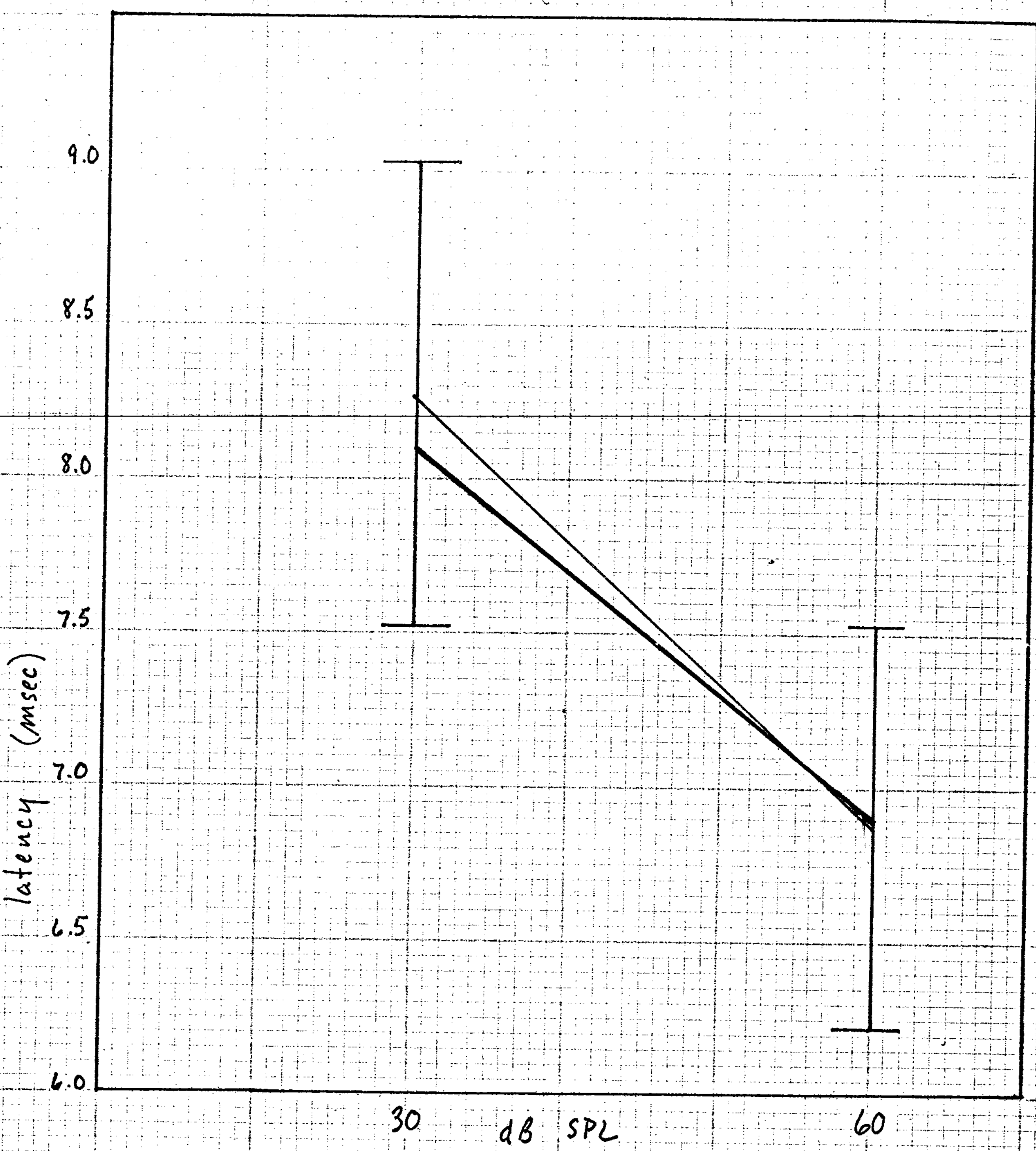

Fig. 5. 2000 Hz. Average Relationship between Intensity and Wave P_6 latency. Black Line: Mean latency values for 15 children. Red line: Latency values for a single adult. Vertical bars show ± one standard deviation.

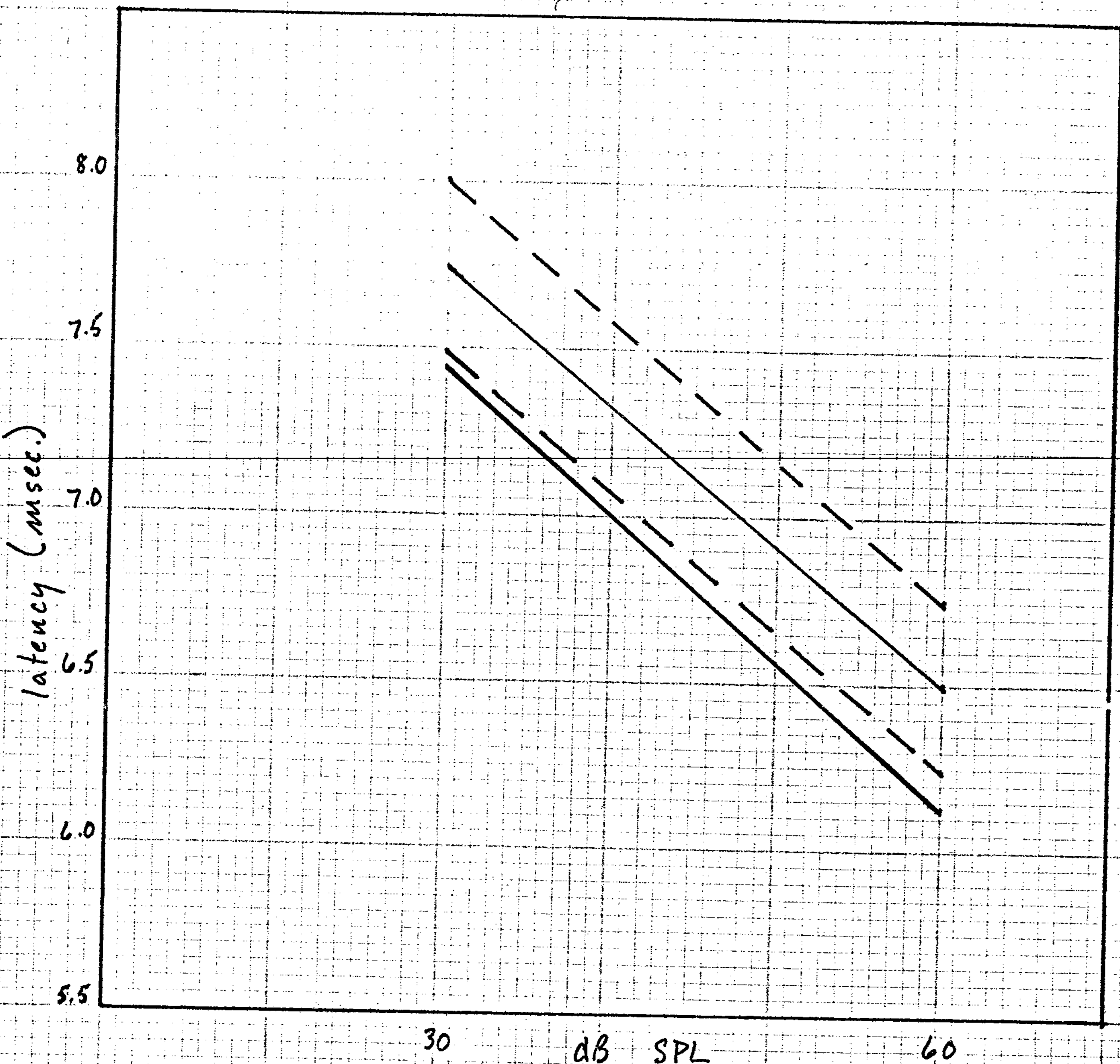

Fig. 6. 4000 Hz. Averaged slope of mean latency values for 15 children. Black line: Children. Red Line: Adult values Dashed lines show ± one standard deviation.

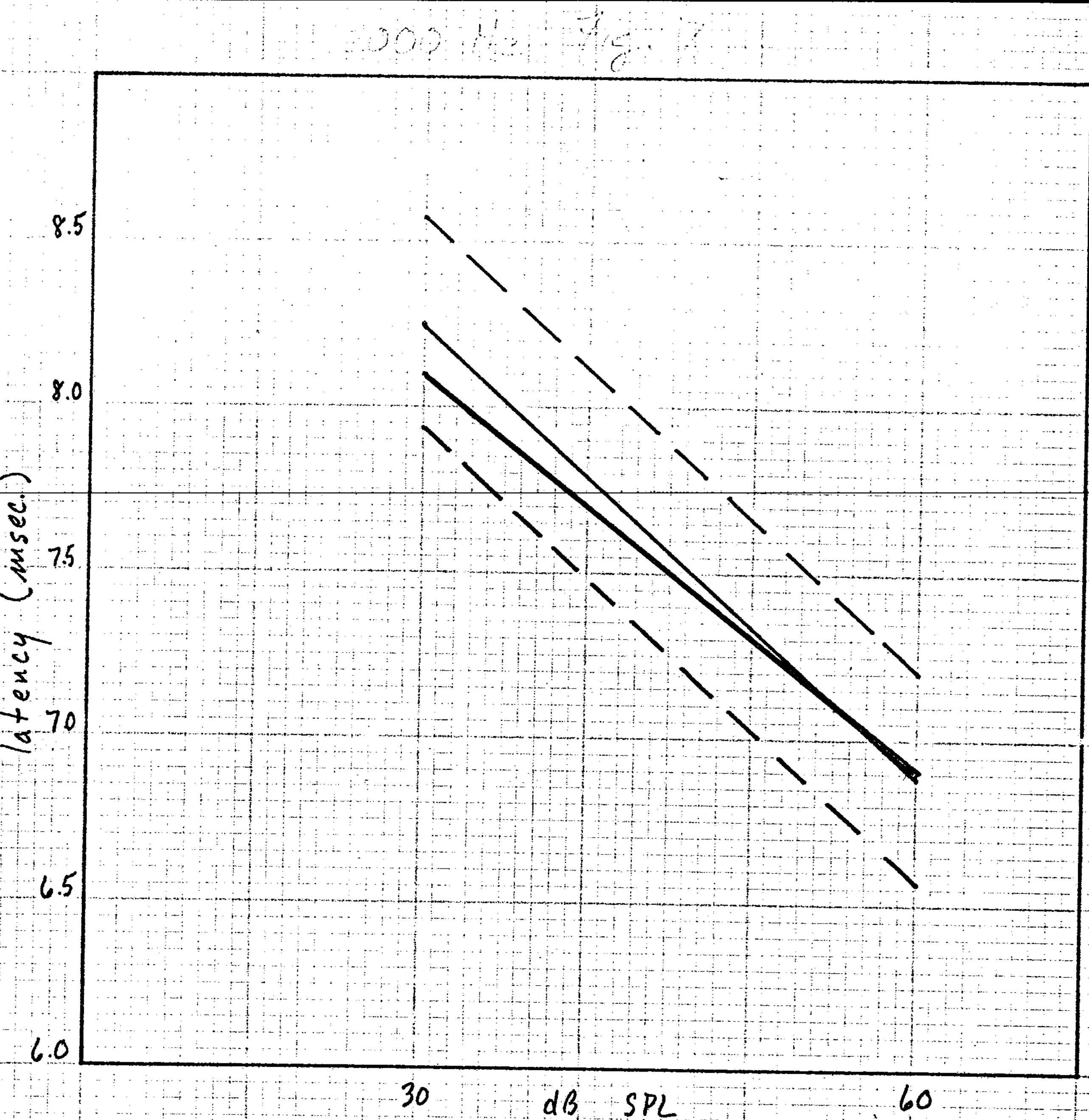

Fig. 7. 2000 Hz. Averaged slope of mean latency values. Black Lines: Mean slope for 15 children. Red Line: Mean slope of a single adult. Dashed lines show ± one standard deviation.

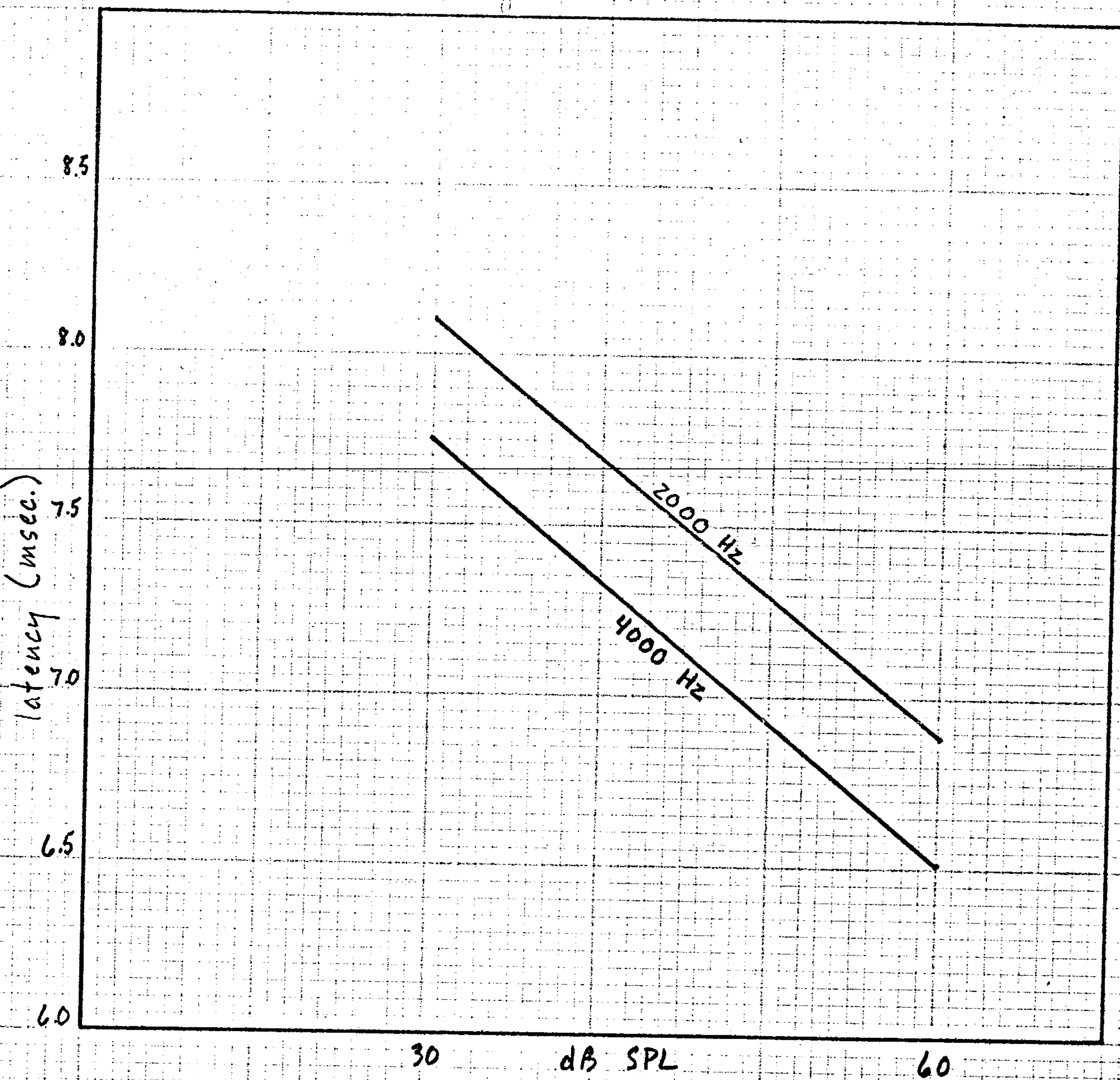

Fig. 8. 4000 and 2000 Hz. Mean slope at the frequencies for 15 children.

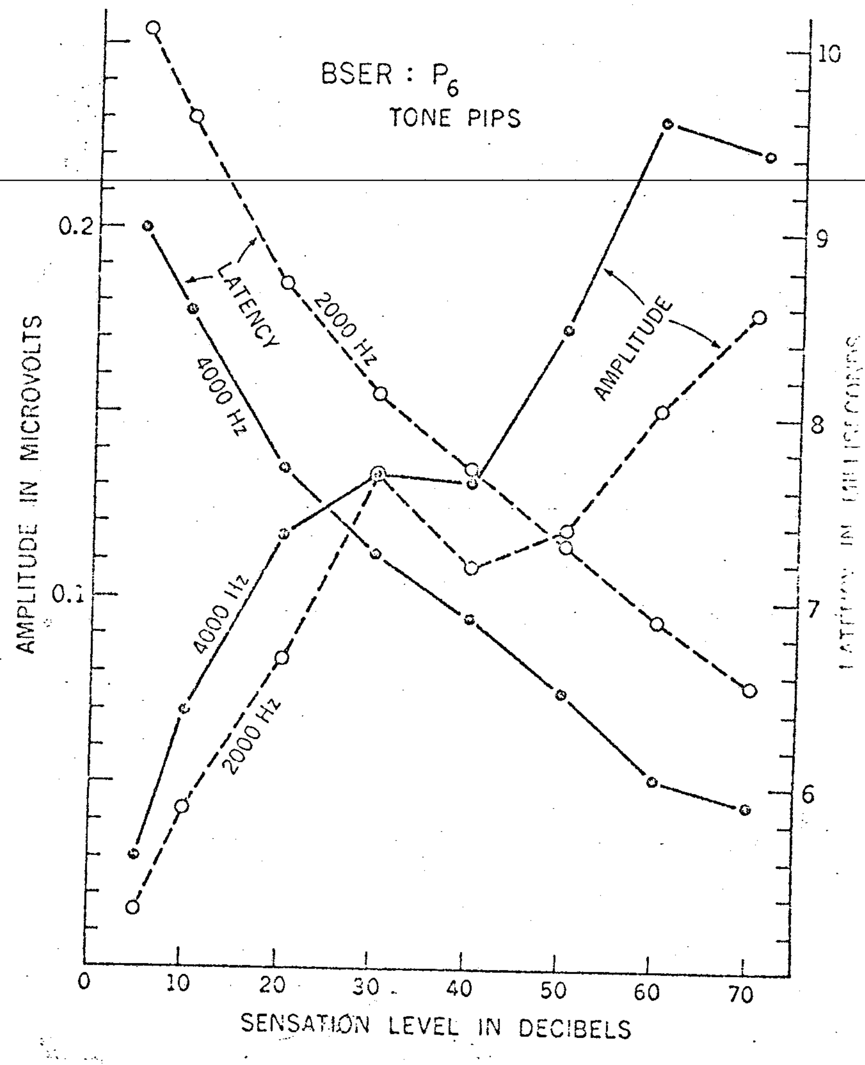

Fig. 9. Latency and Amplitude curves for a single adult at 4000 and 2000 Hz.

Clinic Children "within normal limits"
2000 Hz

Child	Age	$\bar{X}$ latency (msec) 60 dB	30 dB	Δ $\bar{X}$ latency 30-60 dB
J.W.	1-4	6.27	7.7	1.43
K.W.	0-8	6.5	7.2	.7
A.W.	0-9	6.15	7.5	1.35
R.E.	2-10	7.2	9.1	1.9
B.L.	0-2	7.3	8.7	1.5
P.D.	0-10	7.55	8.6	1.05
W.H.	1-8	5.7	7.3	1.6
E.D.	1-0	7.05	8.0	.95
J.F.	2-8	6.65	8.25	1.55
C.R.	1-9	6.4	7.55	1.15
D.S.	4-6	8.2	9.2	1.0
C.S.	2-6	7.0	8.4	1.4
H.E.	0-8	7.3	8.65	1.35
D.M.	3-2	6.9	9.6	1.7
	$\Sigma \bar{x}$ =	96.17	115.75	$\Sigma \Delta$ = 18.63
	$\bar{x}$ =	6.87	8.27	$\bar{X} \Delta$ = 1.33
	σ =	.65	.75	σ = .33