

# **Experimental studies of early word learning in infants from bilingual and minority-language homes**

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# Early word learning in infants from bilingual and minority-language homes

The basic questions to be asked here:

1. At what age do infants begin to recognize word forms?
2. How does a *bilingual community* affect word learning in infants exposed primarily to the minority language, or to both languages?

## Some preliminary thoughts

*Implicit (incidental) learning* of prosodic, segmental, phonotactic patterning increases over 1st year - without voluntary *attention* or *intent* to learn.

*Explicit learning* of particular form-meaning correspondences begins at age 1-2 years, as infants begin to *actively seek to know* the 'names of things'.

# Mira: Finnish child, 14 mos.

QuickTime™ and a Sorenson Video decompressor are needed to see this picture.

*(Kunnari, 2000)*

Learning to distinguish *kissa* 'cat'  
from *koira* 'dog'

# How does word learning begin?

Segmental sequences begin to 'sound familiar' only from about 9 months on (Jusczyk, 1997) - this is implicit learning.

At that age infants respond with more attention - *longer head-turns* - on hearing patterns *typical of the native language* (i.e., frequently heard patterns).

To *connect word forms with meanings* a child must recognize a particular segmental sequence - and its accentual pattern - as *familiar*.

This is critical to permit the association of a form with the relevant situation, event, object or person.

This study is designed to identify the timing of the advance in *word form recognition*, a step *prior to* actual word learning (i.e., associating the form with meaning).

# When do infants begin to recognize word forms?

Longer attention to *untrained familiar* than to phonotactically matched *rare* words:

French infants - by 11 months.

*(Hallé & Boysson-Bardies, 1994)*

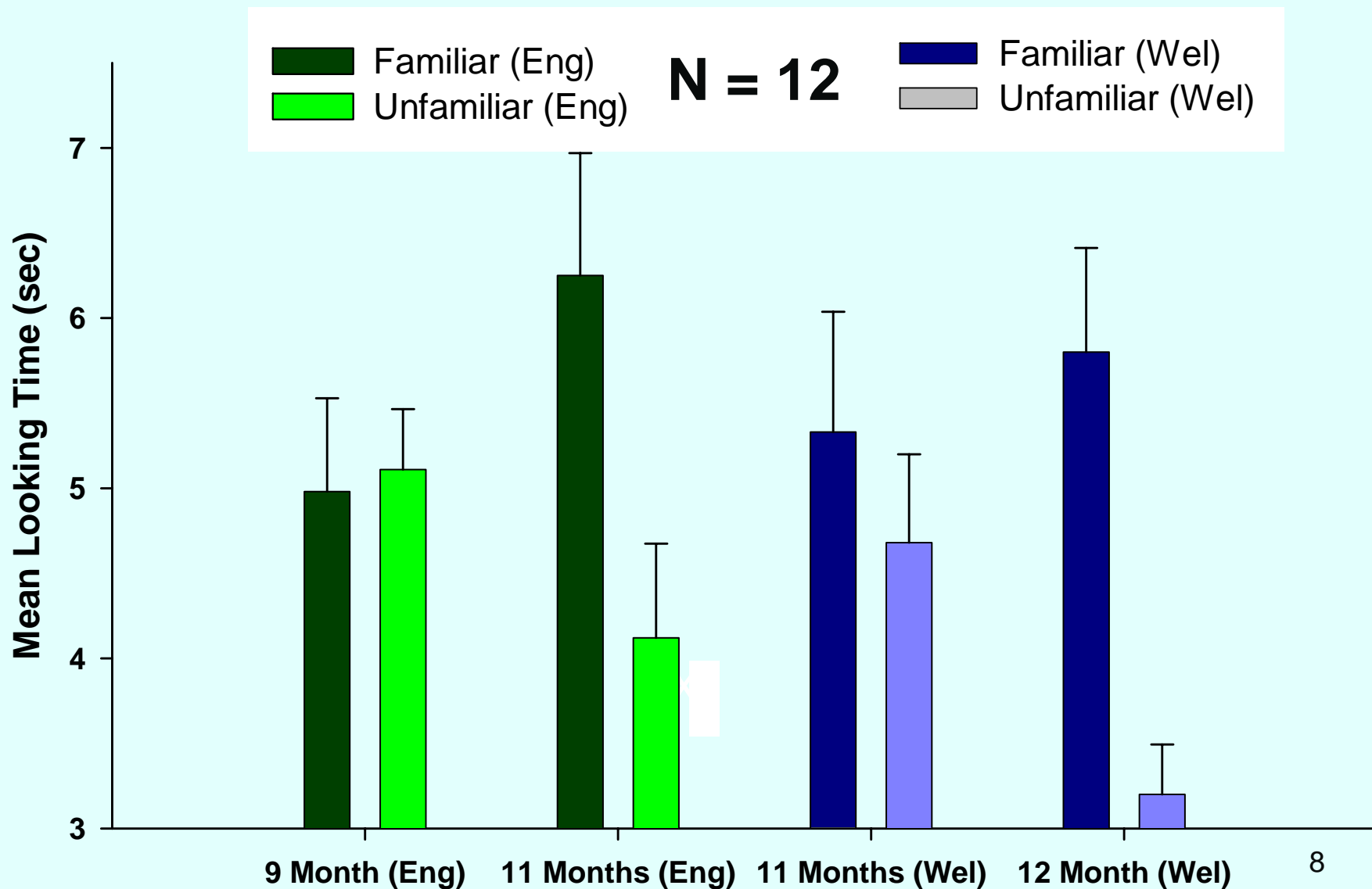
English infants - by 11 mos. (& *not* by 9 mos.)

*(Vihman, Nakai, DePaolis & Hallé, 2004)*

*Welsh infants - not yet by 11 months*

*(Vihman & DePaolis, 1999)*

# English (9 & 11 months) and Welsh (11 & 12 Months).



# Testing infant word form recognition

Cross-sectional samples of

*monolingual English and Welsh*

*infants:*

9, 10, 11, 12 mos.

*bilingual English-Welsh learners:*

11 mos. only

**Primary goal:** To test earlier finding of delay  
in word form recognition for Welsh infants

We oppose common words -

*apple, naughty, bottle, nappy, thank you*

to *similarly structured* **uncommon** words

(highly unlikely to be heard often by infants):

*Eiffel, courtly, nettle, wacky, juncture*

*Note that our experiments involve no*

*specific word training or familiarization.*

# Testing infant word form recognition

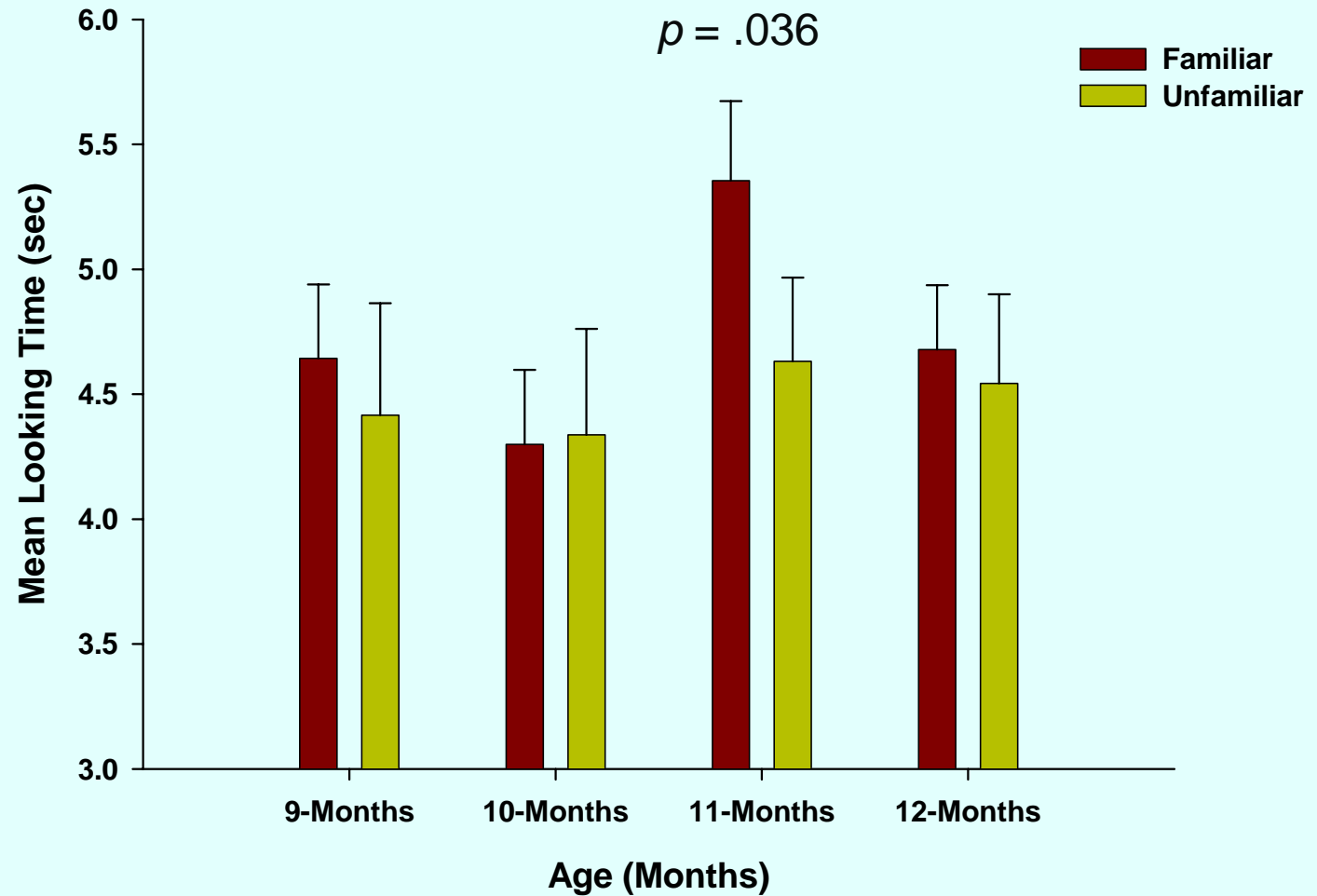
Two experimental paradigms in parallel:

1. 'head turn' (HT), a behavioral method;
2. Event Related Potentials (ERPs), a direct recording of brain responses from the surface of the infant's scalp.
3. Stimuli: 33 each, Familiar and Rare words - to allow ERPs to be analyzed.
4. Three voices: one for HT, two for ERPs - with rotation across children.

# Head-Turn results

1. Monolingual infants: English
2. Monolingual infants: Welsh
3. Bilingual infants: English and Welsh

# Monolingual Infants: English



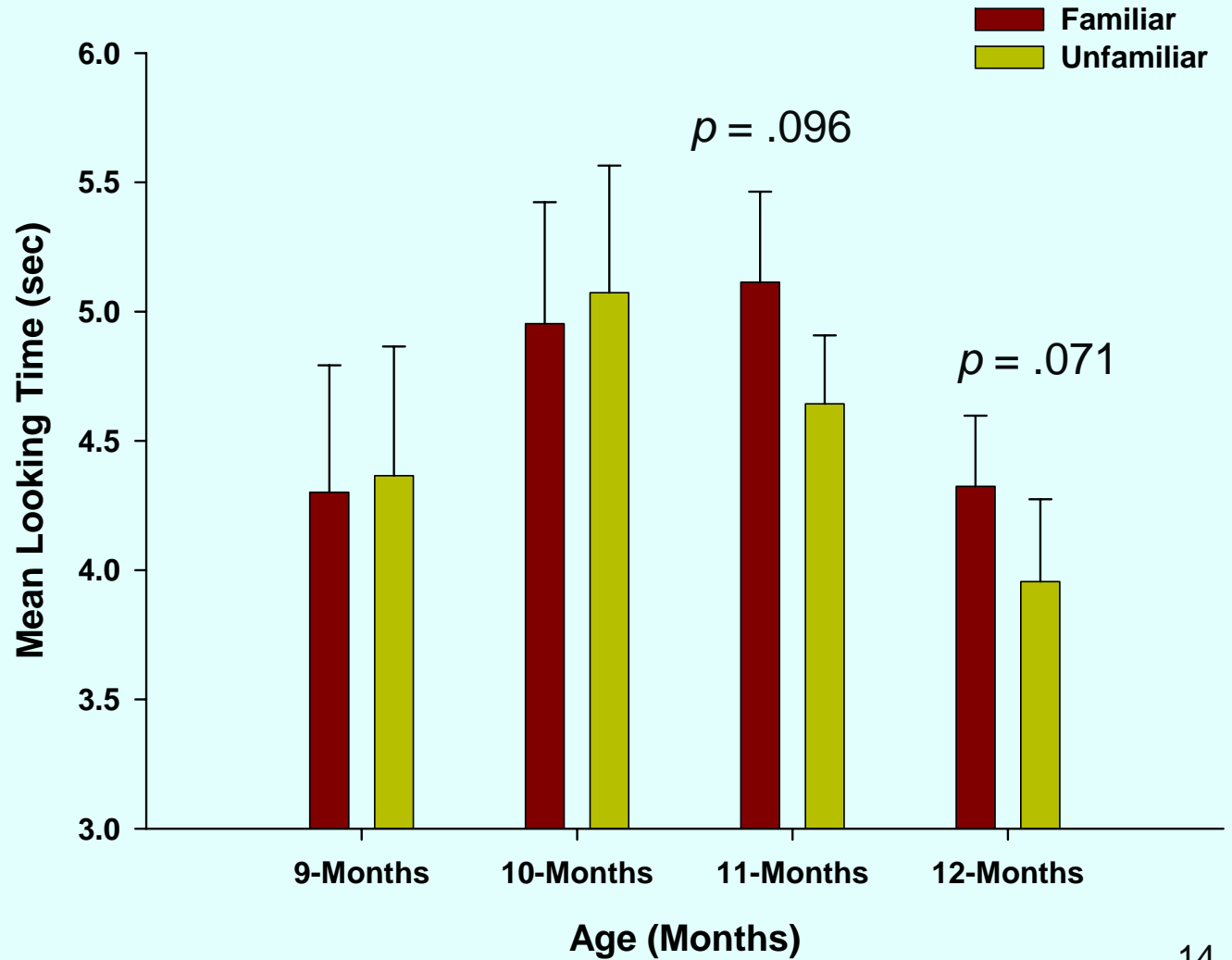
9 mos.  $N = 25$

10 mos.  $N = 27$

11 mos.  $N = 23$

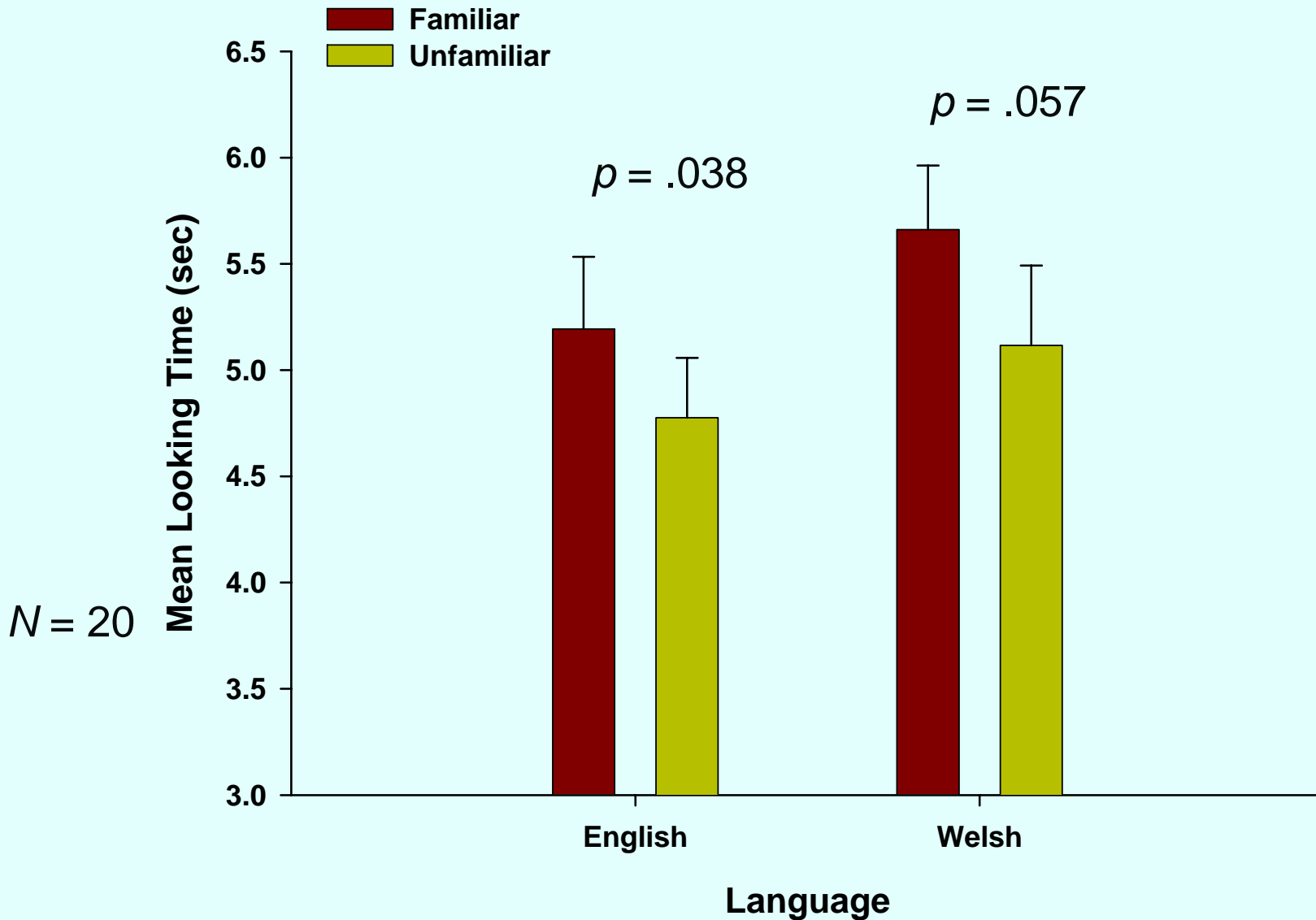
12 mos.  $N = 26$

# Monolingual Infants: Welsh

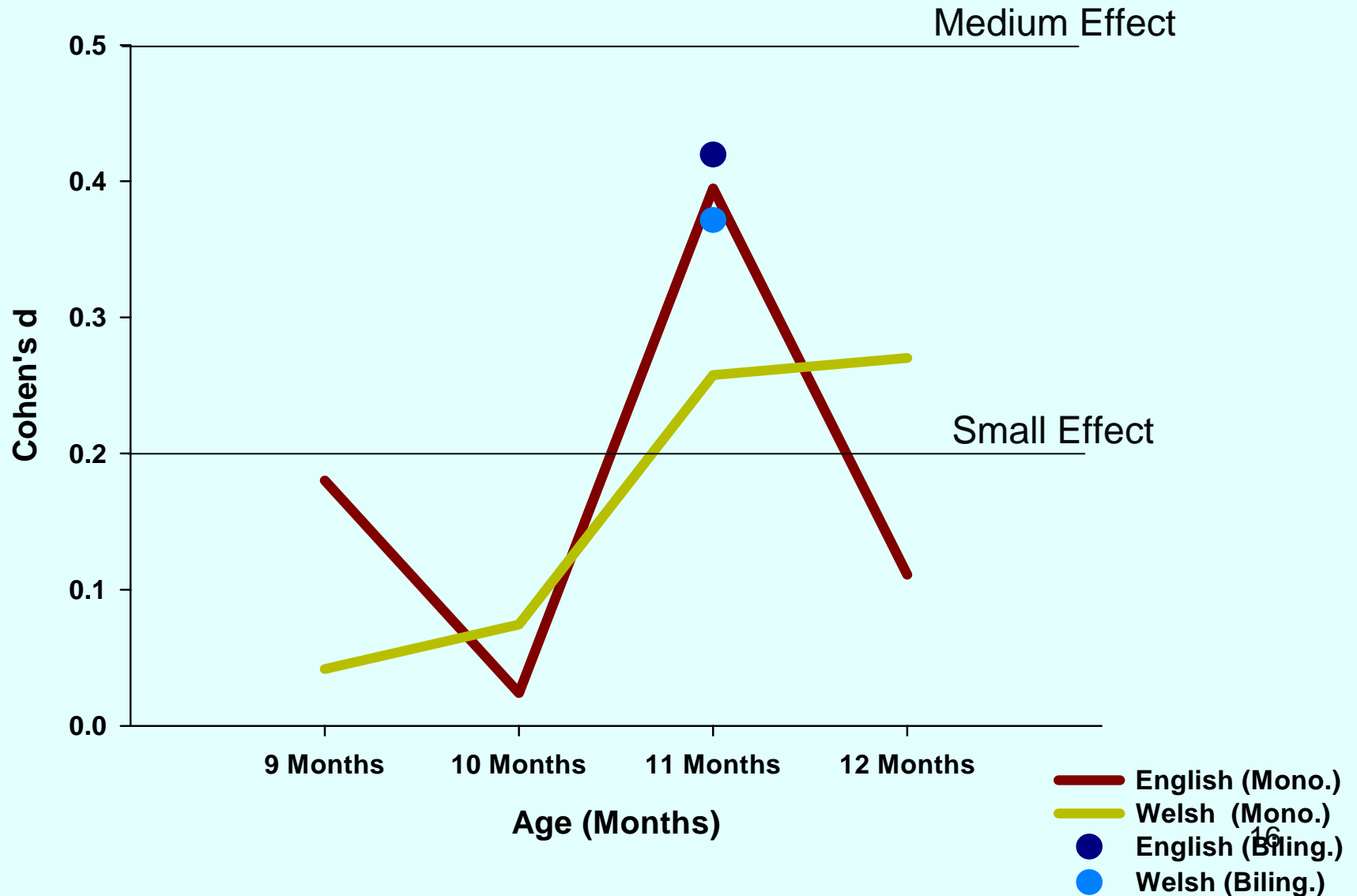


9 mos.  $N = 14$   
10 mos.  $N = 12$   
11 mos.  $N = 27$   
12 mos.  $N = 21$

# Bilingual Infants: 11 Months



# Effect Sizes: Current study only

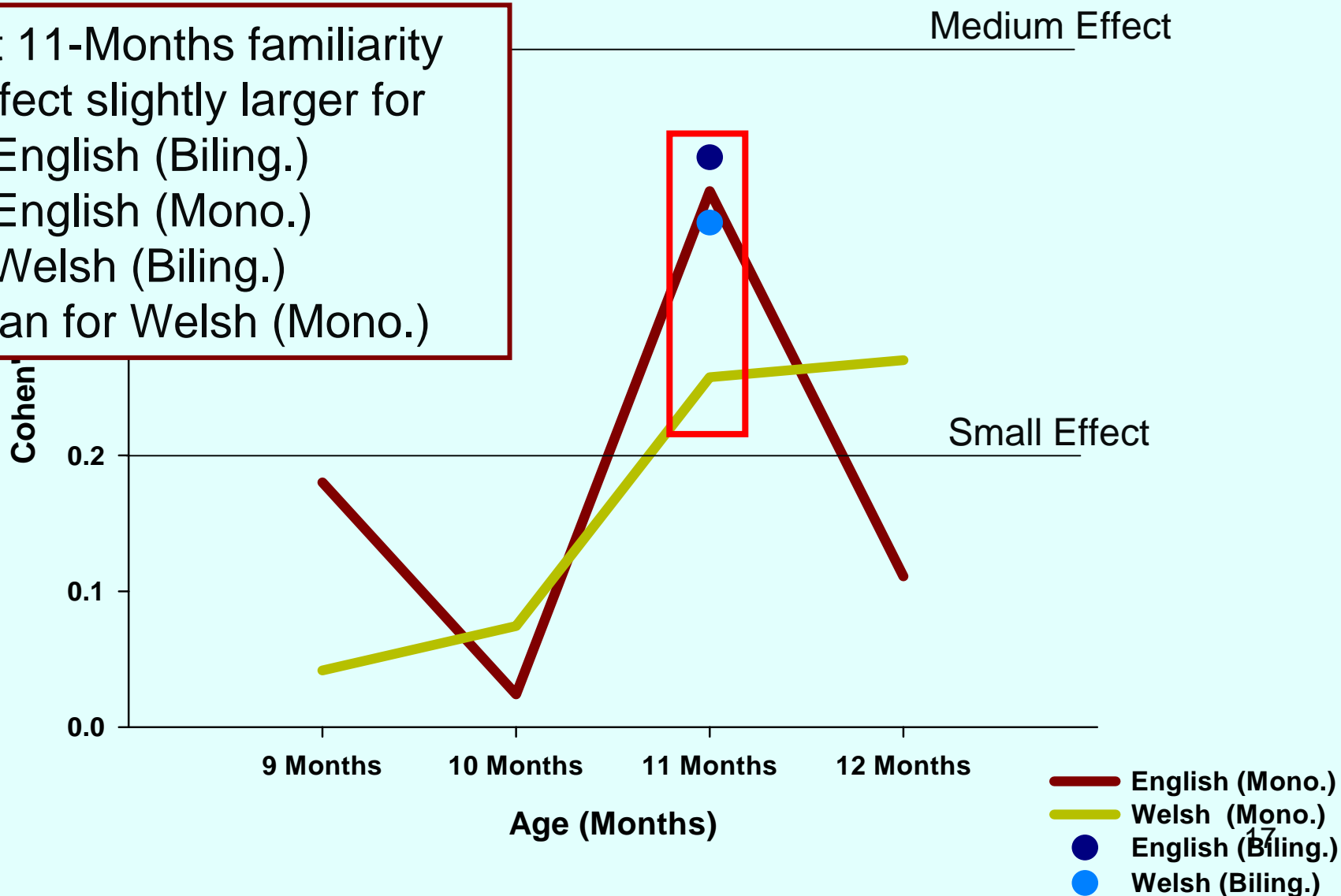


# Effect Sizes: Current study only

At 11-Months familiarity effect slightly larger for

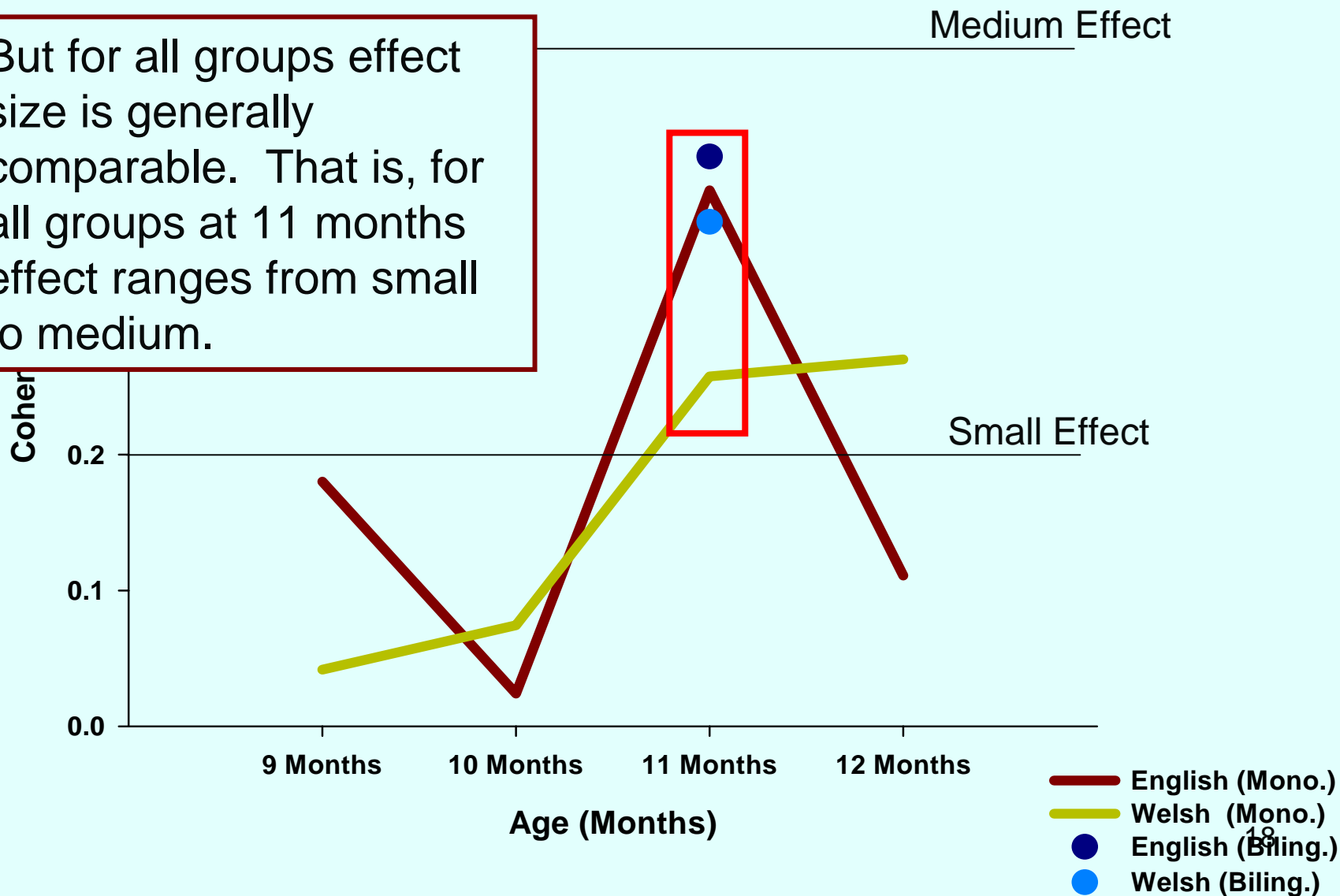
- English (Biling.)
- English (Mono.)
- Welsh (Biling.)

than for Welsh (Mono.)



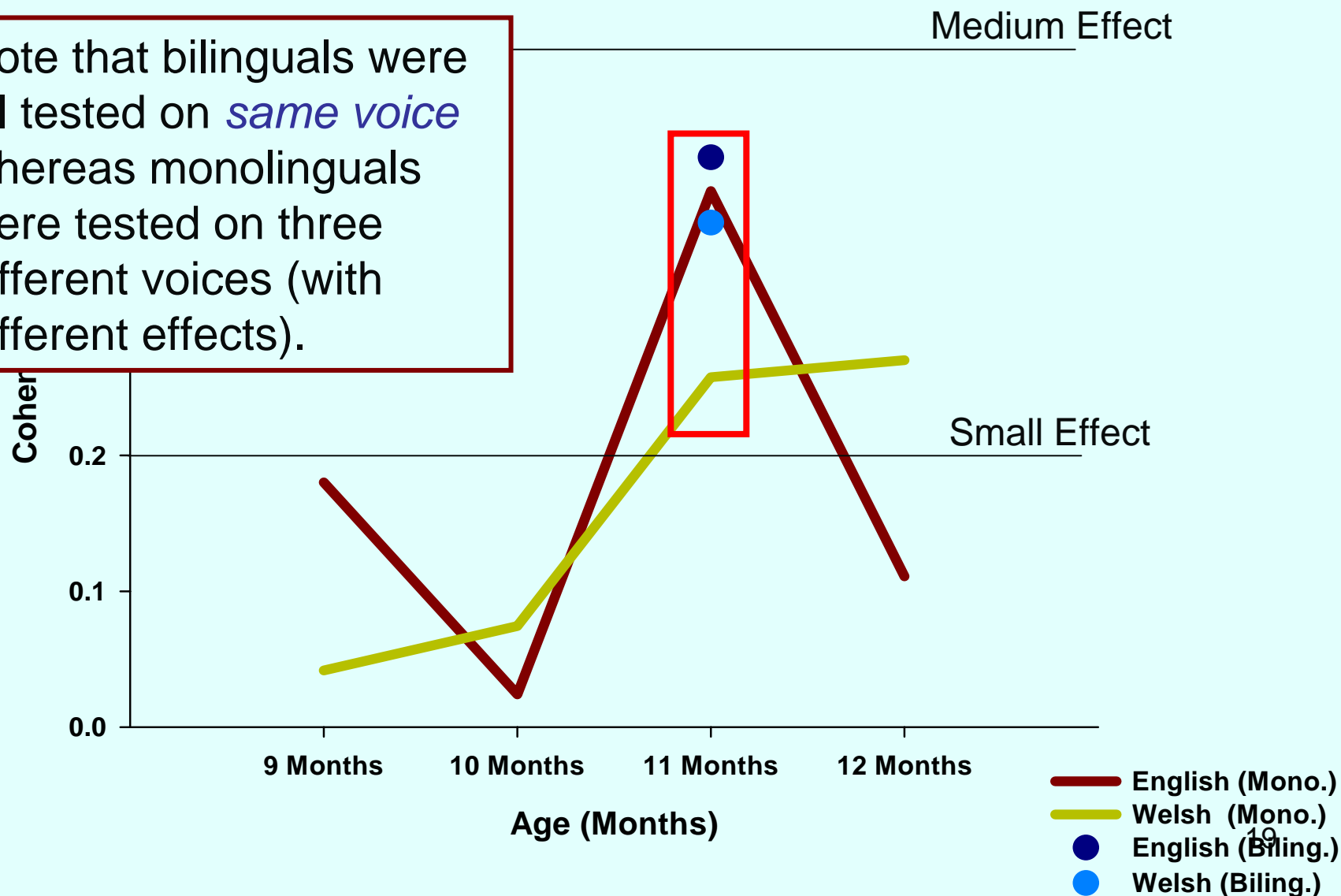
# Effect Sizes: Current study only

But for all groups effect size is generally comparable. That is, for all groups at 11 months effect ranges from small to medium.



# Effect Sizes: Current study only

Note that bilinguals were all tested on *same voice* whereas monolinguals were tested on three different voices (with different effects).



# The methodological issues

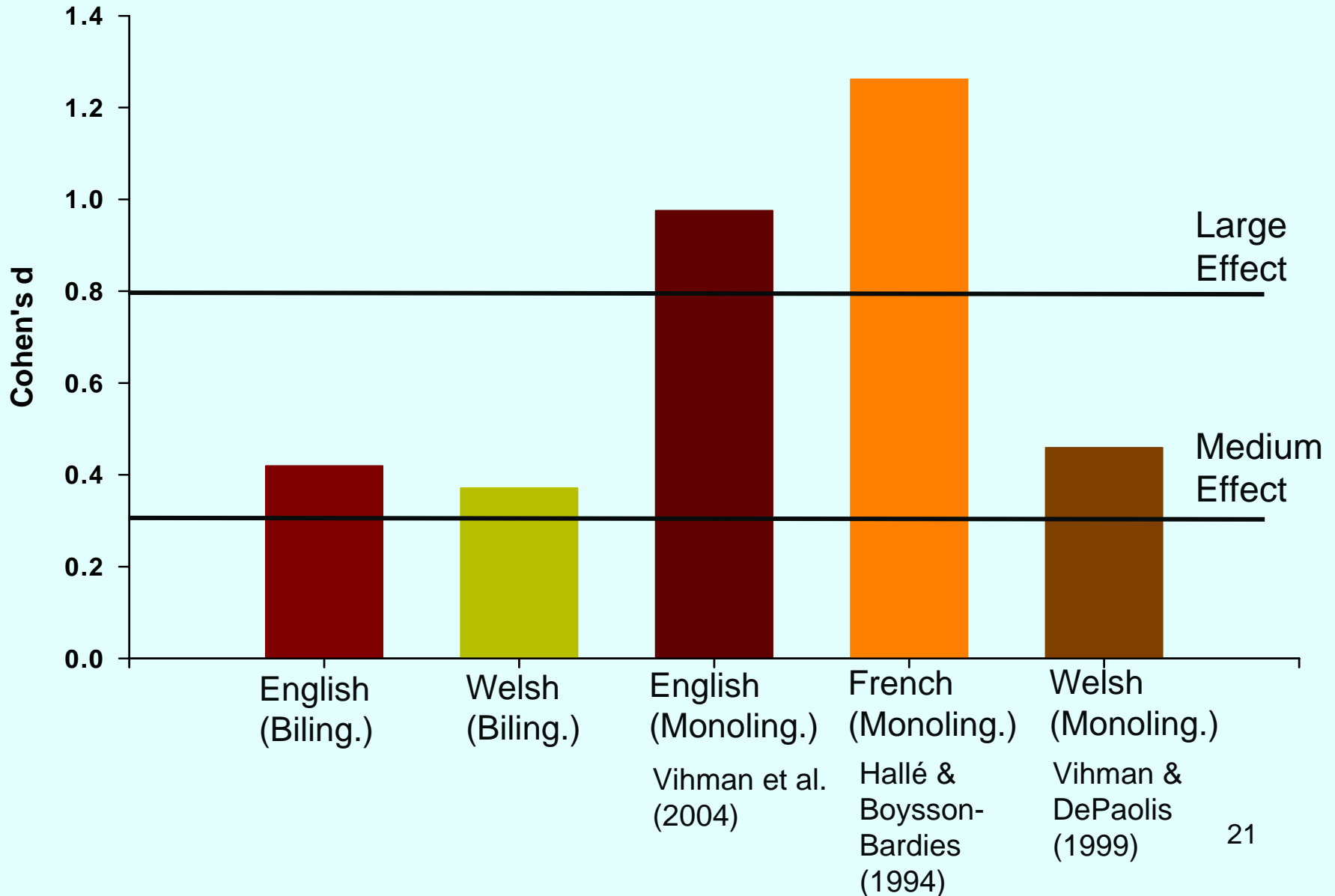
- Different monolingual children heard different voices in HT:

*one voice* for HT - with *11 different words per trial* for 3 trials (repeated once) - for both Familiar & Rare; *two voices*, one for each of two blocks, in ERPs.

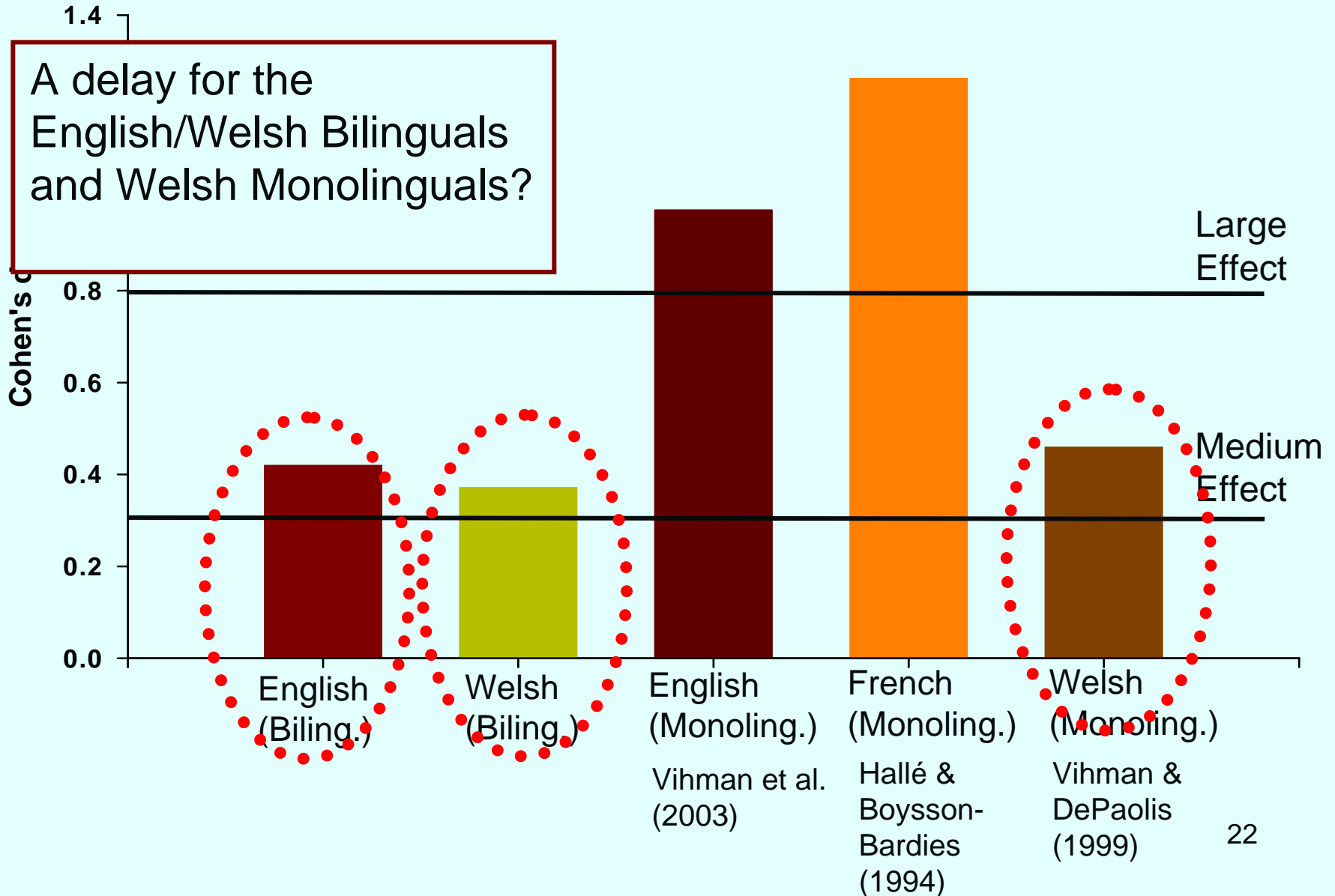
- The voices produced *different effects at different ages* (for small & uneven subsamples for each voice).

- The HT test was **more difficult** (**33 words**) than previous tests (**12 words, reordered in each trial**)<sup>20</sup>

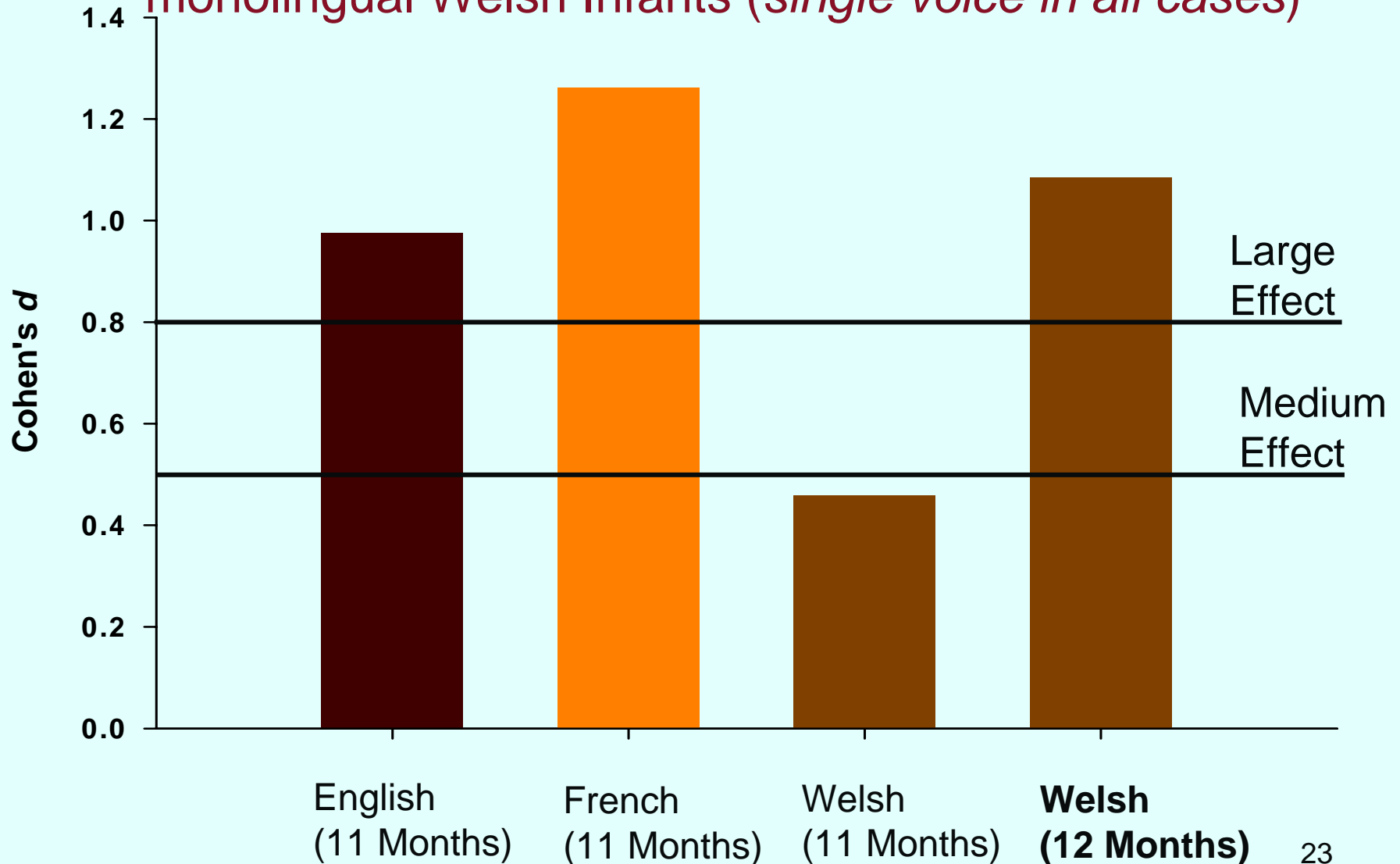
# Effect sizes at 11-months: Comparisons with *single voice* methodology



# Effect sizes at 11-months: Comparisons with single voice methodology

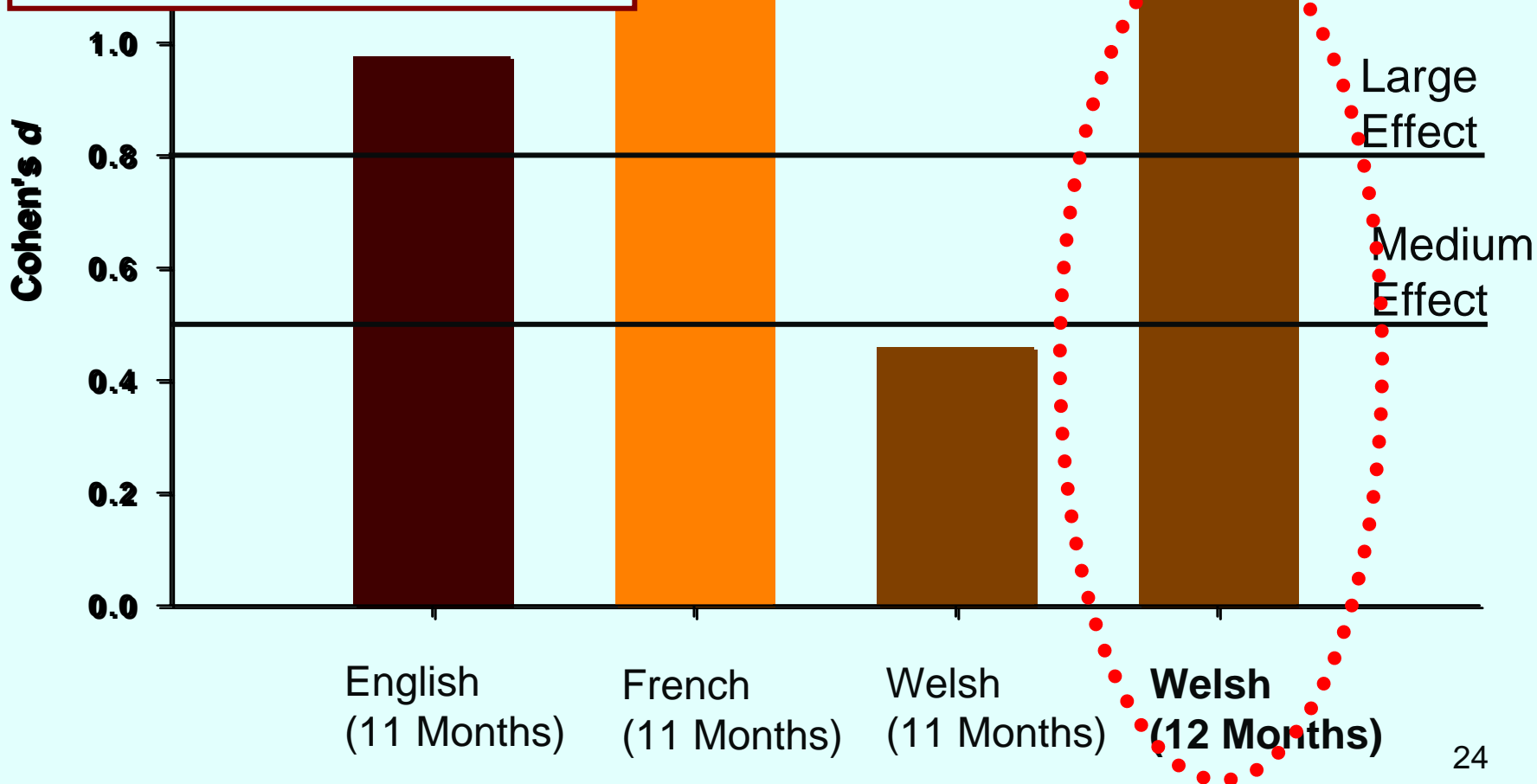


Comparison between 11-month-old monolingual Infants  
(English & French) with 11 and 12 month-old  
monolingual Welsh Infants (*single voice in all cases*)



At 12 months, Welsh infants perform comparably to 11 month old infants reared in predominantly English or French environments.

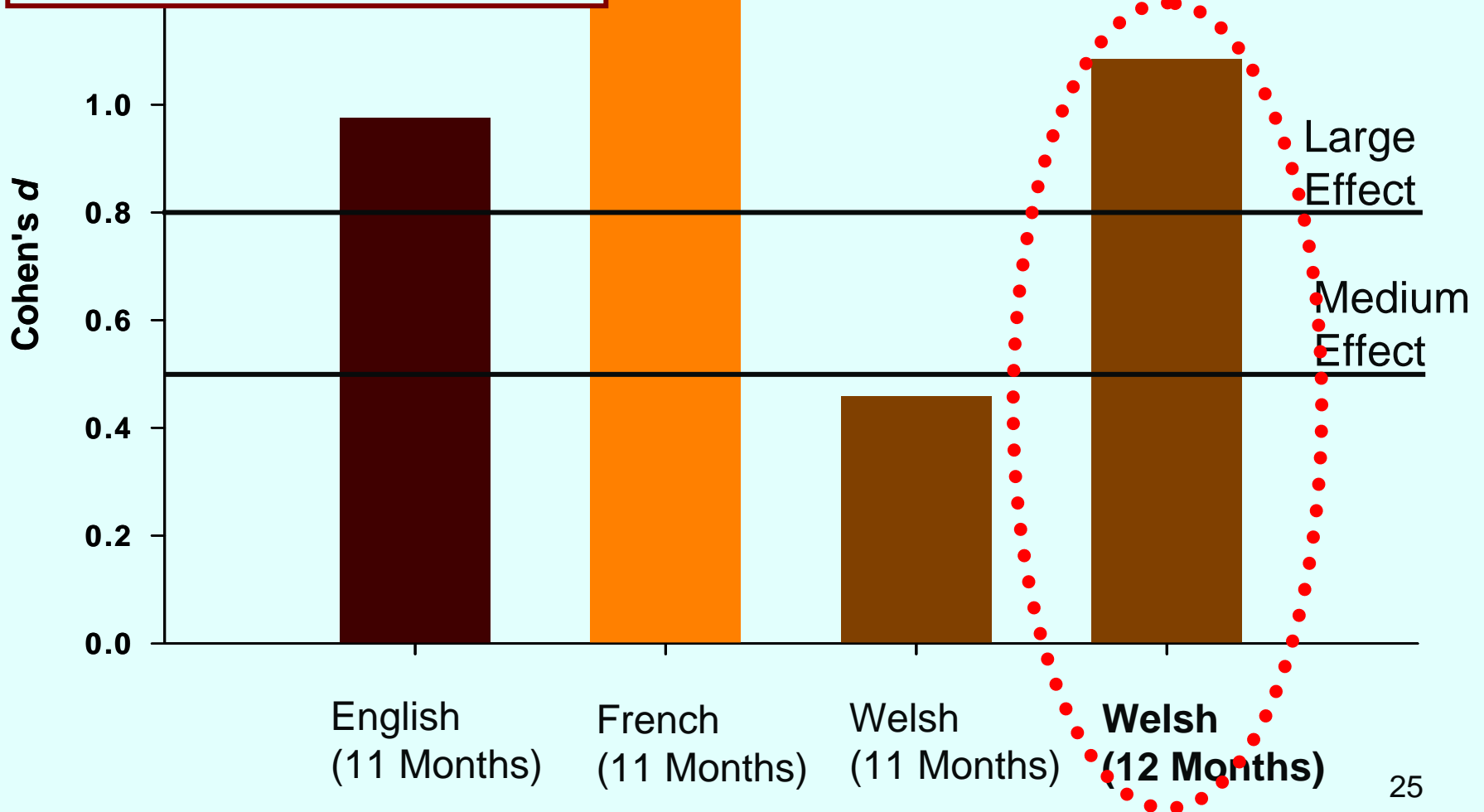
11 Month old monolingual Infants with 12 month-old monolingual Welsh Infants



# Comparison between 11 Month old monolingual Infants

We would predict that bilinguals would show a comparable familiarity effect at 12 months.

# with 12 month-old monolingual Welsh Infants



# Cross-linguistic HT results in summary

- ❖ At 11 mos. monolingual English infants respond significantly more to familiar words but *Welsh learners do **not***.
- ❖ Welsh learners show the effect only at 12 months.
- ❖ Effect sizes for 11-mo-old *bilinguals* are far smaller than for English and French, if test methods are kept constant.

# Babies prepared for ERPs

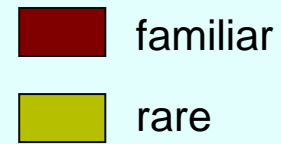


# Event-Related Potentials

Allow us to look in some detail at time course of word recognition.

Thierry et al. (2003) - testing English monolinguals at 11 mos. - found significant difference between response to Familiar vs. Rare words *within 250 ms* (N2 peak) - time enough to hear only onset consonant(s) and possibly first vowel.

# ERPs in F4 (frontal right): *Site of largest response*



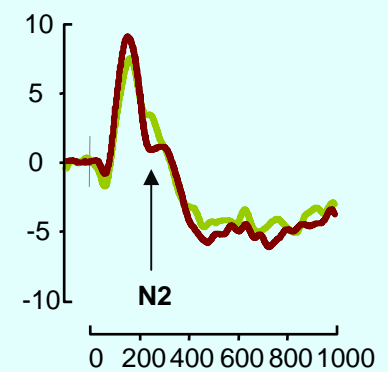
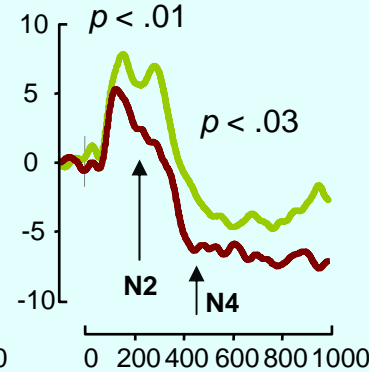
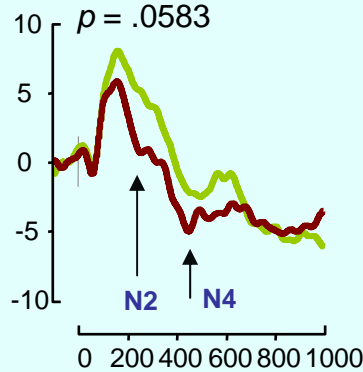
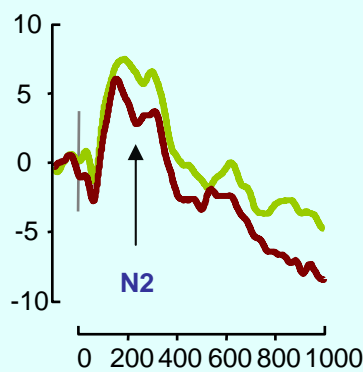
9 mos  
N = 15

10 mos  
N = 21

11 mos  
N = 16

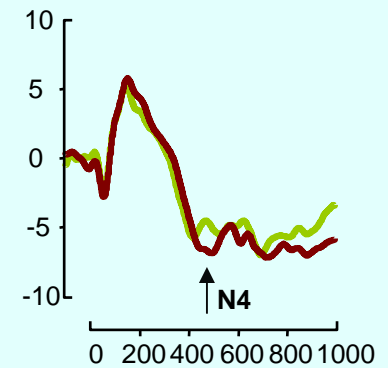
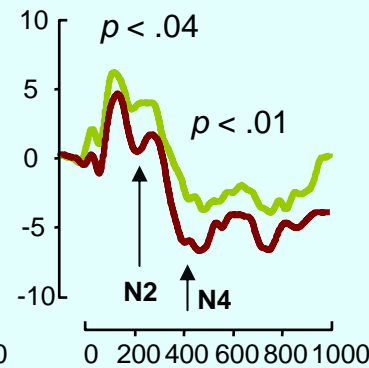
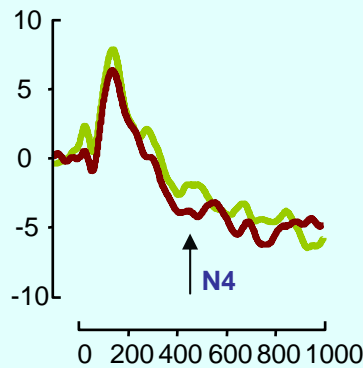
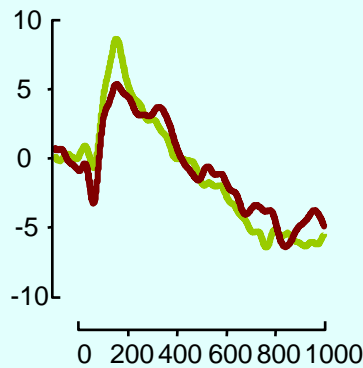
12 mos  
N = 19

English



Welsh

N = 13  
per group



Increased negativity for FAMILIAR words

# Statistical tests based on *5 electrodes*

(F3, F4, C3, Cz, C4, i.e. Fronto-Central scalp)

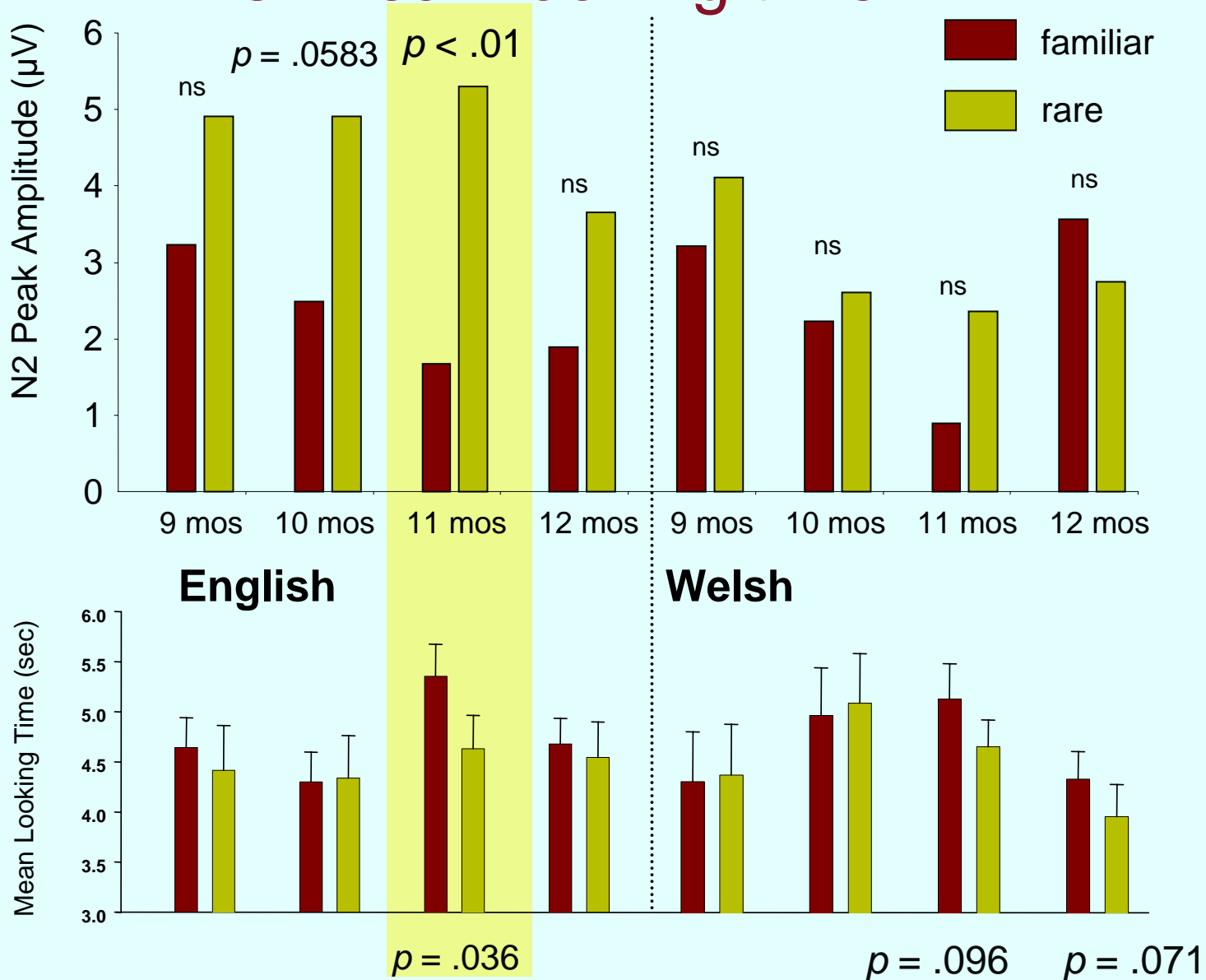
One-tailed paired t-tests, *familiar vs. rare*

| ERP components | English |        |        |        | Welsh  |        |        |        |
|----------------|---------|--------|--------|--------|--------|--------|--------|--------|
|                | 9 mos   | 10mos  | 11mos  | 12mos  | 9mos   | 10mos  | 11mos  | 12mos  |
| P1             | 0.4676  | 0.0919 | 0.0621 | 0.0661 | 0.1425 | 0.2965 | 0.4396 | 0.3077 |
| N2             | 0.1843  | 0.0498 | 0.0118 | 0.1177 | 0.2911 | 0.4300 | 0.3437 | 0.1605 |
| P3             | 0.3916  | 0.1505 | 0.0035 | 0.2830 | 0.4270 | 0.1740 | 0.2641 | 0.2975 |
| N4             | 0.4456  | 0.4098 | 0.0597 | 0.4811 | 0.2556 | 0.2663 | 0.0241 | 0.3119 |
| N              | 15      | 21     | 26     | 19     | 13     | 13     | 13     | 13     |

Significant effect at 10 mos.;  
broader effect N2, P3, N4 -  
at 11 mos.

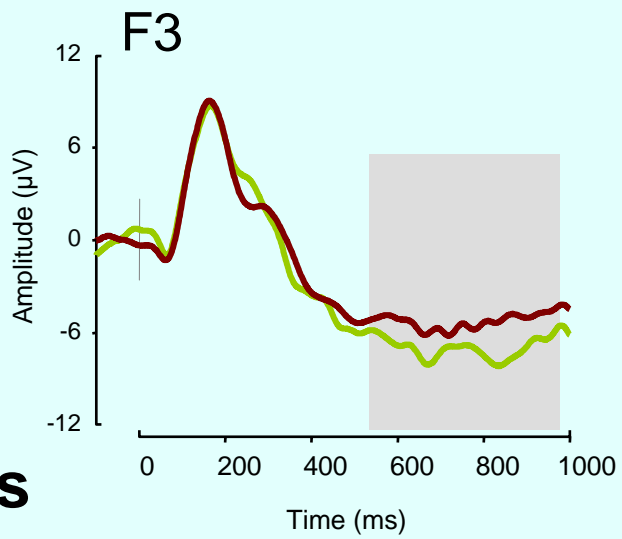
Effect only at 11  
mos. - and N4 only

# Comparison of N2 ERP effect (F3 and F4 only) vs. Mean looking time in HT

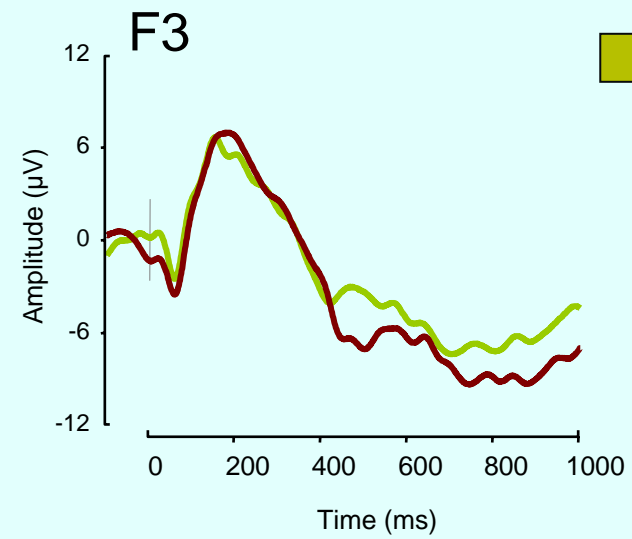


# *Foreshadowed N400: Effort to access meaning*

English

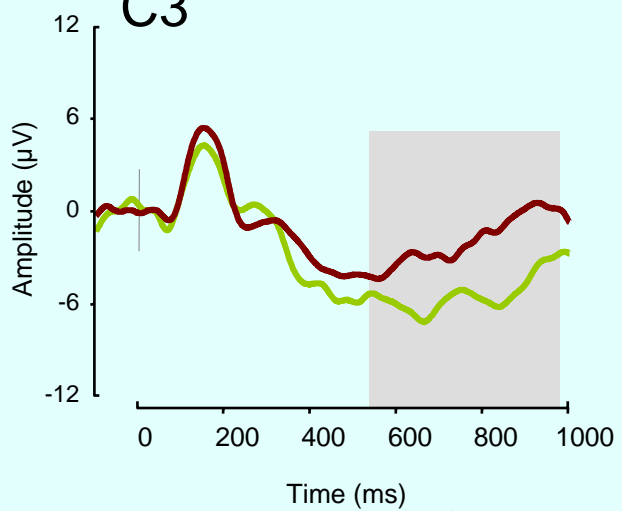


Welsh

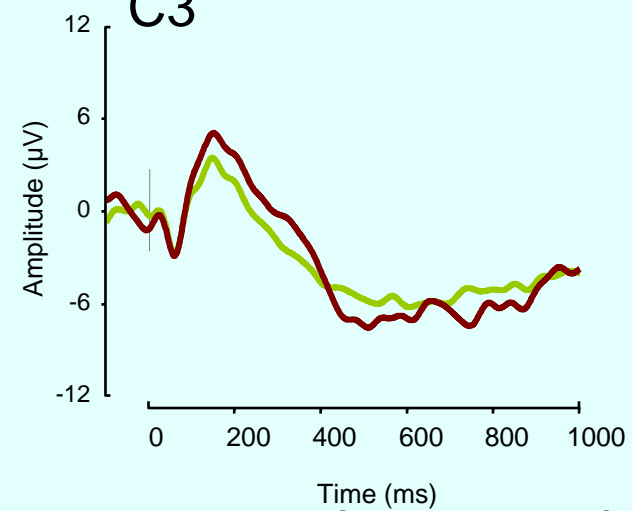


familiar  
rare

C3

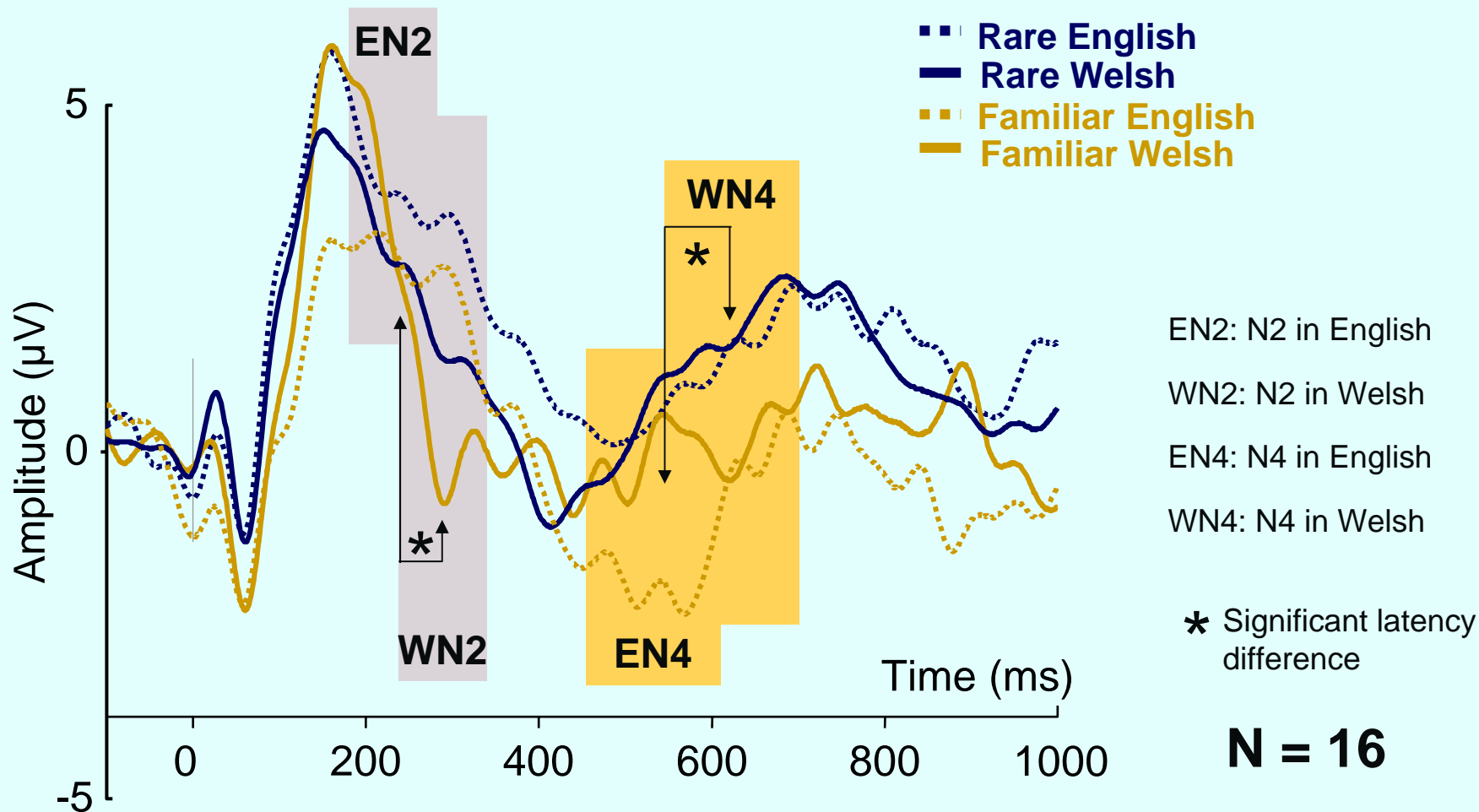


C3



Greater negativity for RARE words (LH only)

# Frontocentral Region (AF3 AF4 C3 Cz C4)



English & Welsh bilinguals: 11 mos.

*Both N2 and N4 significant in both languages*

# What is the N2?

Thierry et al. suggested that N2 is a *mismatch negativity (MMN) effect* (Näätänen, 2001) - a sign in adults of *automatic* (unconscious) *change detection*, elicited by 'odd ball' (or 'rare event') design.

Here, equal numbers of Familiar and Rare words presented - but no one baby knows more than a few words at 11 mos.

# What is the N4?

We suggest that the N4 is a continuation of the implicit word-form recognition expressed by the N2 - elicited by later portions of word.

Notice that the *'late negativity'* for rare words is seen only for English - related to overall stronger MMN effects for English (N2 and N4).

# The ERP results: Interpretations

- ❖ In English, we see significant N2 already at 10 mos.
- ❖ By 12 mos. enough words known to eliminate MMN in English.
- ❖ In Welsh, N4 emerges at 11 mos.
- ❖ In Welsh, N4 is stronger than N2; in English, N2 is stronger than N4.
- ❖ In bilinguals, *both* effects significant in both languages by 11 mos.

# The ERP results: Interpretations

*Accentual differences* between the two languages most likely account for the cross-linguistic N2-N4 'mirror image' effect in word form recognition.

Vihman, Nakai, DePaolis & Hallé (1994) tested effect of accent on word form recognition, contrasting HT in English vs. French.

# The effect of accent: English vs. French

English

SW stress predominates

CV CV



Stressed syllable

French

phrase final accent

CV CV



Accented syllable

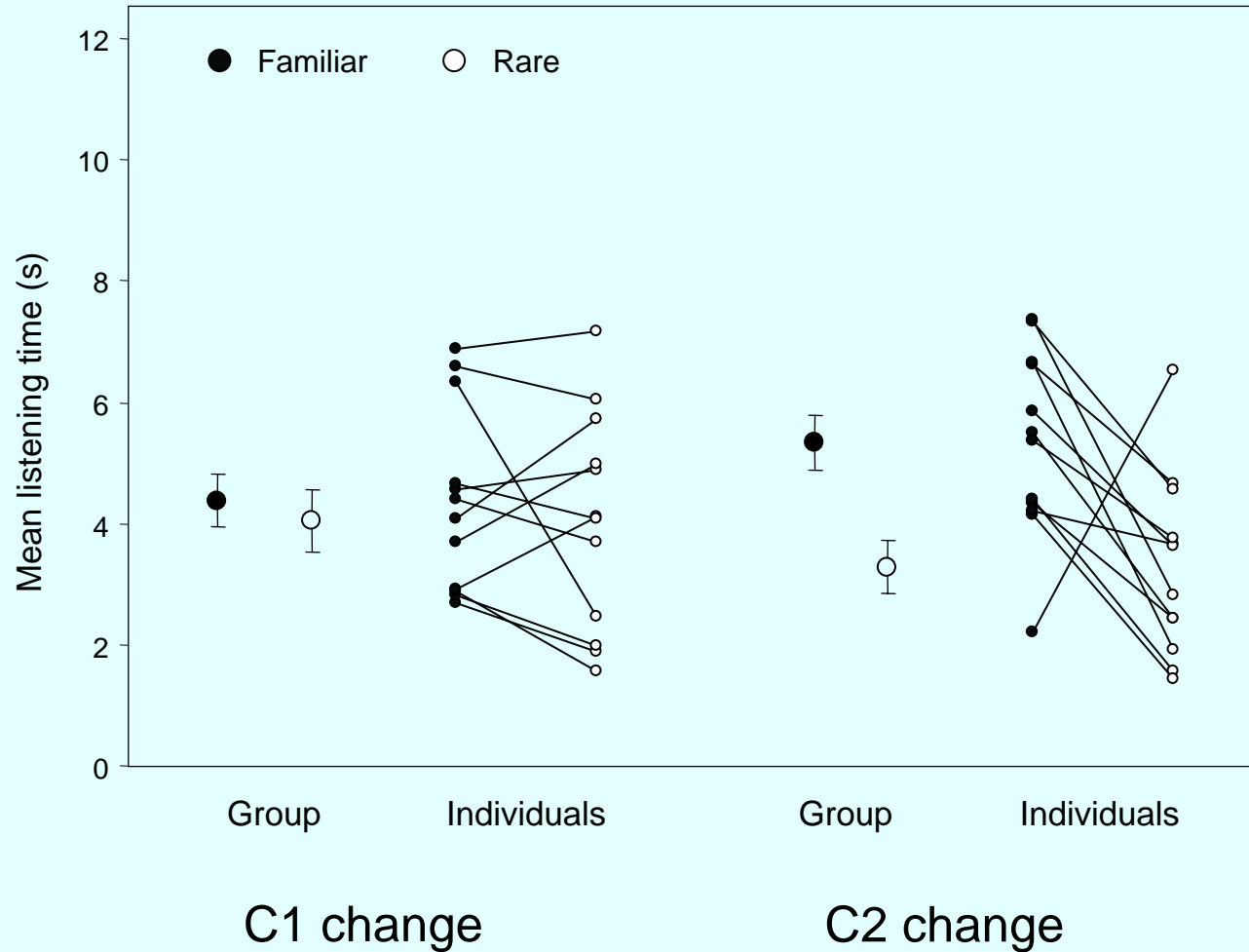
Infants more sensitive to consonant changes  
on *stressed* or *accented* syllable.

# The role of accent

Change of *initial syllable onset-consonant* blocked word form recognition in English but change of the *second (unstressed) syllable onset-consonant* did not.

The reverse was true for French.

# Consonant change (English)

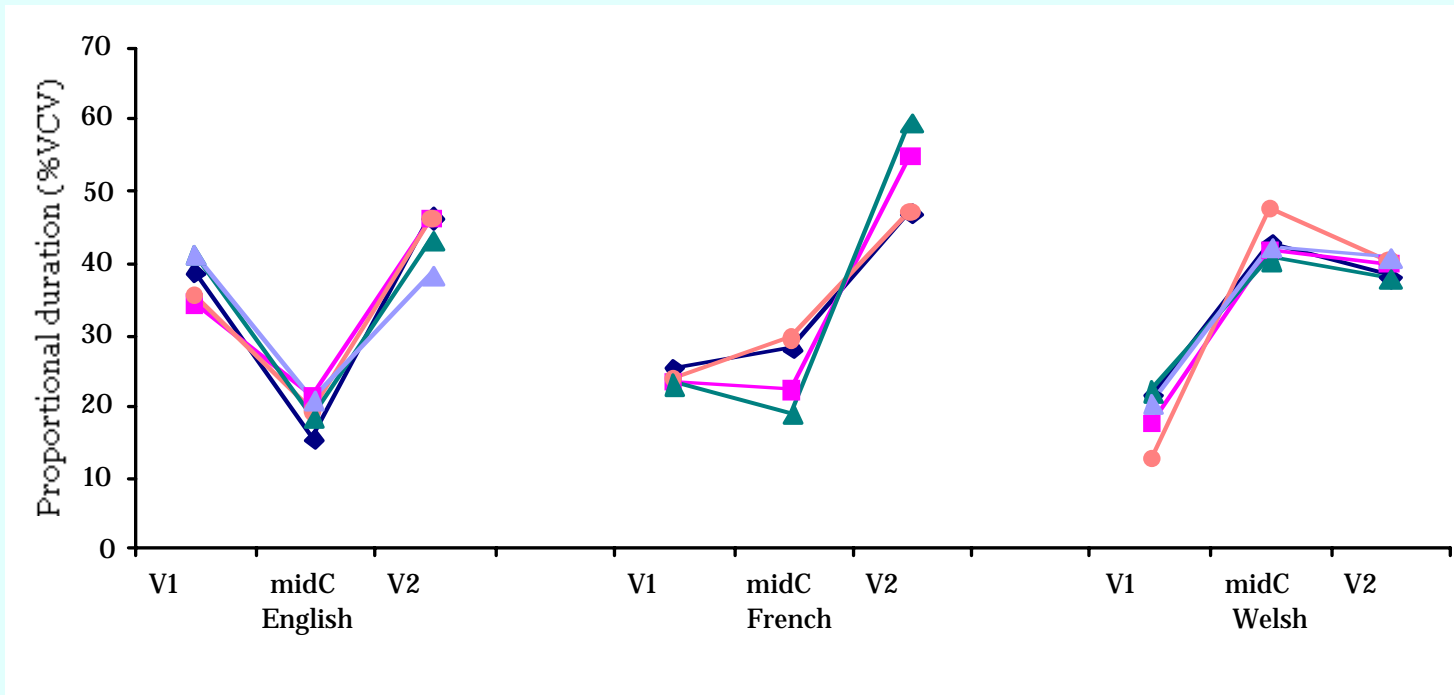
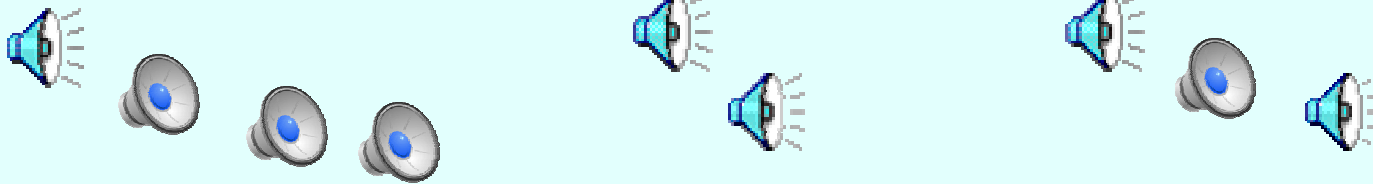


# The effect of accent: The case of Welsh

Welsh accent shares characteristics of both English and French:

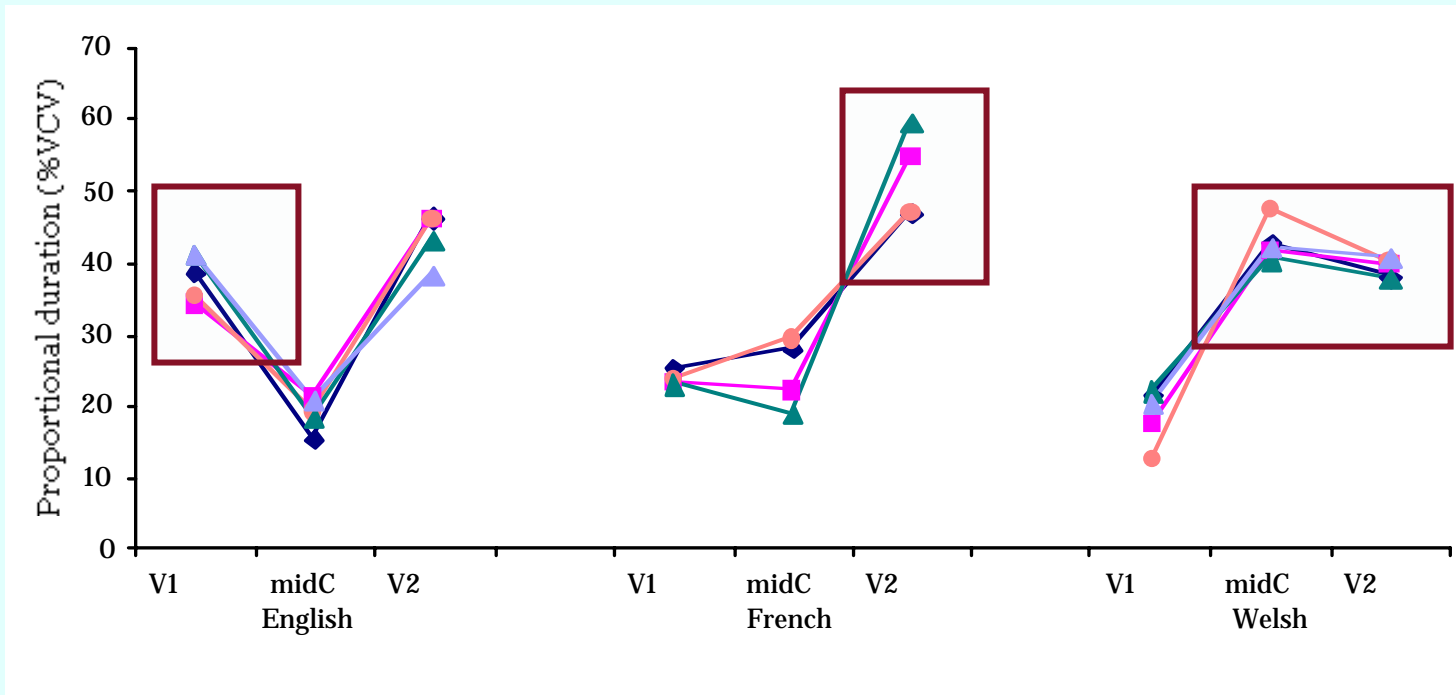
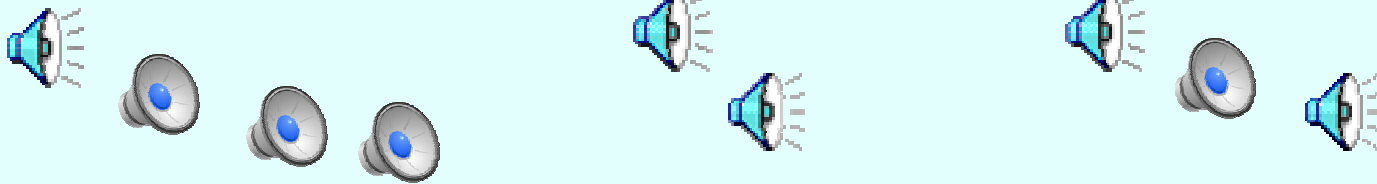
- ❖ Disyllables are generally *trochaic* (strong 1st syllable), as in English, but
- ❖ the *vowel* of the stressed syllable is *short*, the *consonant* of the stressed syllable is *long*, and the final vowel is also *long*, like the final vowel in French.

# *Elicited* adult production: English, French, Welsh 'babi'



Proportion of [b]abi taken up by V - C - V  
Vihman et al., 2006 (LabPhon8)

# *Elicited* adult production: English, French, Welsh 'babi'



Proportion of [b]abi taken up by V - C - V

## How might differences in accent affect infant responses in Head Turn and ERPs?

1. N2 modulation in ERPs subdued in Welsh due to **lower salience of onset consonant**, based on *both accent* and (grammatical) '*mutation*' (which affects ca. 2/3 of our familiar word stimuli).
  2. N4 expresses *same word form effect* but with *longer latency* - based on 2d syllable.
- Experiments with other languages needed to test these interpretations.

# Delay in word form recognition in minority language

- ❖ *Word form recognition* at later age in Welsh monolinguals:
  - no significant HT effect at 11 mos.;
  - widespread N4 modulation only at 12 mos.
  - no ‘foreshadowing’ of semantic processing yet at 12 mos.

Likely effect of learning Welsh as *minority language in bilingual community.*

# Effect of bilingual exposure

Bilinguals show only weak HT effect but significant N2 *and* N4 effects at 11 months.

Dual effect due to *interinfluence* of the two accentual patterns?

Attention to onset consonant in English may *boost attention* to onset consonant in Welsh.

# Conclusion

Word learning in a bilingual community is subtly different, depending on the language(s) spoken to the child.

For the dominant language, time course is the same as in a monolingual setting (e.g., French in France).

For monolinguals exposed directly only to the minority language, we see a slight delay.

For bilinguals, a smaller delay - and a dual accentual response.