

# CORTICAL CORRELATES OF BILINGUALISM



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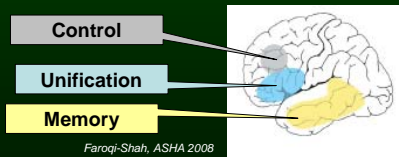
## Questions

1. Are there inherent cross-linguistic differences in neural representation?
2. Do bilingual brains differ from monolingual brains?
3. How are the different languages represented in bilingual brains?
4. How does bilingualism manifest in aphasia?
5. What are the implications for aphasia rehabilitation?

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## 1. Cross-linguistic differences

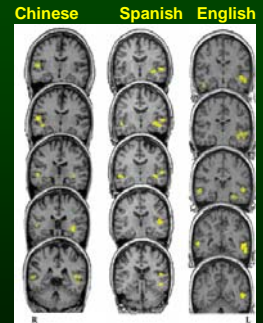
- ◆ In general,
  - Very little research addresses this question
  - Prediction is similar activation patterns for most languages
  - Theoretical perspective (Hagoort, 2005)



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## 1. Cross-linguistic differences

- ◆ An exception...
- ◆ Spoken word recognition
- ◆ Bilateral activity for Chinese
- ◆ Hence language specific characteristics may determine neural activity



Valaki et al. (2004)

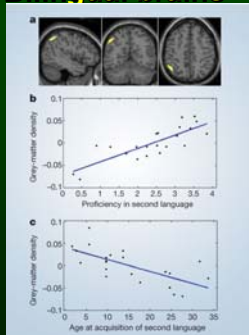
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## 2. Monolingual vs. Bilingual brains

Michelli et al. (2004)

English-Italian

- ◆ Voxel based morphometry
- ◆ Gray matter density
  - Left Inf. Parietal cortex



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## 2. Monolingual vs. Bilingual brains

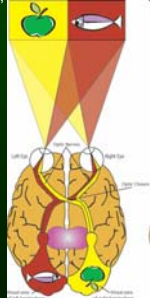
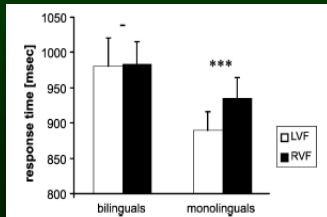
- ◆ Reduced hemispheric asymmetries for non-linguistic tasks (Hausmann et al., 2004)



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## 2. Monolingual vs. Bilingual brains

- ◆ Reduced hemispheric asymmetries for non-linguistic tasks (Hausmann et al., 2004)
  - Face discrim.
  - Turkish-German



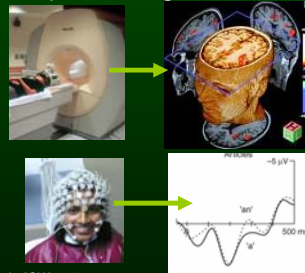
## 2. Monolingual vs. Bilingual brains

- ◆ Meta-analysis of behavioral laterality data for linguistic tasks (Hull & Vaid, 2006, 2007)
  - Bilateral (early bilinguals)
  - Left dominant (late bilinguals)
  - Left dominant (monolinguals)
- ◆ In most neuroimaging studies, no laterality differences between monolinguals and bilinguals (Hernandez et al., 2000, 2001; Kim et al., 1997)

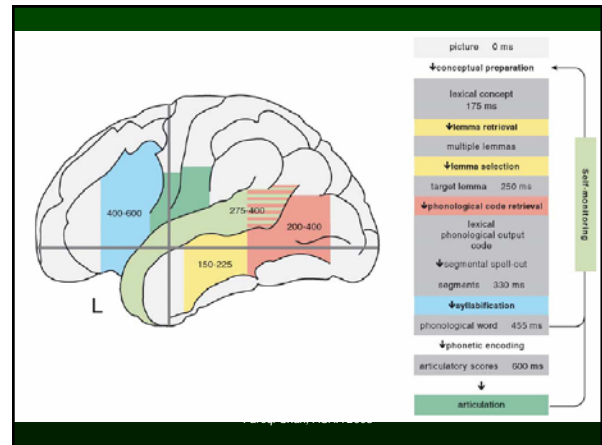
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## 2. Monolingual vs. Bilingual brains

- ◆ Meta-analyses of word processing
- ◆ Monolinguals
  - (Indefrey & Levelt, 2004)
- ◆ Bilinguals
  - (Indefrey, 2006)

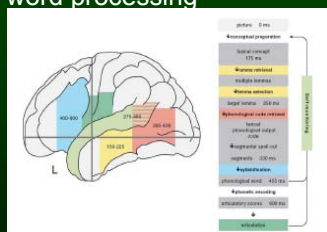


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## 2. Monolingual vs. Bilingual brains

- ◆ Meta-analyses of word processing
- ◆ Monolinguals
  - (Indefrey & Levelt, 2004)
- ◆ Bilinguals
  - (Indefrey, 2006)



- ◆ Similar neural correlates

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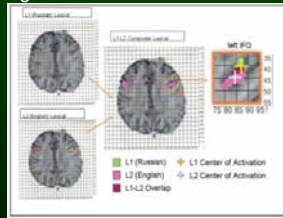
## 3. L1 vs. L2 in bilingual brains

- ◆ Meta analysis (Sampson, unpublished)
  - Reviewed 10 word generation studies
  - Greater similarities or differences?
  - 95/115 brain regions common for both L1 and L2 ( $p < 0.05$ , binomial test)
- ◆ Hence similar neural regions are activated for both languages
- ◆ However...

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### 3. L1 vs. L2 in bilingual brains

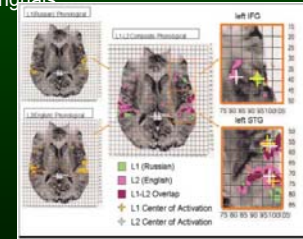
- ◆ Lexical processing (Marian et al., 2007)
- ◆ Russian-English late bilinguals



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### 3. L1 vs. L2 in bilingual brains

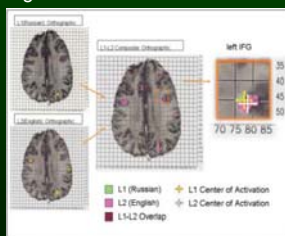
- ◆ Phonological processing (Marian et al., 2007)
- ◆ Russian-English late bilinguals



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### 3. L1 vs. L2 in bilingual brains

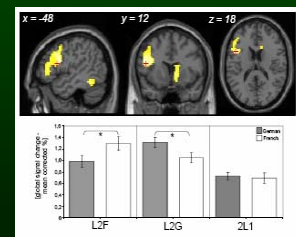
- ◆ Orthographic processing (Marian et al., 2007)
- ◆ Russian-English late bilinguals



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### 3. L1 vs. L2 in bilingual brains

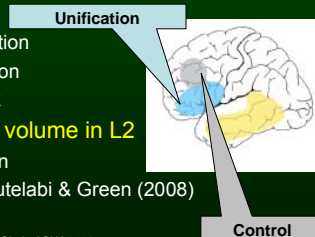
- ◆ Syntactic processing (Saur et al., in press)
- ◆ Late bil.
  - L2 French
  - L2 German
- ◆ Early bil.
  - French-German



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### 3. L1 vs. L2 in bilingual brains

- ◆ Summary
  - Left IFG shows most differences between L1 and L2,
    - Distance of activation
    - Volume of activation
    - Influenced by task
  - Greater activation volume in L2
    - Control & Inhibition
    - Green (2005); Abutelaibi & Green (2008)



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### Interim summary...

1. Are there inherent cross-linguistic differences in neural representation?
  - ◆ Unlikely (except for specific instances, e.g., auditory processing in Chinese)
2. Do bilingual brains differ from monolingual brains?
  - ◆ Somewhat in nonlinguistic tasks
  - ◆ Early bilinguals more bilateral
  - ◆ Late bilinguals and monolinguals more left dominant (Anchoring Hypothesis, Hull & Vaid, 2007)

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### Interim summary...

3. How are the different languages represented in bilingual brains?
  - ◆ Great overlap, increases with proficiency (Convergence Hypothesis, Green, 2005)
  - ◆ IFG sensitive to differences in
    - ◆ proficiency and
    - ◆ linguistic process
  - ◆ Possible role of inhibitory control mechanisms

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## 4. Bilingual Aphasia

- ◆ Approx. 45,000/year bilingual aphasic cases projected (Paradis, 2001)
- ◆ Patterns of aphasia & recovery patterns
  - Parallel (65% by Fabbro, 2001; 61% by Paradis, 2001)
  - Selective / Differential
  - Successive
  - Antagonistic

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## 4. Bilingual Aphasia

- ◆ Breakdown across languages
  - **Faroqi-Shah (in prep.)**
    - Multilingual aphasic patient (Arabic, French, English)
      - Nouns > verbs
      - Agrammatic production with morphosyntactic errors
      - Good grammaticality judgment, poor comprehension of sequential commands
  - **Parallel breakdown**
    - Weeks et al. (2008)
    - Poncelet et al., (2007)
    - Munoz & Marquardt (2003)

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## 5. Bilingual Aphasia Rehabilitation

- ◆ Caution...
  - Neural overlap and parallel aphasia do not necessarily mean identical processing mechanisms
  - Treatment of L1 (or L2) does not automatically generalize across languages (Galvez & Hinckley, 2003)
- ◆ Cross-linguistic cueing and priming data
  - Languages may interfere with one another
  - Directionality effects
    - L2 cues L1 better than vice versa

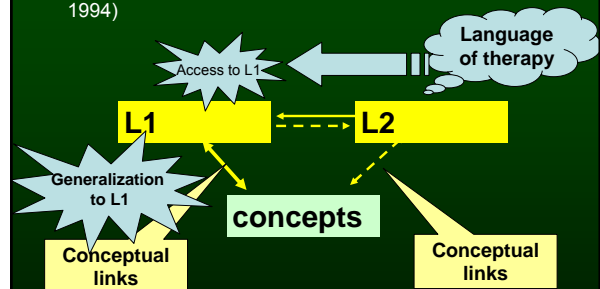
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## 5. Bilingual Aphasia Rehabilitation

- ◆ **Faroqi & Chengappa (1998)**
  - **Syntactic treatment of L2 (wh-questions)**
    - Generalized to L1
    - Did not generalize to L3 and L4
- ◆ **Kiran & Edmonds (2004, 2006)**
  - **Word retrieval treatment of L2**
    - Generalized to L1, but not vice versa
    - Also in Laganaro & Overton (2001); Kohnert (2004);

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- ◆ **Revised Hierarchical Model (Kroll & Stewart, 1994)**



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## 5. Bilingual Aphasia Rehabilitation

- ◆ Cross-language generalization can be facilitated by targeting
  - Overlapping concepts or syntactic structures
  - Treatment of L2 rather than L1 (especially in less proficient bilinguals)

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