Australian tradition

Butterworth, Reeve, Reynolds and Lloyd

PNAS 2008

Philosophical Psychology 2008

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Language necessary for understanding whole numbers

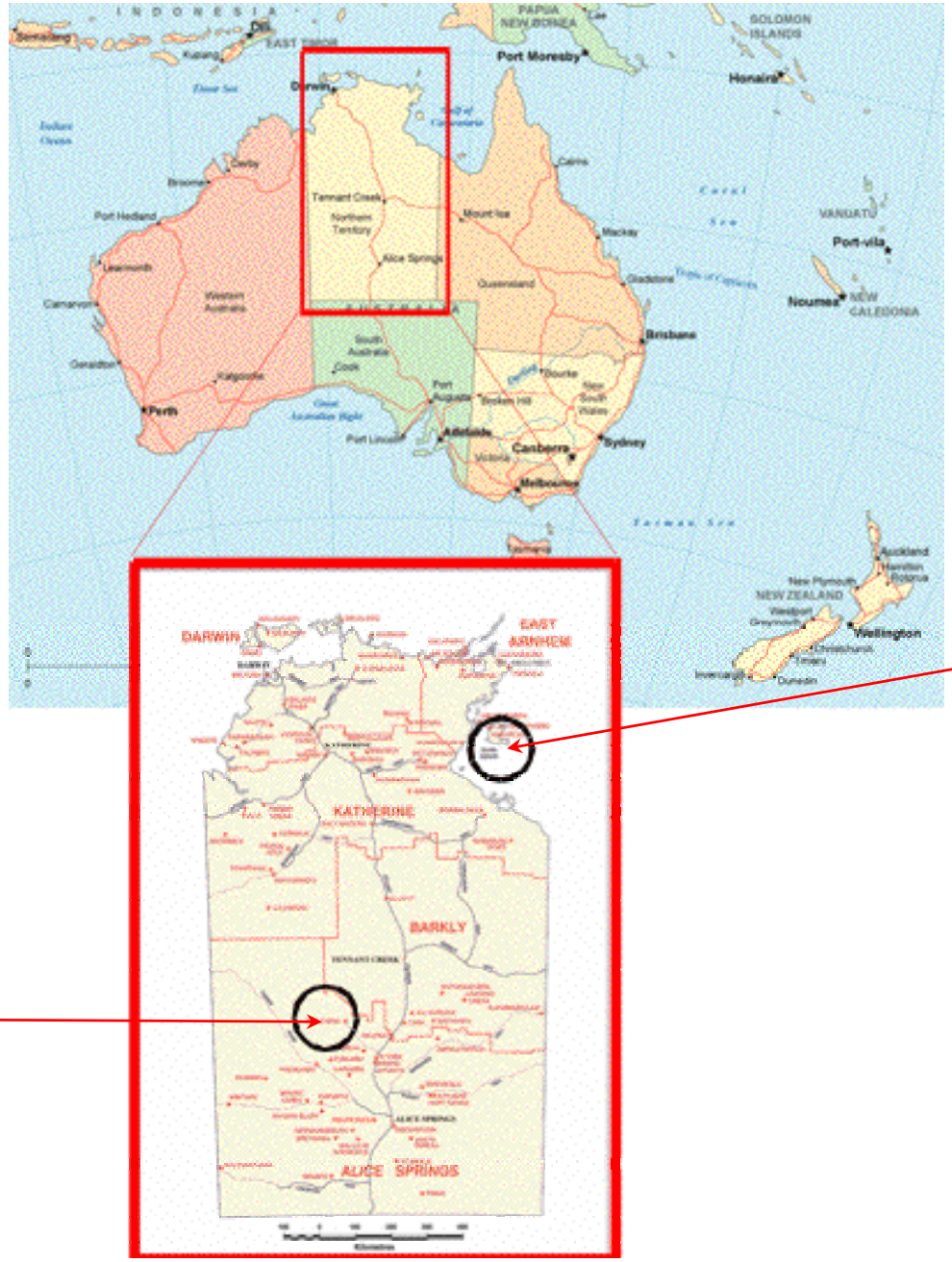
- Pinker ” (*The Stuff of Thought*)
  - counting practices “tend to be invented when a society develops agriculture, generates large quantities of indistinguishable objects, and needs to keep track of their exact magnitudes, particularly when they are taxed or traded.”
- Pica et al, 2004, *Science*
  - “Language would play an essential role in linking up the various nonverbal representations to create a concept of large exact number”
- Carey (*The origin of concepts*)
  - We inherit two domains of core knowledge – object tracking and analogue representations of approximate numerosities – but we need counting words to get to concepts of whole numbers (by the mysterious process of “Quinian bootstrapping” – a kind of inductive inference)
- Chomsky:
  - “the human number faculty [is] essentially an ‘abstraction’ from human language”

Locations and languages: Children 4-7 yrs

- Willowra (Central Desert) N=20
  - Warlpiri (Classifier language)
    - singular (“jinta”), dual plural (“-jarra”; “jirrama”), and greater than dual plural (“jirrama manu jinta”; “marnkurrpa”; “wirrkardu”; “panu”)
- Angurugu (Groote Eylandt) N=12
  - Anindilyakwa (Classifier language)
    - (1) singular, (2) dual, (3) trial (which may in practice include four), and (4) plural (more than three)
    - 1 (“awilyaba”), 2 (“ambilyuma” or “ambambuwa”), 3 (“abiyakarbiya”), 4 (abiyarbuwa”), 5 (“amangbala”), 10 (“ememberrkwa”), 15 (“amaburrkwakbala”), and 20 (“wurrakiriyabulangwa”).
    - Derived from Macassan traders, and used for ritual purposes.
    - Introduced only in adolescence
- Yappera School (Melbourne) N=13
  - English

So do children without number words have a concept of whole number?

That is abstract and can be used in arithmetic



Angurugu
(Anindilyakwa)

Willowra
(Warlpiri)

Butterworth, Reeve, Reynolds, & Lloyd, 2008, *PNAS*

- Tasks
  - Identifying numerosities: memory for counters
  - Identifying numerosities across modalities: cross-modal matching
  - Adding numerosities

Basic set up

Memory for counters

Response

Cross-modal matching

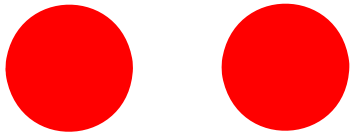
Cross-modal matching

Addition

Addition

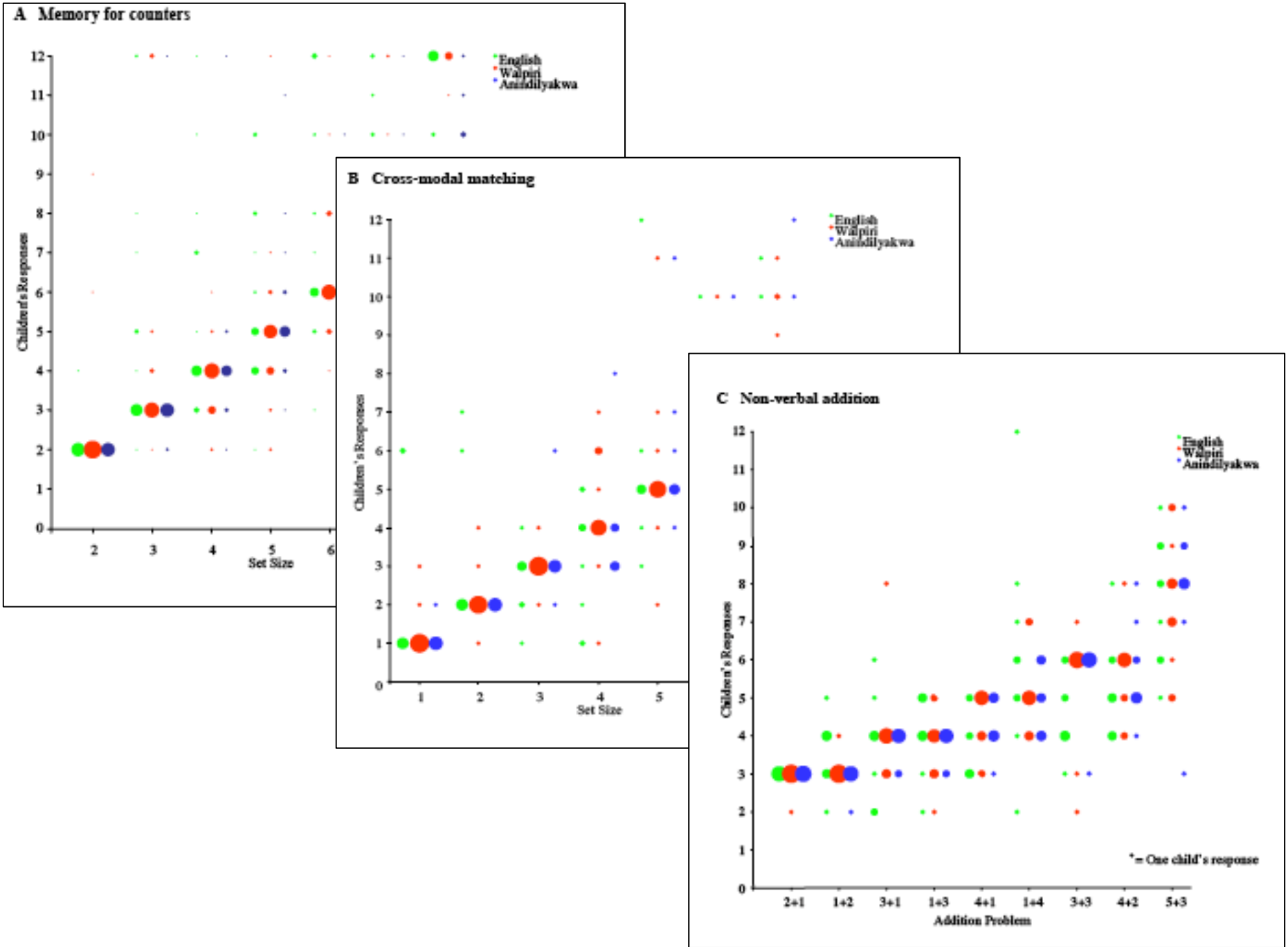
Interviewer’s mat

Child’s mat



Non-verbal Addition

Response


A Memory for counters
Children's Responses
Set Size
English
Warlpiri
Anindilyakwa
B Cross-modal matching
Children's Responses
Set Size
English
Warlpiri
Anindilyakwa
C Non-verbal addition
Children's Responses
Addition Problem
2+1
1+2
3+1
1+3
4+1
1+4
3+3
4+2
5+3
English
Warlpiri
Anindilyakwa
*= One child's response

Different strategy use: nonverbal addition

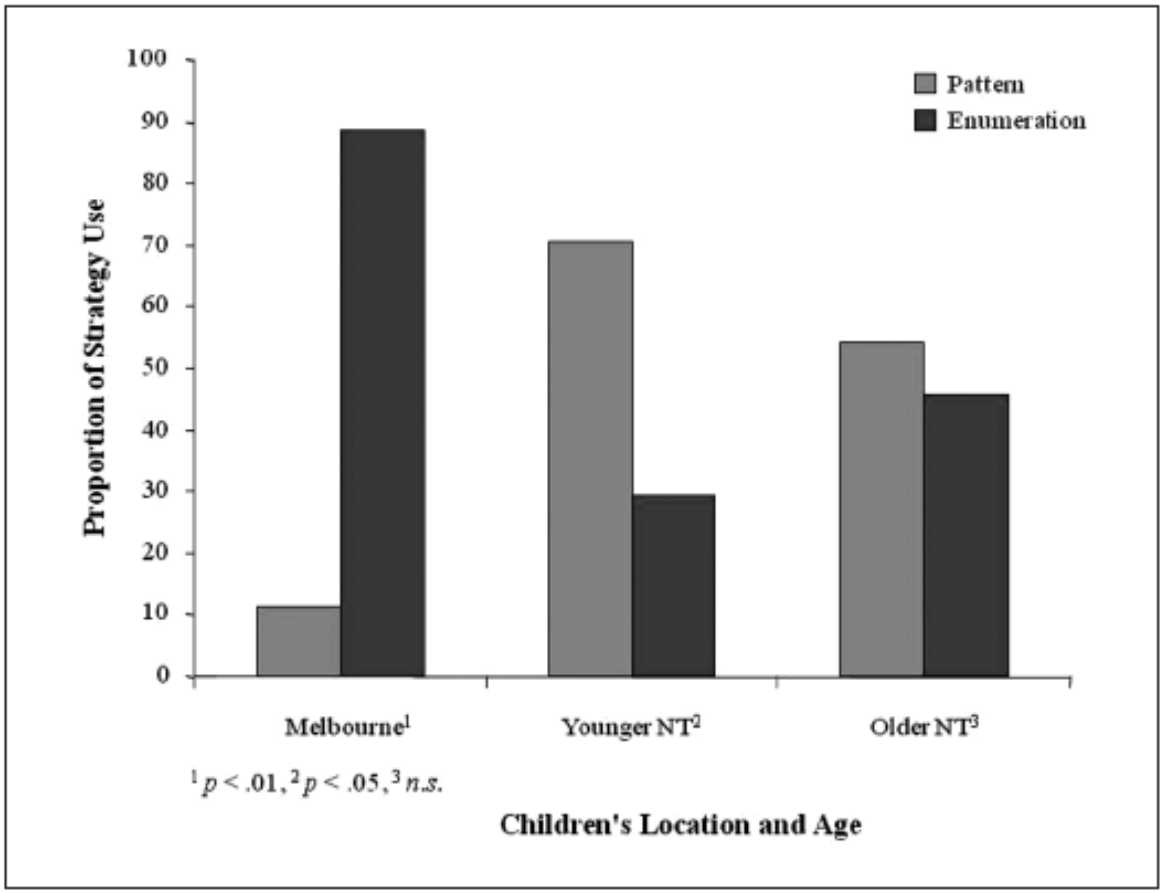


Figure 1. Proportion of Strategy Use for Correct *Nonverbal Addition* Responses as a Function of Children's Location and Age