

## BACKGROUND

Coherence masking protection (CMP) refers to the phenomenon in which lower thresholds for accurate vowel labeling in noise are obtained when an informative F1 is presented with a constant, and therefore non-informative, F2/F3 cosignal than when F1 is alone (Gordon, 1997; 2000).

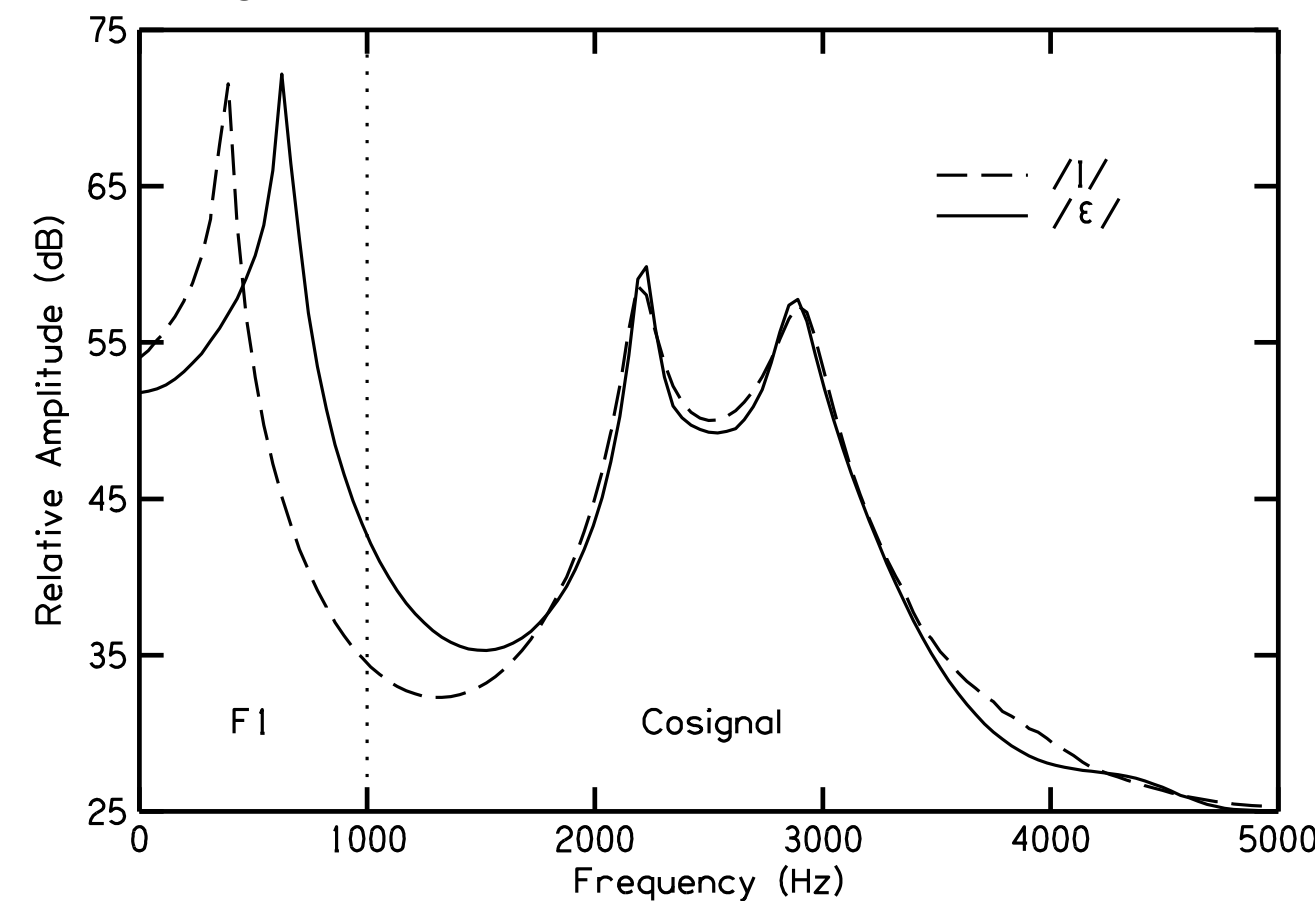


Figure 1. LPC Smoothed Spectrum of Stimuli

Tarr and Nittrouer (2009) reported this effect for adults, and showed enhanced effects for children, with synthetic speech. With sine waves, no CMP was found for any group.

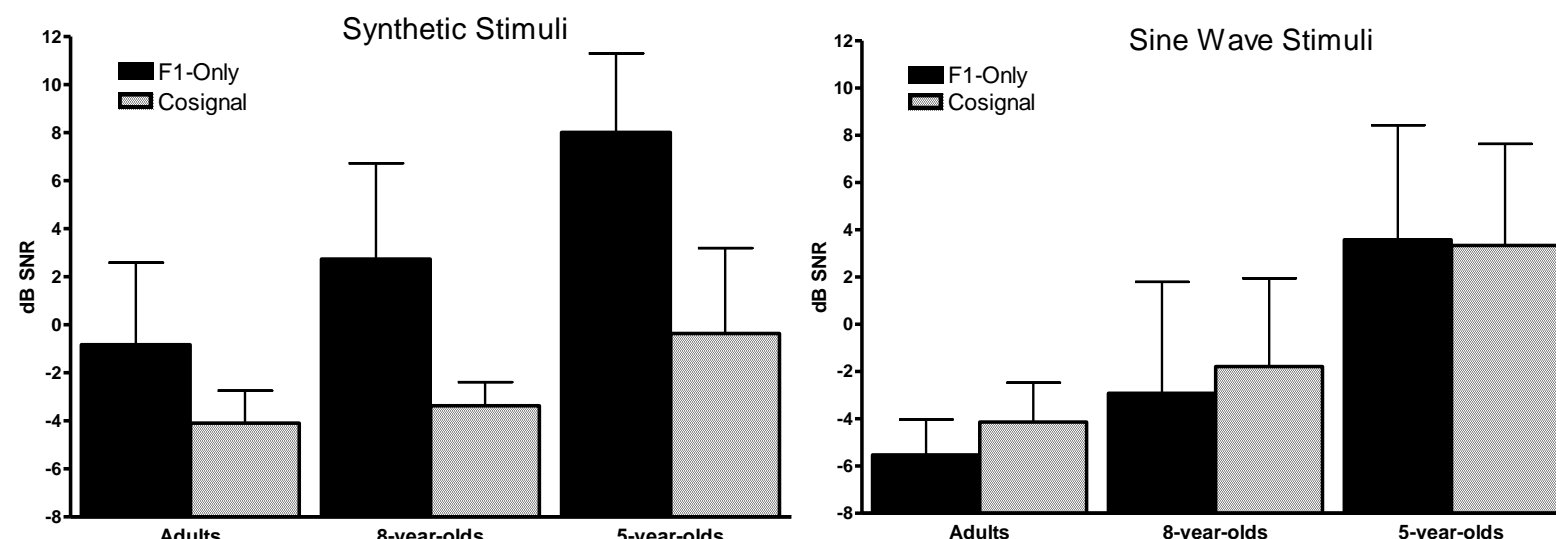


Figure 2. Mean thresholds for synthetic stimuli. Figure 3. Mean thresholds for sine wave stimuli.

### QUESTIONS

Is children's large CMP effect explained by:

- the primitive ASA principle of harmonicity for stream segregation?
- a schema-based ASA principle of signal integration?

To answer these questions, two experiments were conducted with new stimuli. In Experiment 1, the harmonicity principle for inherently speech-like stimuli was violated. Experiment 2 aimed to evoke a speech-like percept for a non-speech signal.

## STIMULI

Speech sounds were steady-state vowels, 60 ms long

Tarr and Nittrouer (2009)

Synthetic Stimuli

- F1 frequency = 375 Hz (/i/) or 625 Hz (/ε/), bandwidth 50 Hz
- F1 amplitude = 74-48 dB SPL in 2-dB increments
- F2 = 2200 Hz, bandwidth of 110 Hz,
- F3 = 2900 Hz, bandwidth of 170 Hz
- Identical F2/F3 for both vowels, -12 dB from F1
- f0 frequency = 125 Hz

Sine Wave Stimuli

Sine wave substituted at formant peaks of F1, F2, F3

Tarr and Nittrouer (2011)

Experiment 1: Different f0 Stimuli

Synthetic F1 with f0 = 125 Hz, Synthetic F2/F3 with f0 = 175 Hz

Experiment 2: Hybrid Stimuli

Sine wave substituted at formant peak of F1, Synthetic F2/F3 with f0 = 125 Hz

Three conditions:

- Lower: F1 = 337 Hz (/i/) or 587 Hz (/ε/)
- Same: F1 = 375 Hz (/i/) or 625 Hz (/ε/)
- Higher: F1 = 438 Hz (/i/) or 688 Hz (/ε/)

**Masking Noise:** White noise low-pass filtered below 1000 Hz at 62 dB to mask F1, 600 ms in duration. Stimuli presented 420 ms after the onset of noise.

## METHOD

Participants

Experiment 1: Adults (20), 8-year-olds (20), 5-year-olds (15).

Experiment 2: Adults (20), 8-year-olds (19), 5-year-olds (15).

Criterion for inclusion

Training was provided with feedback using, in order: 1. natural words, 2. synthetic words, and 3. different f0 or hybrid 60-ms stimuli (F1 or F1 + cosignal). Participants had to correctly label 9 of 10 consecutive stimuli in quiet to move to testing.

Task

Participants labeled stimuli by saying the word *bit* or *bet* and pointing to a picture associated with the word. An adaptive procedure was performed following the '3-down, 1-up' procedure to obtain an 80% correct labeling threshold (Levitt, 1971). Masking noise remained constant at 62 dB SPL, speech stimuli varied from 74 dB to 48 dB. Step size of 8 dB was used for the first two runs, 4 dB for the next 2 runs, and 2 dB for the last 12 runs. Mean of the last 8 runs was the threshold.

- 8 conditions:
1. Hybrid F1 Lower; 2. Hybrid F1 Lower + Cosignal;
  3. Hybrid F1 Same; 4. Hybrid F1 Same + Cosignal;
  5. Hybrid F1 Higher; 6. Hybrid F1 Higher + Cosignal;
  7. Synthetic F1; 8. Different f0 Synthetic F1 + Cosignal;

## RESULTS

Trends were consistent for all three conditions of the hybrid stimuli. Average across Lower, Same, and Higher conditions is shown.

	CMP Difference			
	Tarr and Nittrouer (2009)		Tarr and Nittrouer (2011)	
	Synthetic	Sine Wave	Different f0	Hybrid
Adults	-3.3 (2.2)	+1.4 (1.2)	+0.3 (2.7)	-1.1 (1.7)
8-year-olds	-5.9 (3.2)	+1.2 (3.7)	-5.1 (3.5)	-4.8 (5.2)
5-year-olds	-8.4 (3.2)	-0.1 (4.4)	-7.1 (3.1)	-9.0 (5.8)

Table 1. Mean CMP difference for each condition. Standard deviations are in parentheses.

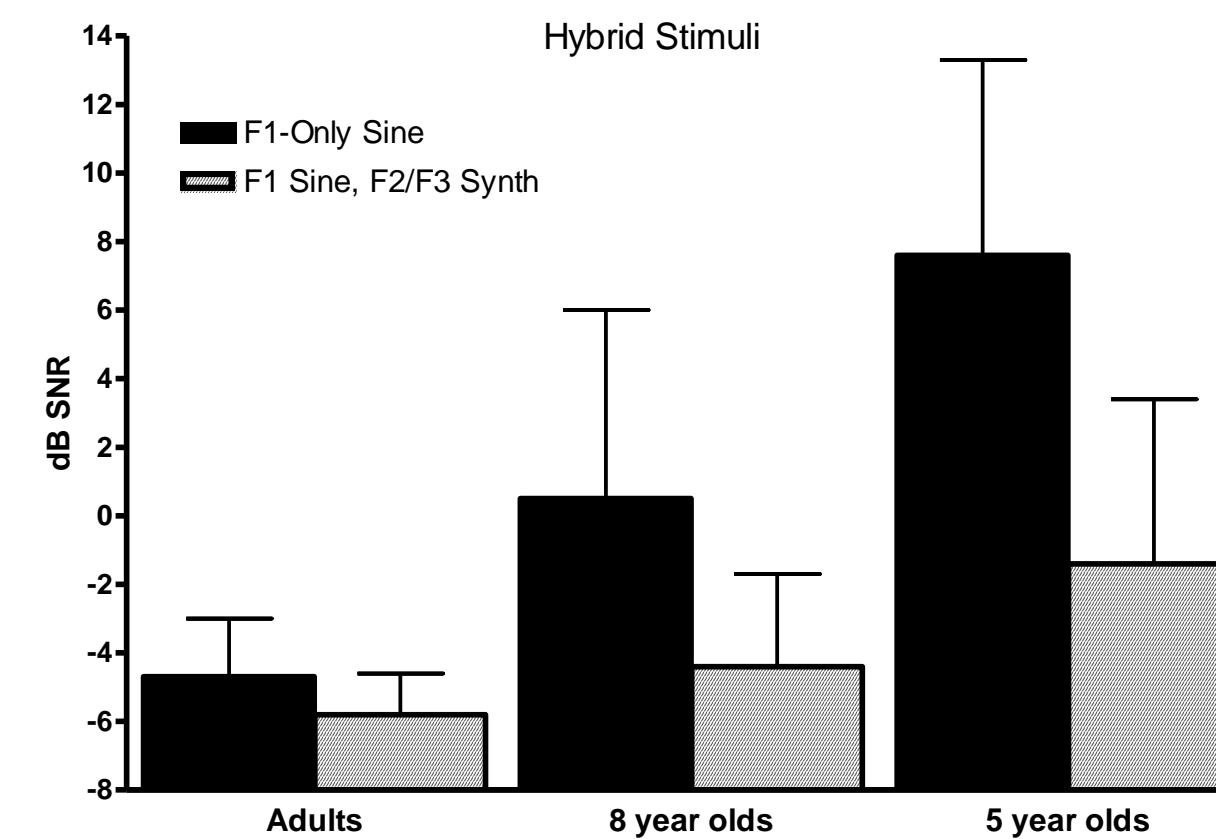


Figure 4. Mean thresholds for hybrid stimuli.

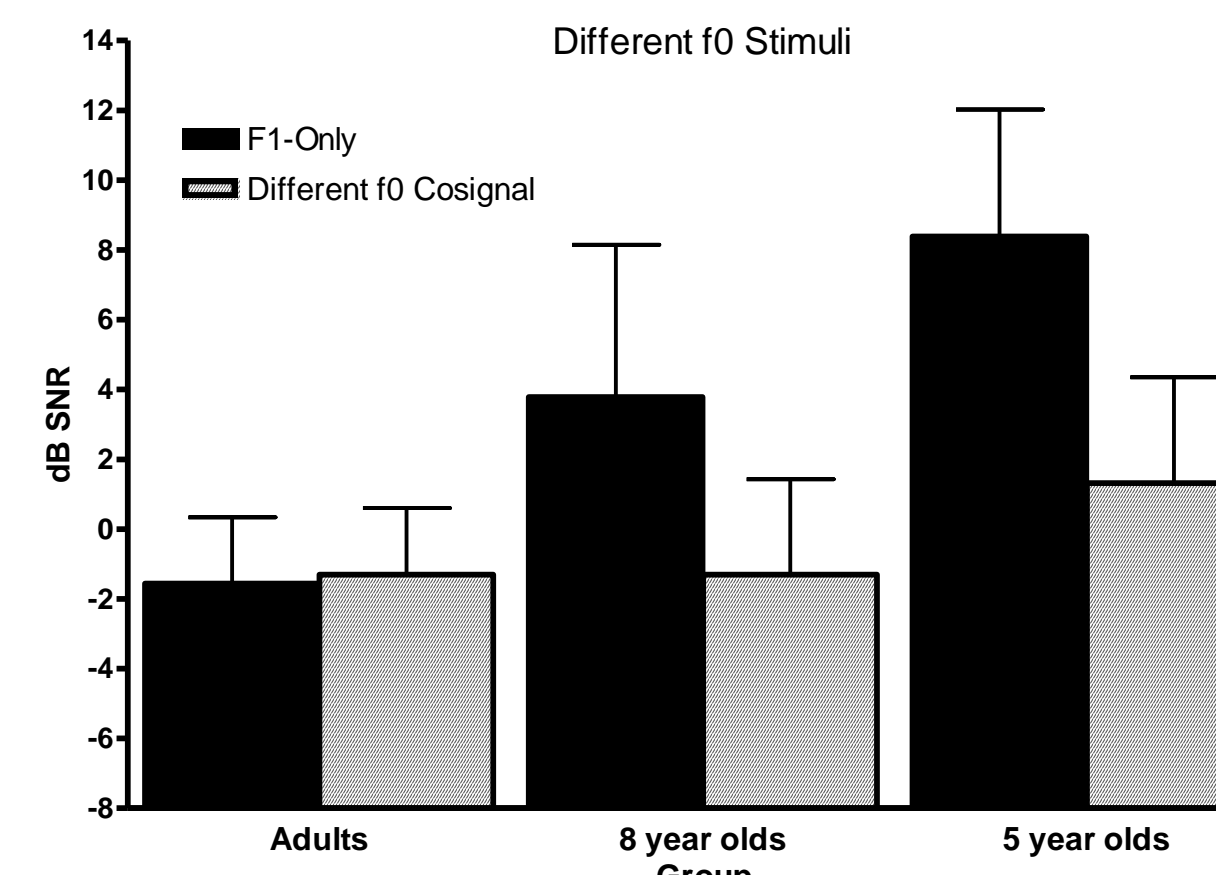


Figure 5. Mean thresholds for different f0 stimuli.

## SUMMARY

Adults did not show a significant CMP effect in either of the new experiments. Disruptions in harmonicity of a signal easily perturbed adults from integrating spectral components, even for speech-like signals.

8- & 5-year-olds showed significant CMP effects in both new experiments similar in magnitude to those found for synthetic speech.

Adding a disharmonic cosignal helped children label vowels.

Adding a speech-like cosignal helped children label vowels for non-speech signals.

## CONCLUSIONS

Children override the primitive ASA principle of harmonicity with schema-based grouping for signals when adults do not.

Children evoke a speech-like schema-based principle of grouping for non-speech signals when adults do not.

**Children do not utilize harmonicity appropriately to segregate signal streams.**

**Children readily organize signals according to a phonetic framework, which is a schema-based principle.**

## REFERENCES

- Gordon, P. (1997). Coherence masking protection in speech sounds: The role of formant synchrony. *Percept. & Psychophys.* 59, 232-242.
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- Levitt, H. (1971). Transformed up-down methods in psychoacoustics. *JASA* 49, 467-477.
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## ACKNOWLEDGEMENT

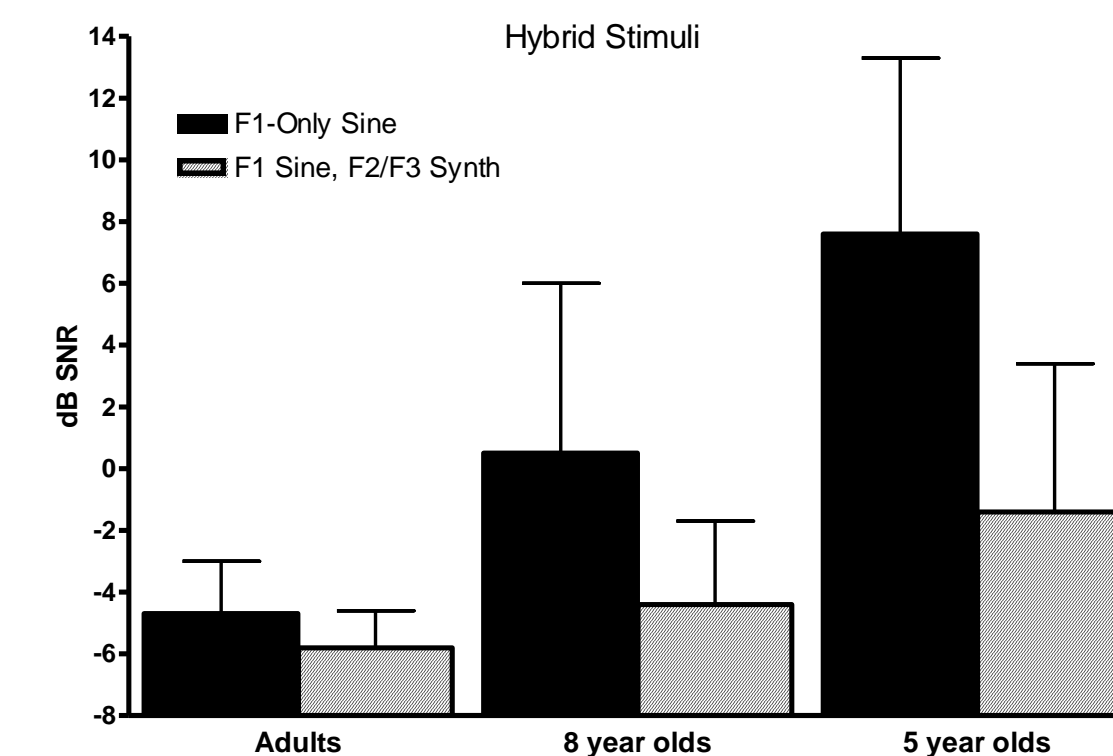
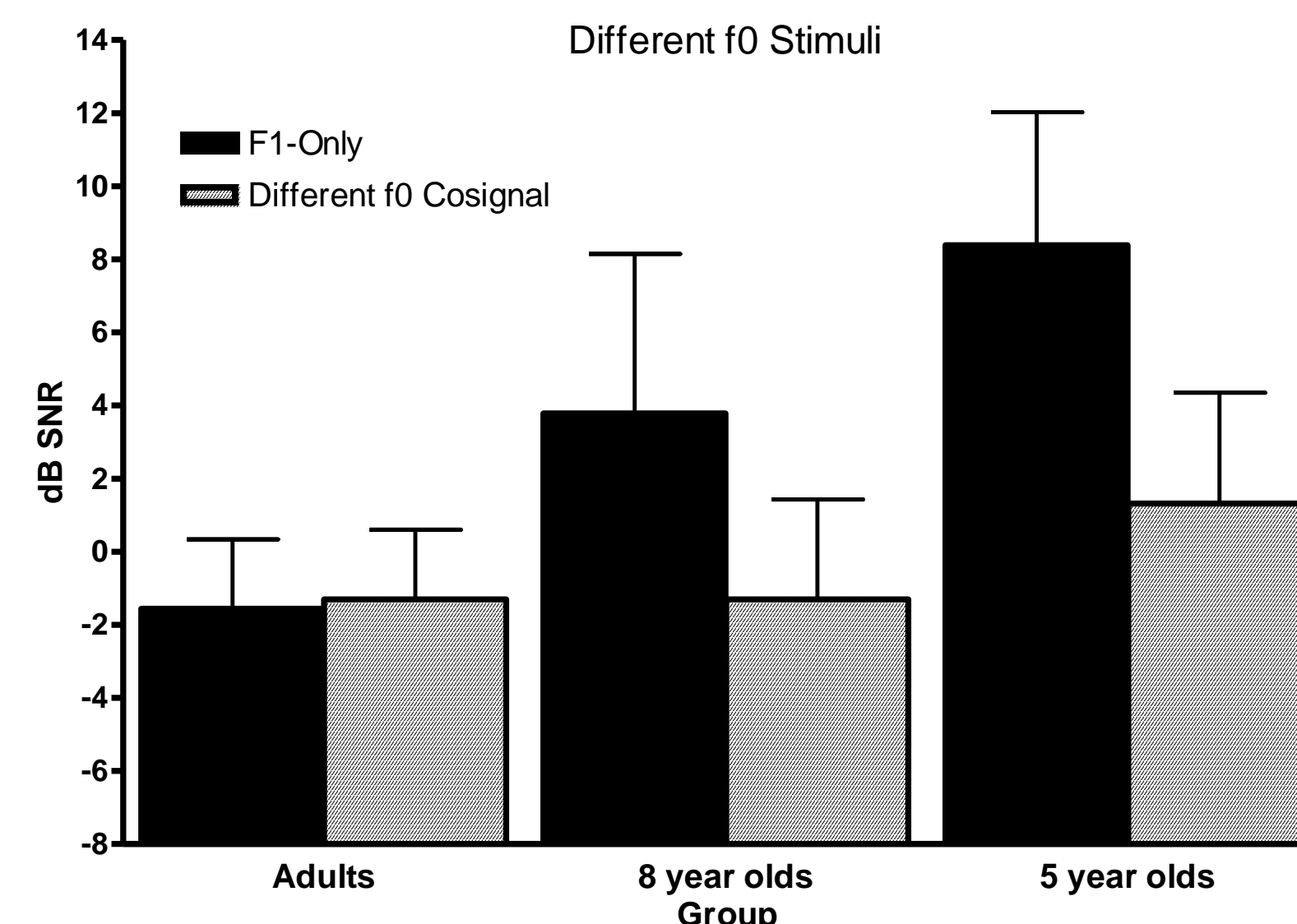
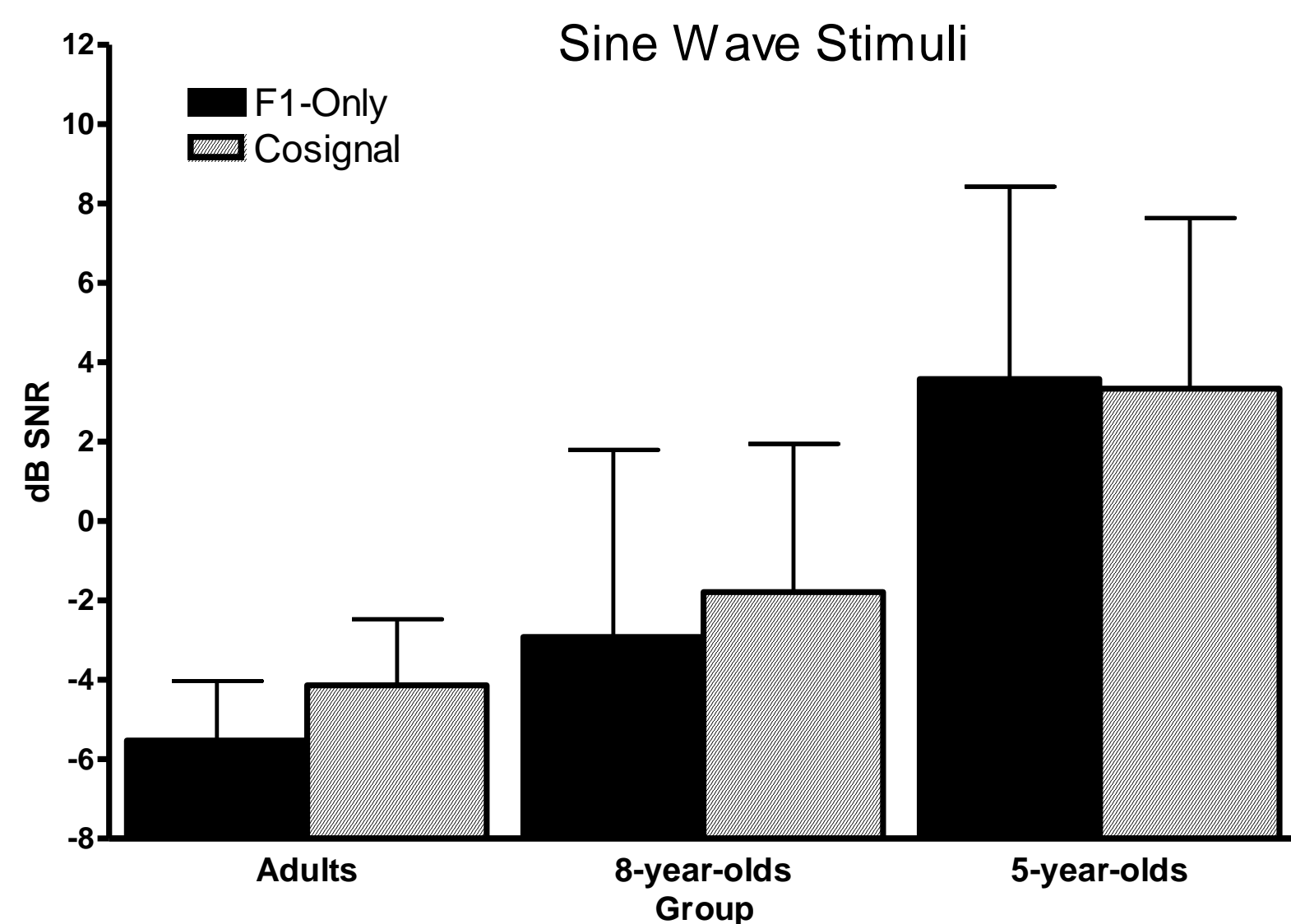
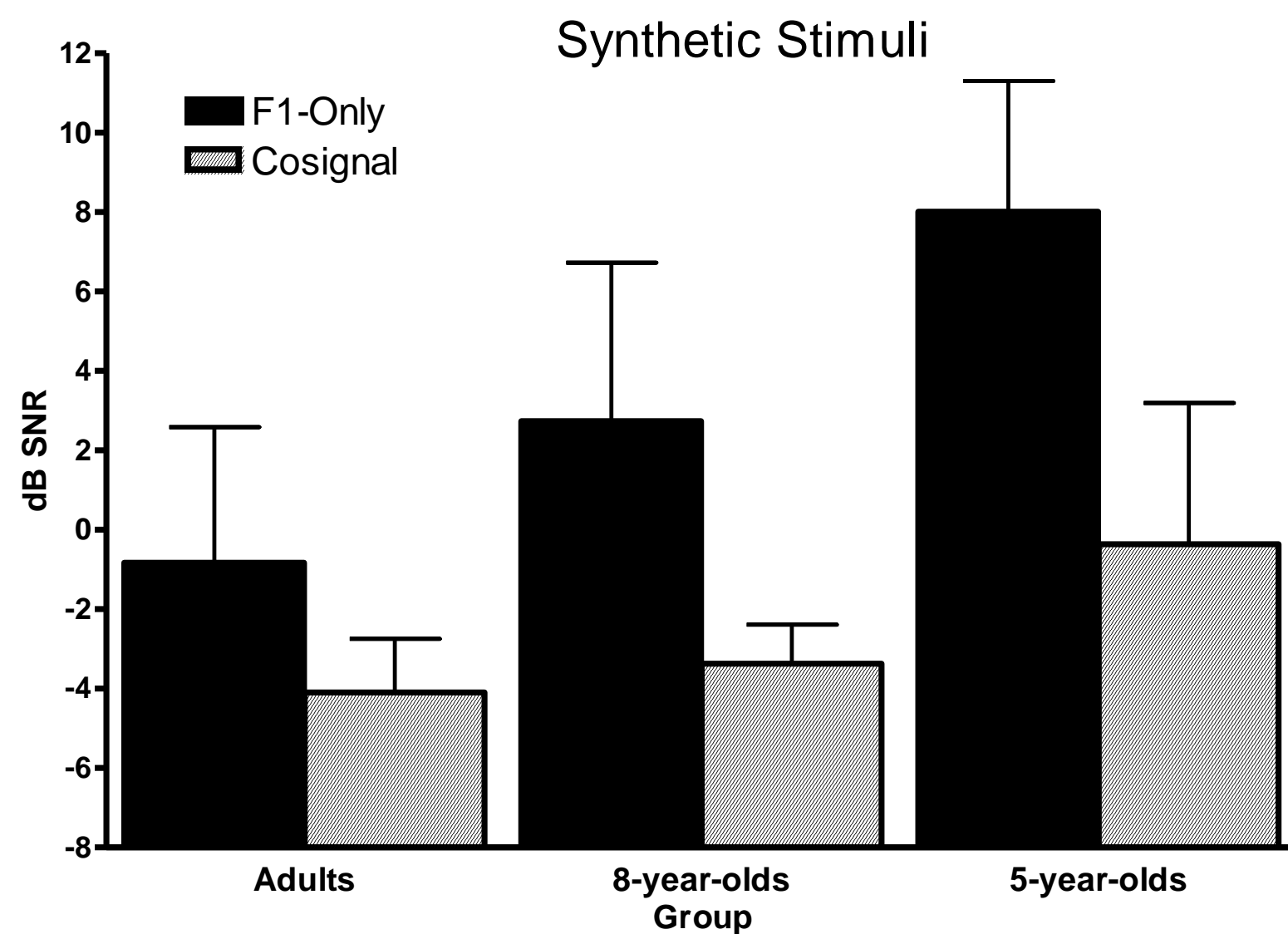
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## SYNTHETIC

## SINEWAVE

## DIFFERENT f0

## HYBRID



Synthetic Stimuli			
	F1 only	Full Formant	CMP Difference
Adults	-0.8 (3.4)	-4.1 (1.4)	-3.3 (2.2)
8-year-olds	+2.7 (4.0)	-3.4 (1.0)	-5.9 (3.2)
5-year-olds	+8.5 (3.7)	-0.8 (2.9)	-8.4 (3.2)

Sinewave Stimuli			
	F1 only	Full Formant	CMP Difference
Adults	-5.5 (1.5)	-4.1 (1.7)	+1.4 (1.2)
8-year-olds	-2.9 (4.6)	-1.8 (3.7)	+1.2 (3.7)
5-year-olds	+5.0 (5.1)	+3.5 (4.8)	-0.1 (4.4)

Different f0 Stimuli			
	F1 only	Full Formant	CMP Difference
Adults	-1.6 (1.9)	-1.3 (1.9)	+0.3 (2.7)
8-year-olds	3.8 (4.4)	-1.3 (2.7)	-5.1 (3.5)
5-year-olds	+8.4 (3.6)	+1.3 (3.0)	-7.1 (3.1)

Different f0 Stimuli			
	F1 only	Full Formant	CMP Difference
Adults	-1.6 (1.9)	-1.3 (1.9)	-1.1 (1.7)
8-year-olds	3.8 (4.4)	-1.3 (2.7)	-4.8 (5.2)
5-year-olds	+8.4 (3.6)	+1.3 (3.0)	-9.0 (5.8)

Effect			
	dF	F	p
Age	2,67	43.57	<.001
Formants	1,67	200.35	<.001
Age x Formants	2,67	15.6	<.001

Effect			
	dF	F	p
Age	2,67	43.02	<.001
Formants	1,67	0.73	NS
Age x Formants	2,67	4.96	.01

Effect			
	dF	F	p
Age	2,50	23.25	<.001
Formants	1,50	80.83	<.001
Age x Formants	2,50	25.69	<.001

CMP Difference			
	Lower	Same	Higher
Adults	-0.9 (2.2)	-1.9 (1.4)	-0.64 (1.2)
8-year-olds	-5.4 (5.7)	-5.9 (5.4)	-3.2 (4.0)
5-year-olds	-7.0 (4.9)	-9.1 (5.6)	-10.7 (6.5)

Effect			
	dF	F	p
A: Condition	2,102	0.65	NS
A: Formants	1,51	1.93	NS
A: Cond. x Formants	2,102	1.07	NS
8: Condition	2,102	5.33	.006
8: Formants	1,51	32.3	<.001
8: Cond. x Formants	2,102	4.78	.01
5: Condition	2,102	0.19	NS
5: Formants	1,51	87.1	<.001
5: Cond. x Formants	2,102	5.81	.004