"Are you synching what I'm synching?"

Infants' Detection of Audiovisual Synchrony in Language Development.

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Synchrony Matters

*"Neurons that **fire together wire together**."*

- Hebb

*Synchronous firing is **critical** to binding disparate areas of the neocortex.*

- Edelman et al.

"Rhythm is gonna get you"

- Gloria Estefan.

A talk in two parts

Part I: Infants use synchrony to segment words from speech.

Part II: Infants use synchrony to learn the meaning of words.

"Synchrony is foundational to early language development."

Part I

Audiovisual Synchrony & Speech Segmentation

Synchrony

In a world of many complicated signals.

Synchrony gets *attention*

If something visual is moving simultaneous with a sound... this can, literally, help you **hear better**.

Visual Hypothesis

Infants should be able to use the visual synchronization between the face and the speech stream to segment words from that stream in a noisy/blended stimulus.

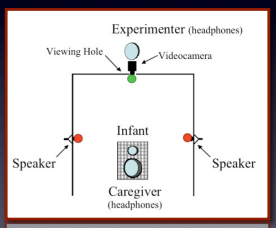
In collaboration with Rochelle Newman & Peter Jusczyk

Design

Familiarization

The bike was very shiny...
His feet were sore...

Test



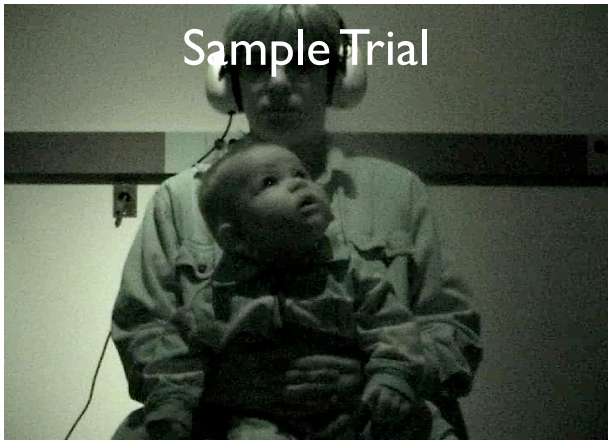
Three types of video

Synchronized Display - Video was synchronized with the target audio.

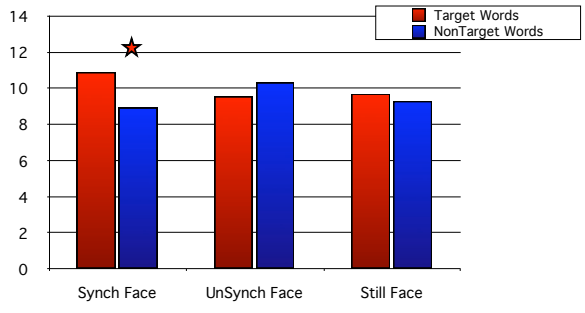
Unsynchronized Display - Video was the opposite of the target audio.

Static Display - Video was a single static frame presented throughout.

Sample Trial



Combined Results



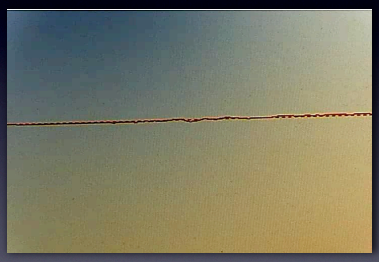
Interim Conclusions

- Infants successfully segmented the speech stream at 0dB signal-to-noise ratio!
- +15dB over previous work without faces.
- Infants can use what they see to hear better.
- Synchronized visual information aids in stream separation and subsequent segmentation.

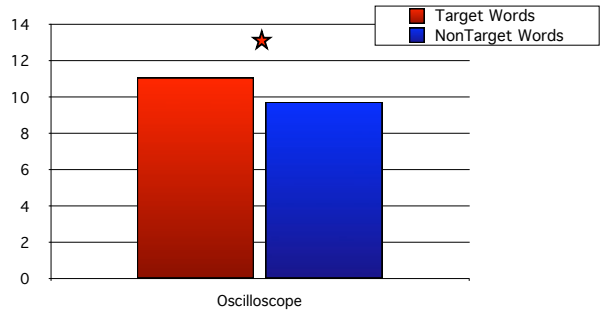
What caused these results?

- Face-specific/viseme-specific information?
- Labs of Massaro and Werker have shown infants to be poor at phoneme-specific integration.
- Perhaps ANY synchronized visual would help.

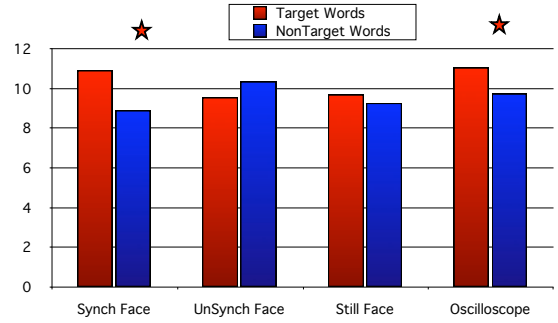
Modification



Oscilloscope Results (n = 26)



Results (n = 26 * 4)



Oscilloscope Results

- Infants showed evidence of segmentation even when it was a correlated oscilloscope pattern.
- Infant domain general sensitivity to **any** form of synchronized visual information allows them to segment the speech stream.

Part II

Audiovisual Synchrony & Word Learning

Gogate & Colleagues

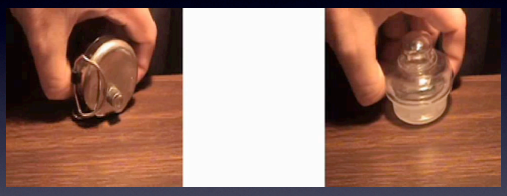
- In an experimental task, infants only learn word meaning if object is moved synchronous with word!
- Observational data indicates mothers who use AV synchrony in labeling have children with higher vocabularies.

Emergentist Model

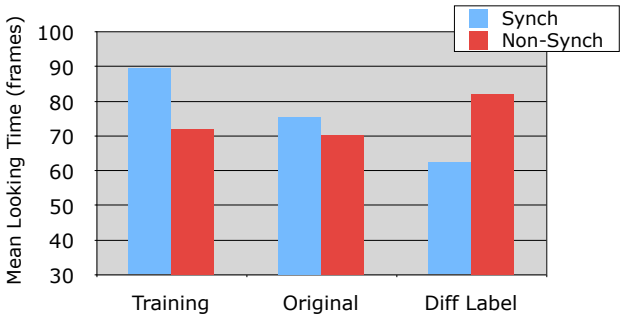
In Hollich, Hirsh-Pasek, and Golinkoff (2000), we proposed a model of an active word learner which has the following properties:

- **Multiple Cues** - Attentional, Social, Linguistic
- **Differential Weighting** over time
- **Emergent** properties

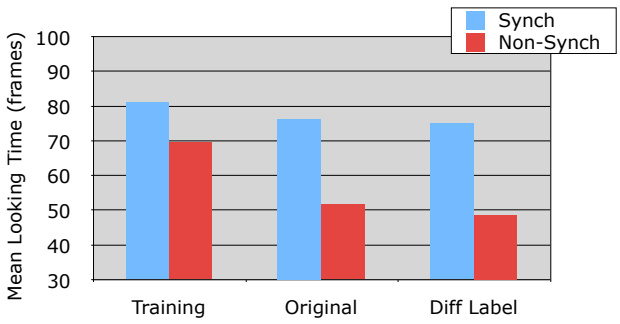
Familiar Phase



25mo Results (n = 20)



15mo Results (n = 20)



Results

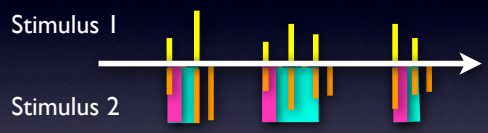
- Older infants use synchrony to reliably attach a label.
- Not so for younger infants.
- They likely are conservative in their labeling strategy.

Nonetheless

Synchrony is very helpful, and is one way whereby infants gain a toehold onto the process of segmenting words from speech and learning their meaning.

How?

Kinds of synchrony



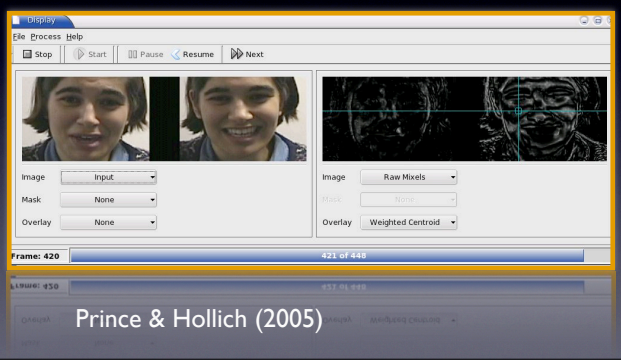
Onset Duration Amplitude

In Phase Out of Phase

Need for Microgenetic Analysis

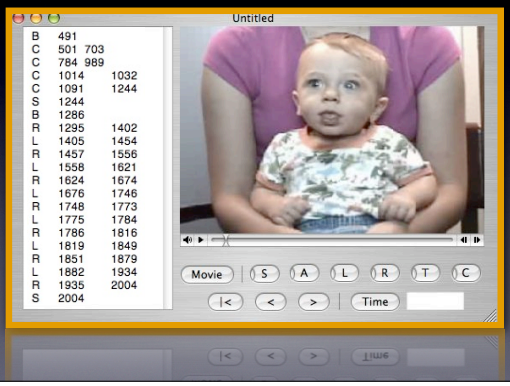
- All of this suggests that even something is simple as detection of audiovisual synchrony is more than an **all or nothing** process.
- To better understand the mechanism we need to know what is happening **moment-by-moment,** and have principled predictions about what infant behavior **SHOULD** look like, **IF** they are using a particular algorithm.

Sensory-oriented models

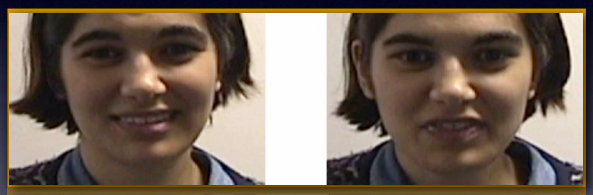


Prince & Hollich (2005)

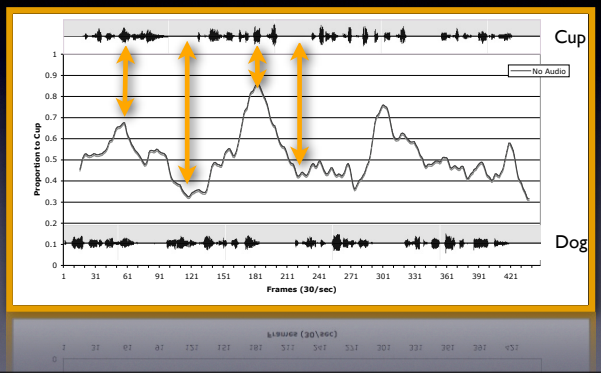
Frame-by-Frame Coding



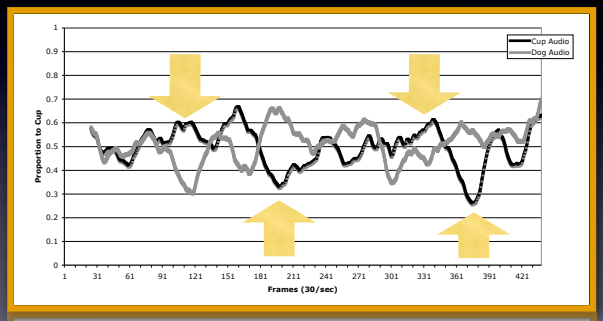
Consider a preferential looking task with two faces -- only one of which is synchronized with the audio. (Pickens et al., 1994)



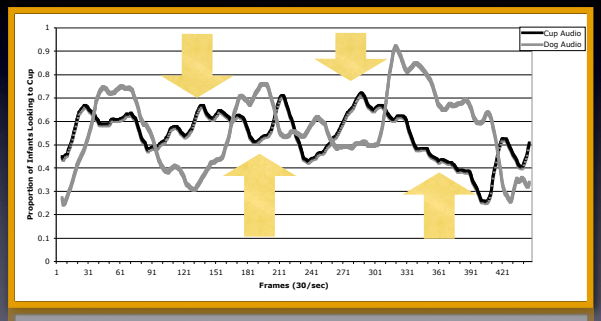
Visual Motion Alone



Model Predictions



Children's Performance



Not perfect but close

- Biggest effects around offsets and onsets.
- Children definitely become bored, leading to a switch in preference, suggesting should model habituation.
- At times, either visual or audiovisual models account for a significant portion of the data.
- Likely individual differences in integration ability, like to model that as well.

Synchrony Matters

- More modalities/neural assemblies in synch, the more stable the representation.
- Thus, synchrony helps highlight important aspects over external and internal background noise.