



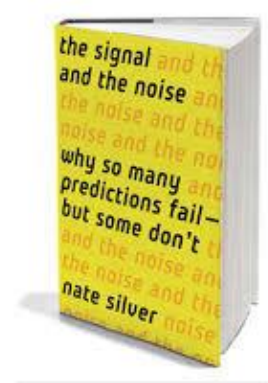
The Signal and the Noise: Finding the Pattern in Human Behavior

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Bilingualism and Executive Function: An Interdisciplinary Approach
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The Signal and the Noise



- ❑ Prediction basis of understanding most phenomena, but it is inexact
- ❑ Silver uses examples from politics, disasters, sports, economy, human behavior, etc. to demonstrate probabilistic reasoning
- ❑ Masses amount of data but accurate prediction requires decisions about the quality of the data
- ❑ However, data reduction usually on basis of preference

...but men may construe things after their fashion

Clean from the purpose of the things themselves

Shakespeare, Julius Caesar

- ❑ All data need to be interpreted and interpretation is not easy nor is it simply arithmetic – requires theoretical framework
- ❑ The signal can get lost in the noise

Research in Bilingualism

- ❑ Google Scholar
- ❑ Some research areas
 - Educational
 - Psychology
 - Linguistics
 - Social
 - Neuroscience
 - Political
 - Cognitive
- Cognitive consequences
 - Attention in infants
 - Behavioral studies of children
 - Brain imaging studies of children
 - Reasoning and problem solving
 - Behavioral studies of older adults
 - Neuroimaging studies of adults
 - Onset of dementia
 - Behavioral studies of young adults
- ❑ Simplified generalizations about **bilingualism** must be treated cautiously

➤ Cognitive consequences

- Attention in infants
- Behavioral studies of children
- Brain imaging studies of children
- Reasoning and problem solving
- Behavioral studies of older adults
- Neuroimaging studies of adults
- Onset of dementia
- Behavioral studies of young adults

Relation Between Bilingualism and Executive Function

- ❑ Large body of research demonstrates effect of bilingual experience on executive function, but some inconsistencies
- ❑ However, both terms, bilingualism and executive function, are ambiguous
- ❑ Need to clarify the terms before considering their relationship
- ❑ Presentations in this workshop have shown different outcomes but have used different assumptions
- ❑ Need to clarify the **signal** and the **noise**

Frontal Attention Network?

Executive function/control
Components (inhibition etc.)
Monitoring
Attention....etc

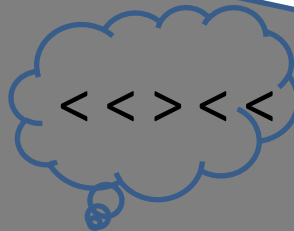
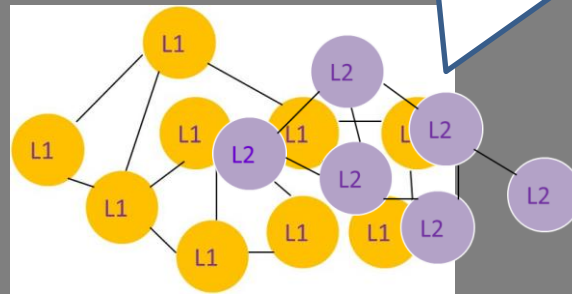
Joint activation depends on:

Proficiency in L1 & L2
Use and contexts
Age of acquisition....etc

Joint activation
Conflict for selection

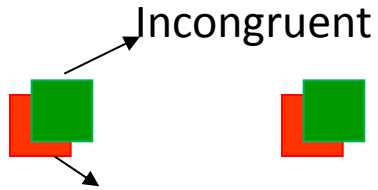
Conflict resolved by
frontal networks

How similar?



Simon Task Across the Lifespan

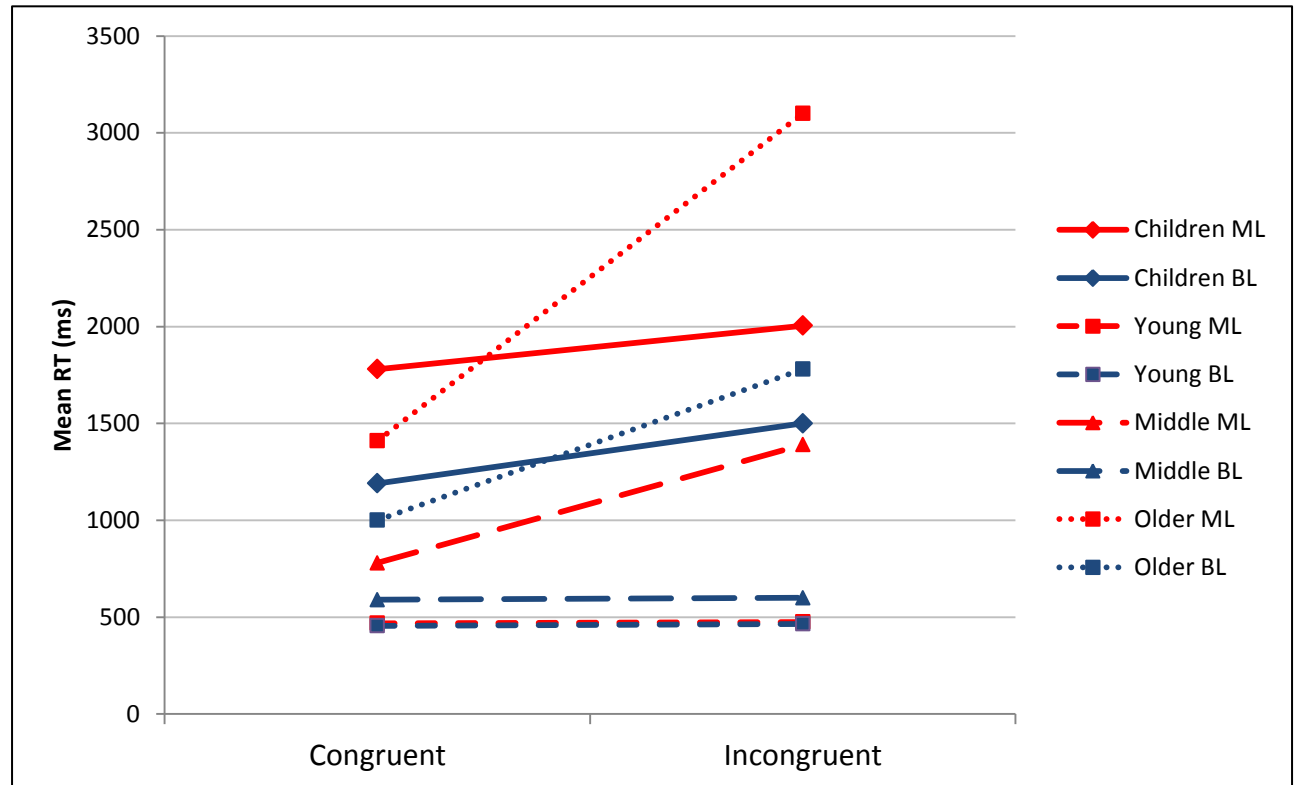
Bialystok et al., 2005



Red → Left
Green → Right

Congruent

Simon Task



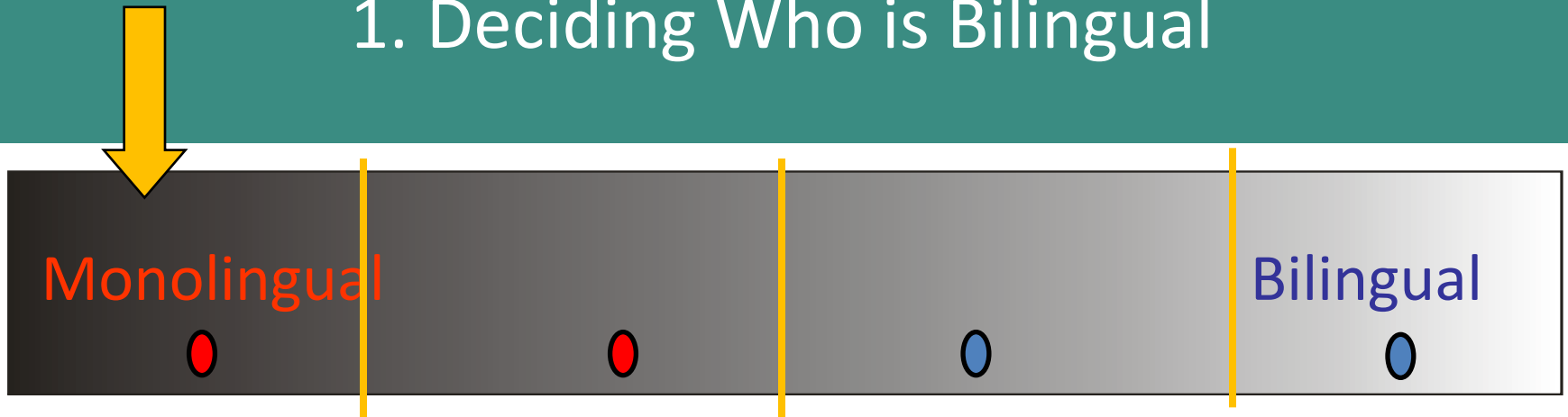
Why No Difference in Some Studies?

- ❑ Almost all studies with no language group effect report behavioral performance for young adults
- ❑ But if bilingualism modifies cognitive systems, then those changes should be found in all (or most) studies

➤ The signal should be clear

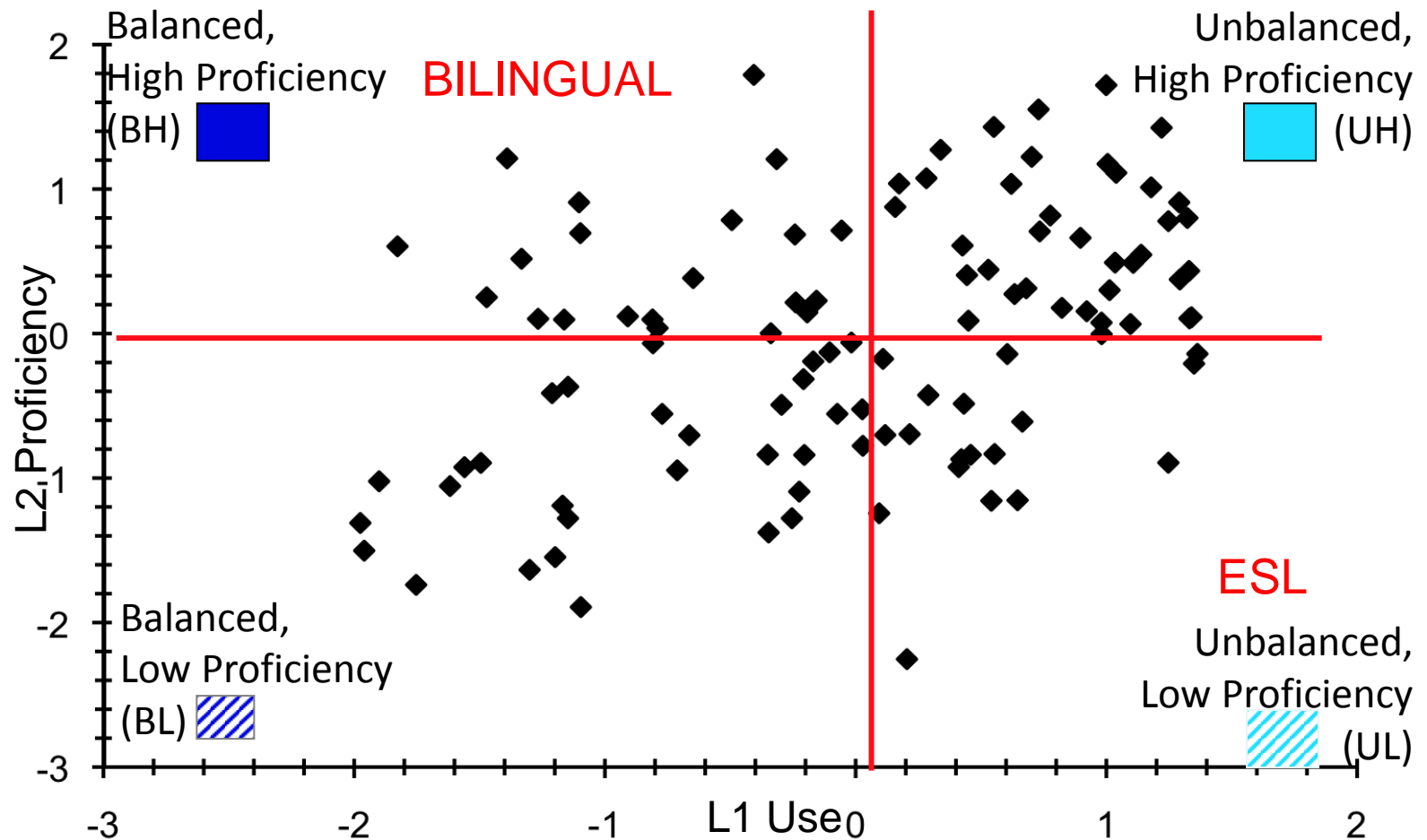
- ❑ Consider three factors (noise):
 1. Participants
 2. Data analyses
 3. Tasks and measures

1. Deciding Who is Bilingual



Bilingualism is not a categorical variable
What happens with intermediate values?

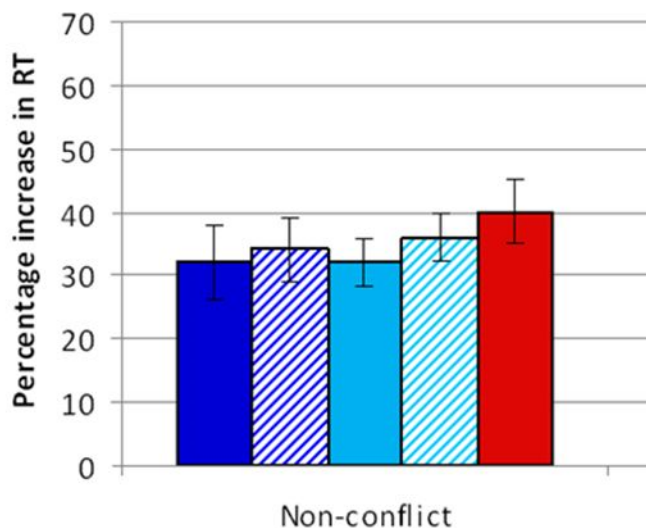
Luk, 2008



Degree and Type of Bilingualism

Luk, 2008

- ❑ 140 young adults classified by quadrants plus 40 monolinguals
- ❑ 2 EC tasks (flanker, anti-saccade)
 - Factor score for baseline, conflict, & non-conflict conditions
 - Difference scores for conflict and non-conflict



■ BH (N=22) ■ BL (N=29) ■ UH (N=38) ■ UL (N=21) ■ Mono (N=40)

Non-conflict: No group differences

Conflict: Bilinguals < Monolinguals, 3 groups not different from either

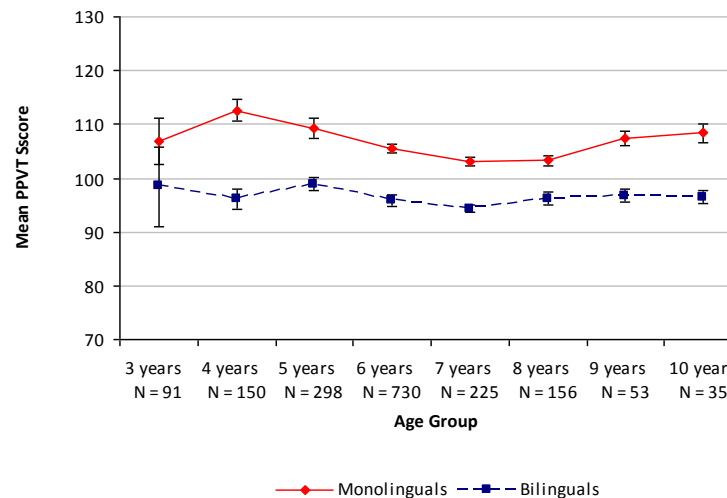
2. Statistical Models for Data Analysis

- ❑ Comparisons between groups (ANOVA models) require that data are normally distributed
- ❑ Significant group differences if group variance greater than individual variance
- ❑ Problem if individual variance is too great (relative to group) or restricted because of ceiling effect
- ❑ Consider the case of vocabulary size for monolinguals and bilinguals

Vocabulary in Monolinguals and Bilinguals

- ❑ Most (not all) studies report higher vocabulary scores for monolinguals than bilinguals in language of testing
- ❑ A large scale study shows this difference is reliable

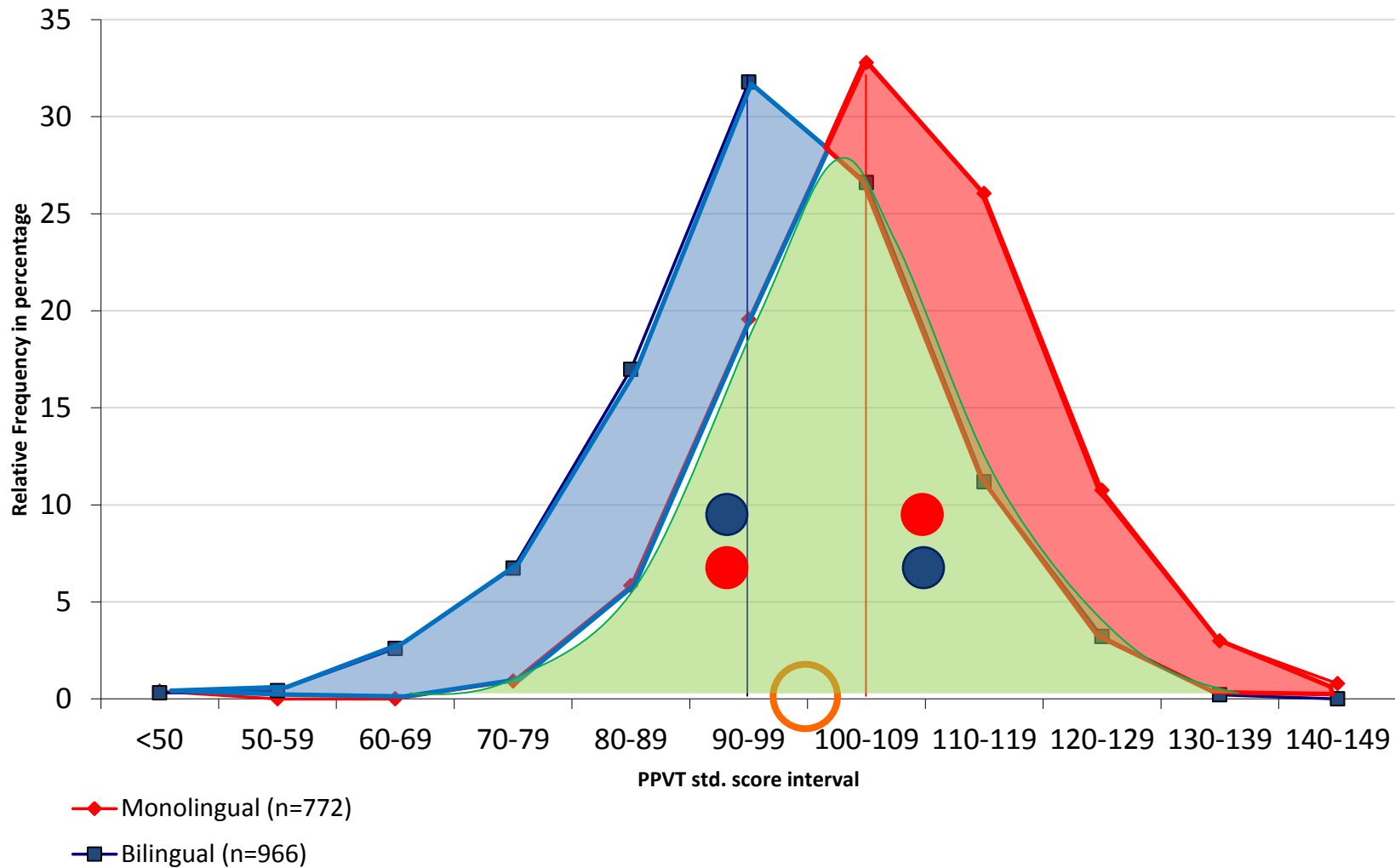
Bialystok et al., 2010, *BLC*
N = 1, 738



- ❑ What does that mean?

Bilingualism and Vocabulary

Bialystok et al., 2010, BLC



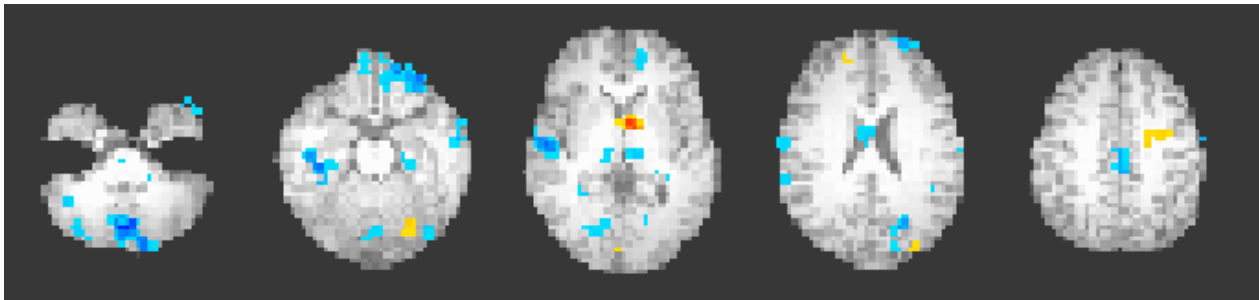
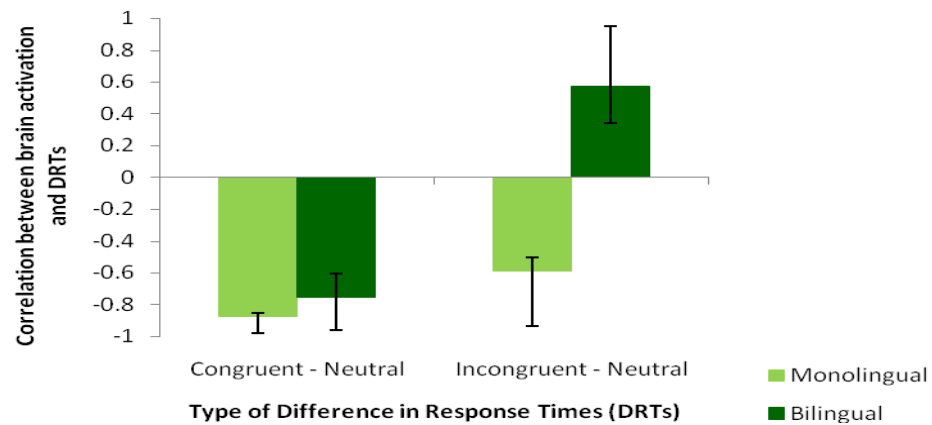
3. Complexity of Behavior and Selection of Measure

- ❑ Human behavior is complex and generates multiple indices
- ❑ Different tasks, populations, ages reflect relevant processing differences in different ways
- ❑ For young adults reaction time (RT) may be a poor measure and not informative, esp. for between group differences
- ❑ Robust effects showing structural brain differences between monolinguals and bilinguals
- ❑ Studies comparing monolingual and bilingual young adults show functional brain differences between groups in neuroimaging measures in the absence of behavioral differences

Behavioral vs. Brain Measures

- ❑ ERP: Kousaie & Phillips (2012): no behavioral differences but ERP differences in conflict monitoring, resource allocation, stimulus categorization for young adults on 3 EC tasks
- ❑ Fernandez et al. (2013): no behavioral difference on go/nogo task but larger N2 amplitude for bilinguals
- ❑ fMRI: Luk et al (2010): no behavior difference but different functional networks used for conflict condition
- ❑ Clearest signal from brain data occurs when functional differences found for equivalent performance

Flanker task in fMRI: Luk et al., 2010



Behavioral vs. Brain Measures for Different Groups

Rubio-Fernandez & Glucksberg, *JECP:LMC*, 2012

- ❑ Studies have shown young bilingual children perform false belief tasks better than monolinguals (Goetz, 2003; Kovacs, 2009)
 - Performance measured by accuracy
 - Adults all perform perfectly, so accuracy not informative
- ❑ Use a more sensitive measure to examine adult performance
- ❑ Eye-tracking with monolingual and bilingual young adults in standard false belief task
- ❑ Behavioral performance similar, but bilinguals showed less interference from their own perspective

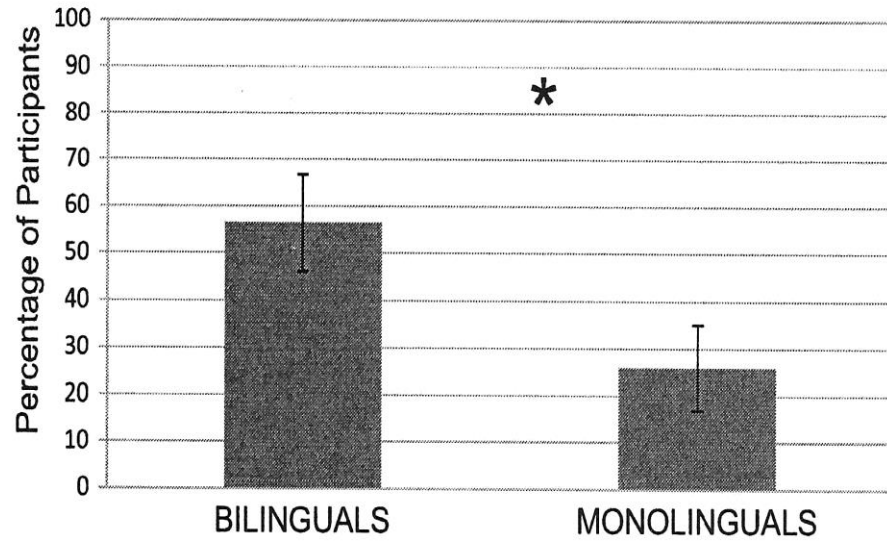
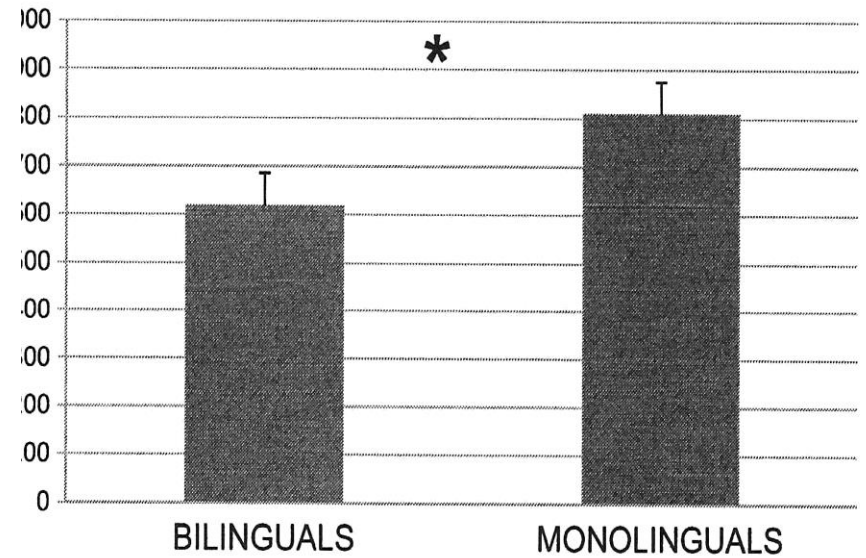


Figure 2. Percentage of participants (\pm standard error of the means) who first fixated on the correct container in the false-belief condition. * $p < .049$, two-tailed.



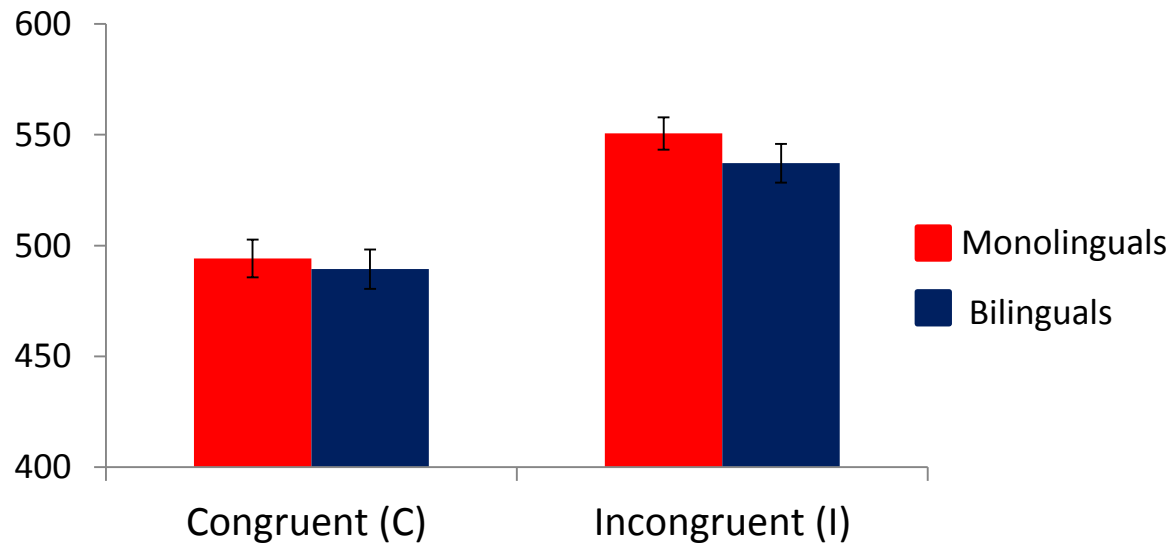
3. Mean fixation latencies (\pm standard error of the means) on the correct container in the false-belief condition. + $p < .045$, two-tailed.

Level of Behavioral Analyses

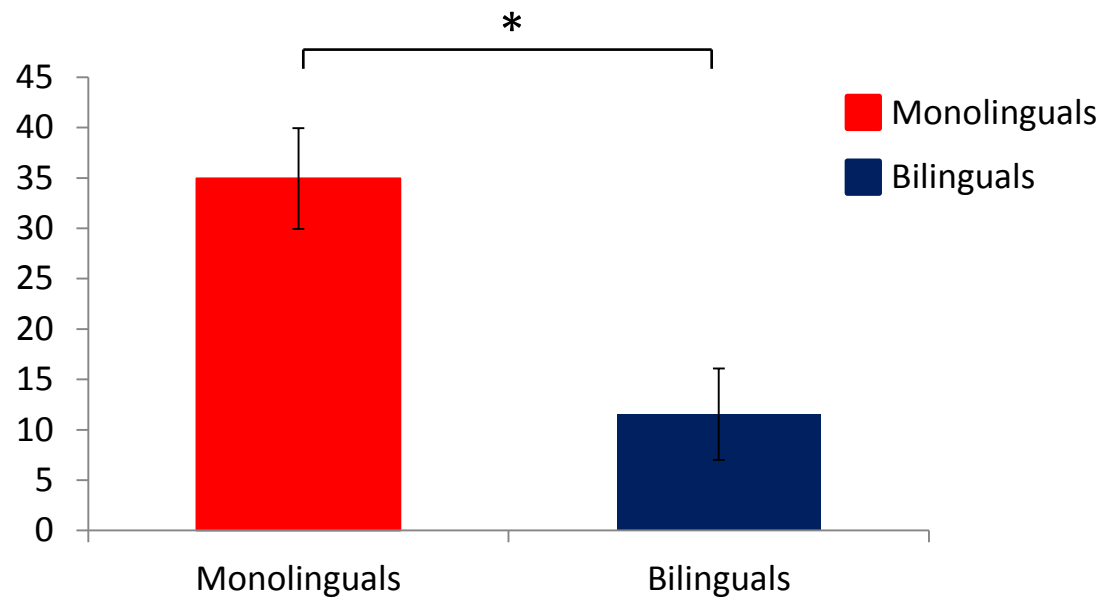
Grundy & Bialystok, *this conference*

- ❑ Research focuses on group means, but most tasks require more finely-tuned processing that may be concealed
- ❑ Simple flanker task may involve inhibition, shifting, and WM, but the demands on each change with the context
- ❑ Consider the demands of the previous trial and its impact on subsequent performance: Sequential Congruency Effect (SCE)
- ❑ 64 young adults, monolingual/bilingual
- ❑ Flanker task: standard analyses of congruent/incongruent
- ❑ SCE analysis of effect of previous trial on size of flanker effect
- ❑ Bilinguals disengage from conflict significantly faster than monolinguals, but difference lost in overall averages

Standard congruency effect RTs



Sequential congruency effects



What do Null Effects Mean?

- ❑ Failure to reject the null hypothesis is not grounds for accepting the null hypothesis
- ❑ Altman & Bland, 1995, BMJ: “Absence of evidence is not evidence of absence”
 - Describe the perils in medical research of rejecting drugs because clinical trials show no significant effect in some studies
- ❑ Fisher, 1935: "... the null hypothesis is never proved or established, but is possibly disproved, in the course of experimentation. Every experiment may be said to exist only in order to give the facts a chance of disproving the null hypothesis."

Bilingualism and the Null Effect

- ❑ Hypothesis testing is based on simple binary decisions
 - A precise effect will be found or will not be found
- ❑ Understanding how the mind/brain processes language in general and how it adapts to process two languages is staggeringly complex
- ❑ What does it mean if one set of hypotheses receives only sporadic support?
 - Indicates complexity of the underlying processes
- ❑ Need to find the signal

Why Does Bilingualism Matter?

- ❑ Massively pervasive experience – more than 50% world population is at least bilingual
- ❑ Sometimes associated with social or economic consequences
- ❑ Heritage language may be key to family and community connections
- ❑ Linguistic experience connected to all aspects of human mind
- ❑ For cognitive function, much evidence that bilingualism is advantageous, some evidence it makes no difference, but no evidence it is harmful
- ❑ Social, educational, and personal factors converge on the importance of maintaining, supporting, and encouraging bilingualism

Summary

- ❑ All research into human behavior is hard to do, but research into bilingualism presents additional challenges
- ❑ Bilingualism is an intense experience that has pervasive effects on the mind and brain, effects that may be different at different stages in the lifespan
- ❑ But the research is complex: Need to find consistent signal through the noise of diverse studies
- ❑ Silver argues that seeing the signal requires conceptual focus to avoid distraction by the noise – it's not just in the numbers
- ❑ A clear understanding of how bilingualism affects the mind is needed to inform policy in health, education, and social service

THANK YOU!

