



**Frequency Discrimination:
Difference Limen**

Or

**Auditory steady State
Response?**

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Alex, 2009**

- Freq. Discrimination is a fundamental auditory process underlying more complex auditory tasks, such as sp. comprehension & understanding (Nagle, 2009).

Theories of frequency perception:

- Phase-Locked theory:
- Place theory: (Schukencht, 1993).

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- ✚ Freq. Discrimination can be measured subjectively by two methods:

- ✚ Difference limen for frequency.
- ✚ Frequency Modulation Difference limens (FMDLs) (Moore B.C., 1993).

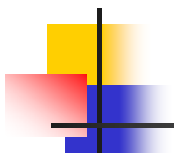
- ✚ DL is the smallest change in frequency that can be detected subjectively (Durrant & Lovrinic, 1995).

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■ ASSR is an electrophysiological response to repeated sound stimuli presented at a high repetition rate (Beck et al., 2007).

■ Modulated stimuli used for eliciting ASSR are useful in assessing how the brain can detect changes in frequency and amplitude (Picton, 2003).

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FM Difference Limen

Versus

Auditory Steady State Response

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✿ Is there a difference between subjective FD (using FMDL) and objective FD (using ASSR)?

✿ Is there a relation &/or a correlation between these two tests since they both measure frequency discrimination?

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Aims

➤ To compare FD in normal H. subjects using FM stimuli in subjective and objective methods.

➤ To correlate between these two procedures.

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Subjects & Method

- ✦ Thirty normal hearing adults.
- ✦ They were 16 females & 14 males.
- ✦ The inclusion criteria:
 - ✦ H T = or < 25dBHL from 250: 8KHz.
 - ✦ Normal ME function

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1 - FMDL

- ✦ Measured at: 500, 1000, 2000, 4000Hz.
- ✦ Mono. signals at 40dB SL.
- ✦ FMDL was defined as the smallest detectable difference in frequency modulation (Krishnamurti, 2000).

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2- ASSR

- Four frequencies were tested separately in each ear.
- Frequencies were: 500, 1K, 2K, 4K Hz.
- Modulation rate was:

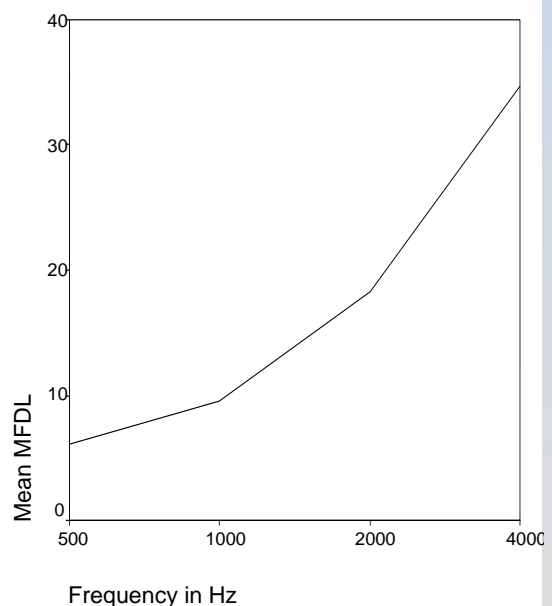
77 85 93 101 → Rt

79 87 95 103 → Lt

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Results

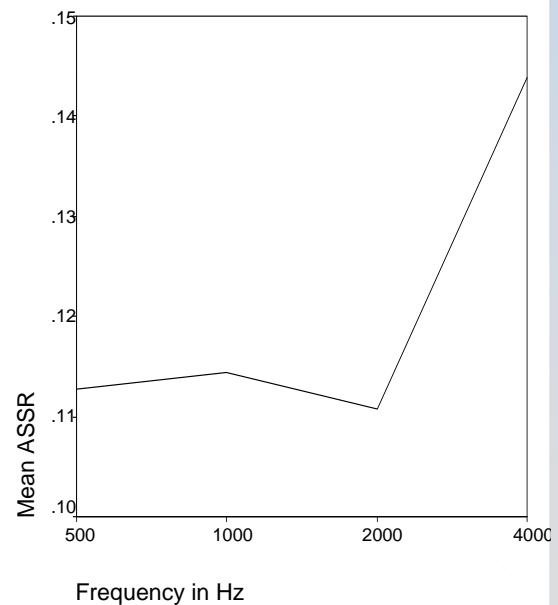
- FMDL increased as the carrier freq. increased from 500:4KHz.
- This result agrees with Propst et al., 2002 & Demany & Smal, 1989. But does not agree with Chen & Zeng 2004.



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ASSR Results

- ASSR response amplitude increased as the carrier freq. increased from 500:4000Hz.
- This result agrees with John et al., 2003 & John et al., 2002.



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Table (1): T- test for comparing FMDL &ASSR

Freq. In Hz	FMDL Mean (SD)	ASSR Mean (SD)	t-value	p- value
500	6.1 (2.20)	0.113 (0.96)	-14.874	0.000
1000	9.6 (0.81)	0.115 (0.1)	-63.37	0.000
2000	18.26 (2.50)	0.111 (0.12)	-39.66	0.000
4000	34.66 (5.69)	0.144 (0.19)	-33.217	0.000

Table (2): ANOVA of the FMDL.

Variables	Sum of Squares	Mean Square	F	p- value
Between Freq.	14615.56	4871.86	441.36	0.000
Within Freq.	1280.43	11.04		

Multiple Comparisons

Dependent Variable: MFDL

Scheffe

(I) TYPE	(J) TYPE	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
500	1000	-3.5000*	.85784	.001	-5.9337	-1.0663
	2000	-12.1667*	.85784	.000	-14.6003	-9.7330
	4000	-28.5667*	.85784	.000	-31.0003	-26.1330
1000	500	3.5000*	.85784	.001	1.0663	5.9337
	2000	-8.6667*	.85784	.000	-11.1003	-6.2330
	4000	-25.0667*	.85784	.000	-27.5003	-22.6330
2000	500	12.1667*	.85784	.000	9.7330	14.6003
	1000	8.6667*	.85784	.000	6.2330	11.1003
	4000	-16.4000*	.85784	.000	-18.8337	-13.9663
4000	500	28.5667*	.85784	.000	26.1330	31.0003
	1000	25.0667*	.85784	.000	22.6330	27.5003
	2000	16.4000*	.85784	.000	13.9663	18.8337

*. The mean difference is significant at the .05 level.

Table (3): ANOVA of the ASSR.

Variables	Sum of Squares	Mean Square	F	p- value
Between Freq.	0.022	0.007	0.428	0.723
Within Freq.	2.008	0.017		

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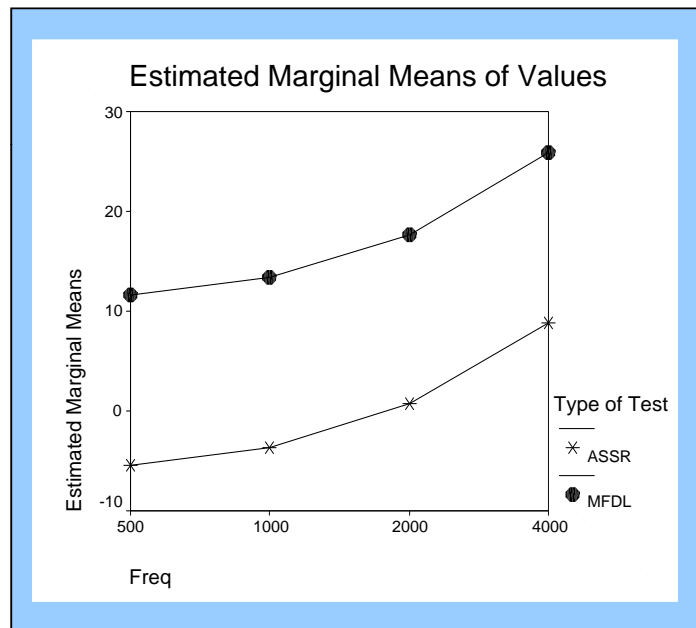
Table (5): ANOVA of FMDL & ASSR

Variable	Type III sum of squares	Mean square	F	P- value
Test	45.36	45.361	1161.4	0.000
Freq.	0.677	0.226	5.774	0.001
Error	9.178	3.906E		

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Figure (3): Correlation between FMDL & ASSR

- In order to drop the measure of units, **standardizing** the values of both tests results was done.
- Results showed **NO Intersection** between the two tests.



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- The absence of significant correlation between FMDL & ASSR in normal hearing subjects, does not mean that we are chasing irrelevant information.
- This correlation may need certain methodology to be apparent, or it may be more evident in subjects with HL.
- In fact, this finding stimulated us to continue to the second phase of this work.

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Conclusions

- FMDL & ASSR amplitude increased significantly with increasing the carrier frequency.
- There was no significant correlation between FMDL & ASSR in normal hearing subjects.

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Recommendations

- ✦ The use different methodologies for subjects with hearing loss.
- ✦ ASSR can then, be used as an objective test for frequency discrimination.

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**Thank You For
Your Attention**

