The Effect of Age and Memory on Sensitivity to Novel Input in Acquisition

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Age effects in Acquisition

- Higher ultimate attainment in children
  (cf. Herschensohn 2007; *inter alia*).
- Despite lower ultimate attainment, adults tend to learn faster and outperform children in linguistic experiments.
  (cf. Krashen, Long & Scarcella 1979; Muñoz 2006, 2008; *inter alia*)
- Studies of age effects are longitudinal data
  (cf. Johnson & Newport 1989; DeKeyser, Alfi-Shabtay & Ravid 2010; *inter alia*)
- Shouldn't we be able to measure the advantage that children have?

Ullman's DP model

- Age effects from shifting memory systems:
  - dominant procedural memory in children
  - dominant declarative memory in adults

    (Paradis 1994; Ullman et al. 1997; Ullman 2001, 2004, 2005, *a.o.*)
- Declarative memory: responsible for remembering facts and events, learning new lexical items. Increases with age.
- Procedural memory: responsible for systematic routine behavior, including grammar. Most accessible for children.

Ullman's DP model

- Presented by Ullman as a dichotomy (L1 in children, L2 in adults)
  - not yet tested at a range of ages.
- Shift from procedural to declarative memory may involve competition.

  (Ullman 2005: 147-151).
- Could explain task effects for adults due to rote memorization via declarative memory.

“Less is More” (Newport 1990)

- Could the apparent advantages found in adults' cognitive abilities actually lead to a disadvantage for learning languages?
- In addition to the possibility of maturational constraints, “a second possibility is that at least some of the constraints crucial to success in language acquisition are nonlinguistic, and that the maturational changes which lead to more difficulty in language learning occur in these nonlinguistic constraints on perception and memory.” (p. 27)
- Hudson Kam & Newport (2009) suggested that children's lower performance in learning an exceptionally irregular artificial grammar was an indication of an *advantage*, such that adults perform well but not by using the same skills that children do when naturally acquiring a language.

Implicit and Explicit learning

- Generally, implicit learning is associated with children and explicit learning is associated with adults, both in terms of instructional methods and learner strategies.
- However, this has been questioned recently.
- Lichtman (2012) found that both adults and children can learn either implicitly or explicitly, depending on the input.
- At the same time, Lichtman found in an artificial language learning experiment that when receiving only implicit input, adults (but not children) were likely to form and express explicit rules.

What is learning?

- Here, I conceptualize of learning as adjusting to input:
    1) A learner receives input.
    2) This input differs from current knowledge.
    3) Learner becomes more targetlike.
- This adjustment requires a certain flexibility in the linguistic system.
- Therefore, learners who are more flexible should be better at learning.
- But which learners are more flexible?

Age? *Proficiency?* *Individual differences?*

Looking for a solution

- Should represent the learning process
- Should require minimal training of subjects
- Should be immediately intelligible:
  - We can use a **dialect**.
    (cf. Siegel 2010 for a description of similar age effects for second dialects.)
- Should be possible to accurately quantify the results:
  - We can use an **artificial grammar**.
- A novel methodology:

Artificial Dialect Repetition

Tasks

- Language background questionnaire
- Language sample elicitation
- Memory tests:
  - Digit span working memory task

    (from Gathercole et al. 2004)
  - Swahili repetition
    (to measure syllables recalled)
- *Artificial dialect repetition*

Artificial Dialect Repetition

- Spanish with 10 systematic grammatical manipulations.
- Also included 10 new lexical items.
- Recorded by trained native speakers of Peninsular Spanish.
- 4 stories, heard 4 times, repeated twice by sentence, then once for the full passage.
- Total of 7 minutes exposure to the dialect.
- Presented with images for each sentence, like a small movie to entertain the children.
- Told it was a “different” dialect (not artificial).

Grammatical Manipulations

- 5 phonetic/phonological manipulations:

#	Domain	Description	Example	Source Language
1	Phonetics	Palatalization: <y,ll> was pronounced as [ʃ], and <j,g> was pronounced as [ʒ].	*allí* [aji] → [aʃi] 'there' *girafa* [xirafa] → [ʒirafa] 'giraffe'	Argentinian Spanish for [ʃ]; Portuguese for [ʒ]
2	Phonetics	Diphthongs made into monophthongs: <ue> → [o] and <ie> → [e].	*fuerte* → [forte] 'strong' *miedo* → [medo] 'fear'	Originally in Latin, still found in other Romance languages
3	Phonology (prosody)	Pragmatically salient information given a rising pitch (F0). Applied digitally.	*Es solamente un* ***esPEjo***. 'It's only a **MIRror**.' Rising pitch in ***esPEjo***	(For example, expressing surprise in English.)
4	Phonology	Word-final /o/ becomes [u].	*miro* → [miru] 'I see'	Brazilian Portuguese
5	Phonology	<c,z> pronounced as [θ].	*cinco* → [θinco] 'five'	Peninsular Spanish

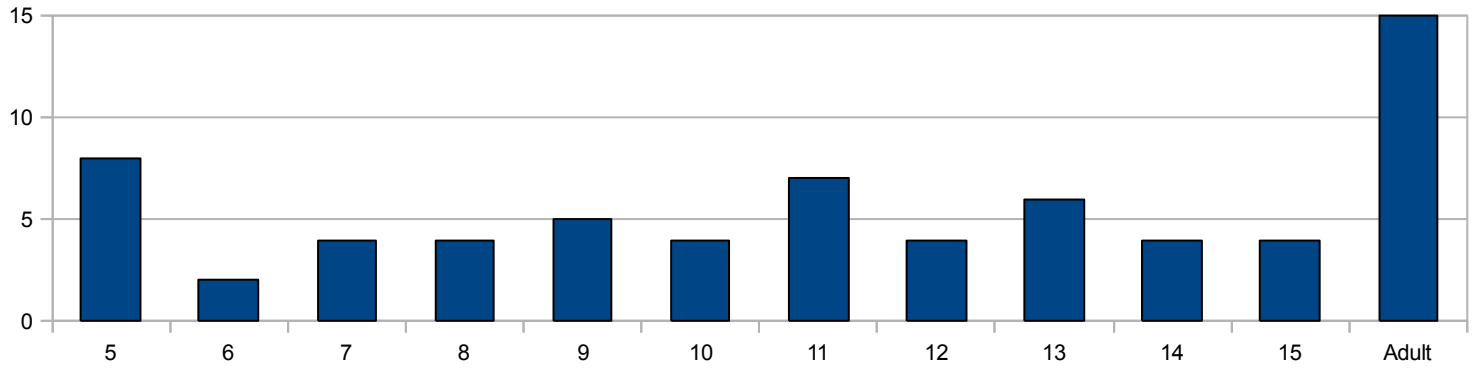
Grammatical Manipulations

- 5 morphosyntactic manipulations:

#	Domain	Description	Example	Source Language
6	Morphology	Adverbial suffix -mente truncated to -mén.	solamente → solamén 'only'	From Catalan -ment and Old French -men
7	Morphology	Irregular verbs regularized based on normal patterns.	dijo → deció 'said' soy → so 'I am'	(For example, in creolization.)
8	Morphology	Regularized masculine singular articles.	un → uno 'a(n)' el → lo 'the'	(Based on analogy to Portuguese.)
9	Syntax	All noun modifiers except articles (demonstratives, quantifiers, possessives, numbers) go after the noun.	Este idioma 'this language' → idioma este 'language this'	Based on head-initial languages like Swahili.
10	Syntax	A secondary verb goes at the end of a sentence.	podemos cruzar el río 'we can cross the river' → podemos el río cruzar 'we can the river cross'	Like underlyingly verb-final "V2" in German.

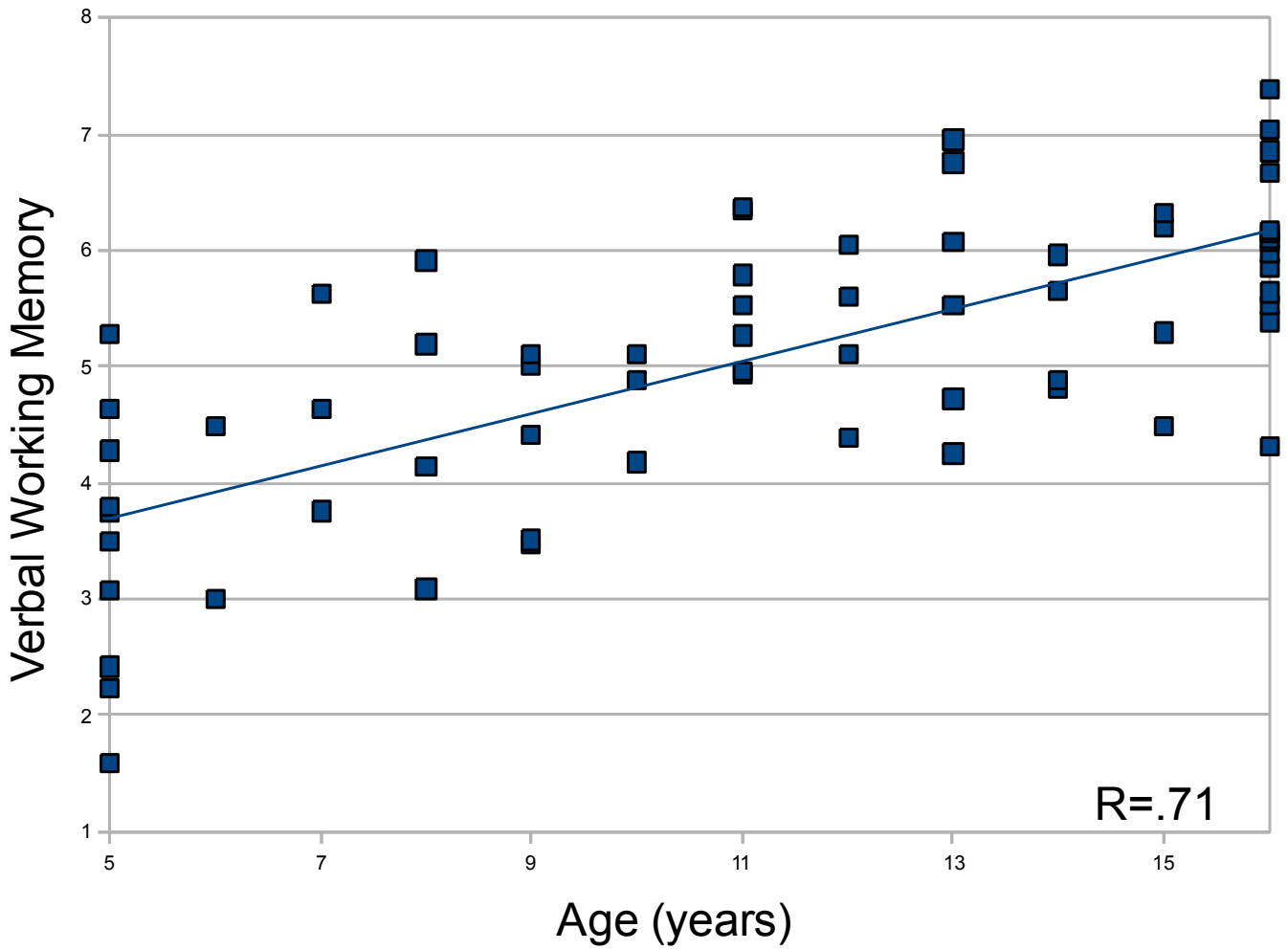
L1 Study

- 67 native speakers of Ecuadorian Spanish
- Most of the children tested at the same public school and adults from the community in Machala, Ecuador, on the coast.
- All had minimal exposure to other languages, primarily basic English as taught in school.
- Ages 5 through 15, and adults:



Verbal Working Memory

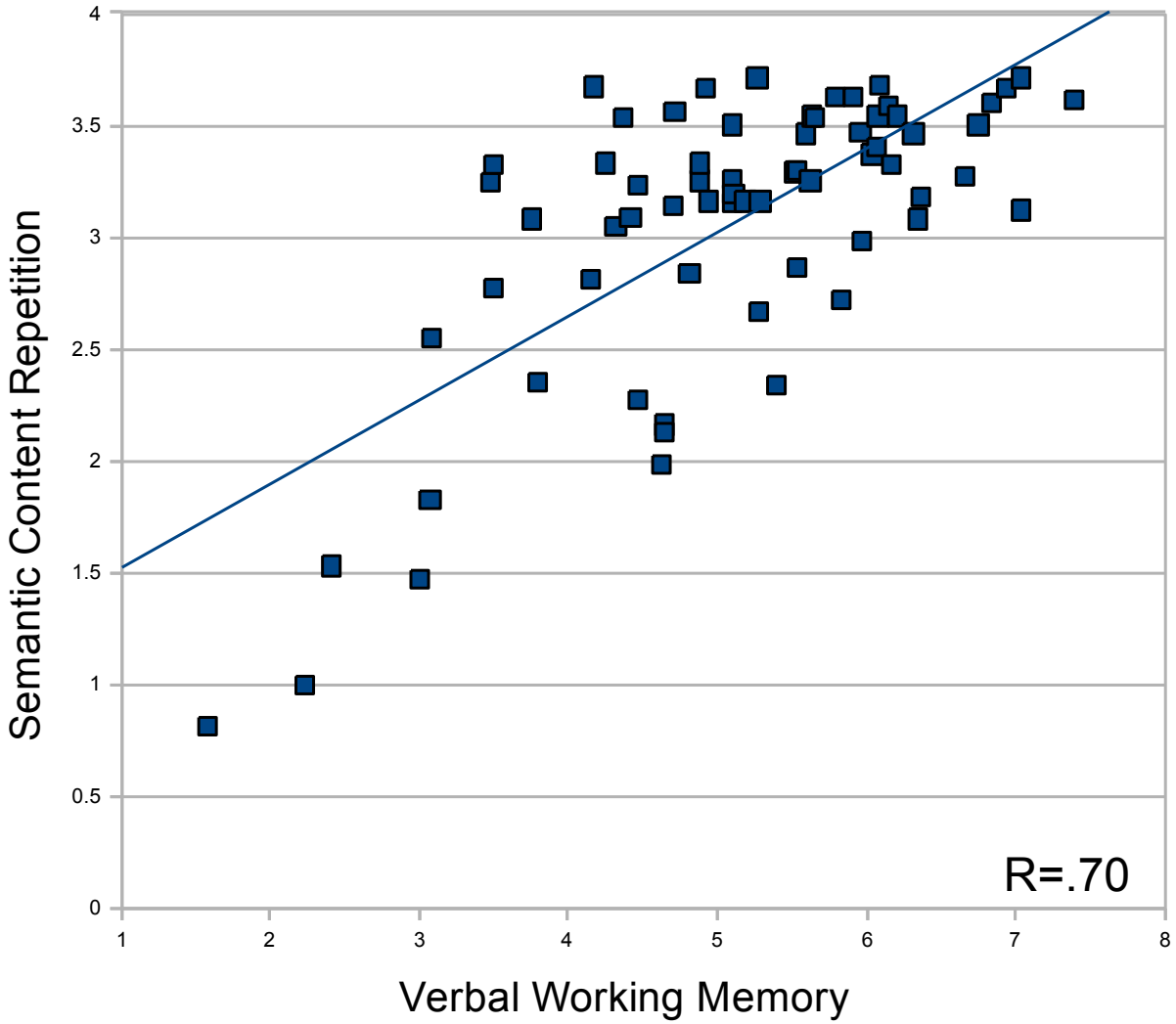
- Working memory increases with age



(Note: adults 16+ all considered 16.)

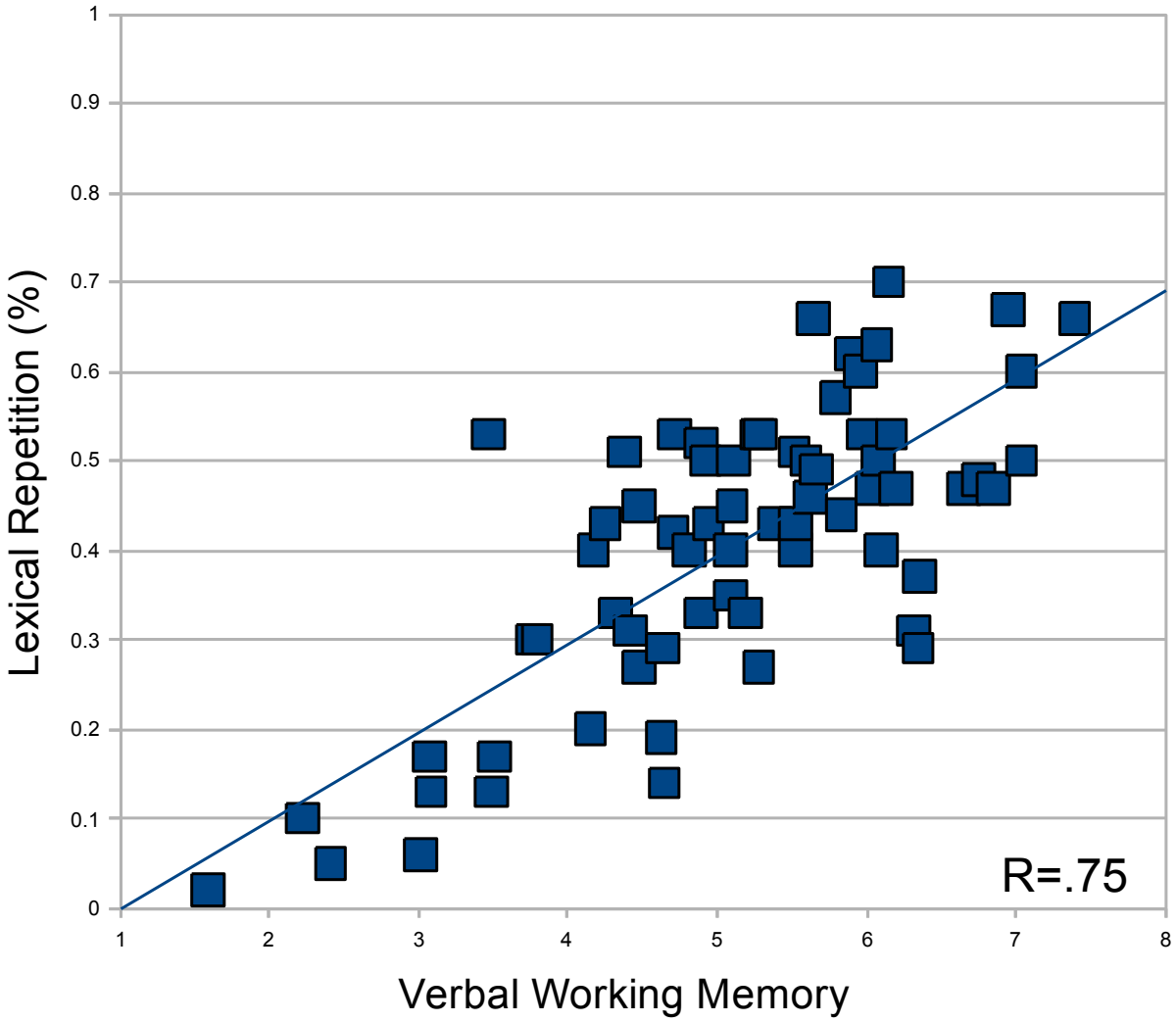
Semantic Content Repetition

- Semantic content repetition correlates with working memory scores.



Novel Lexical Items

- Novel lexical item repetition correlates with working memory scores.



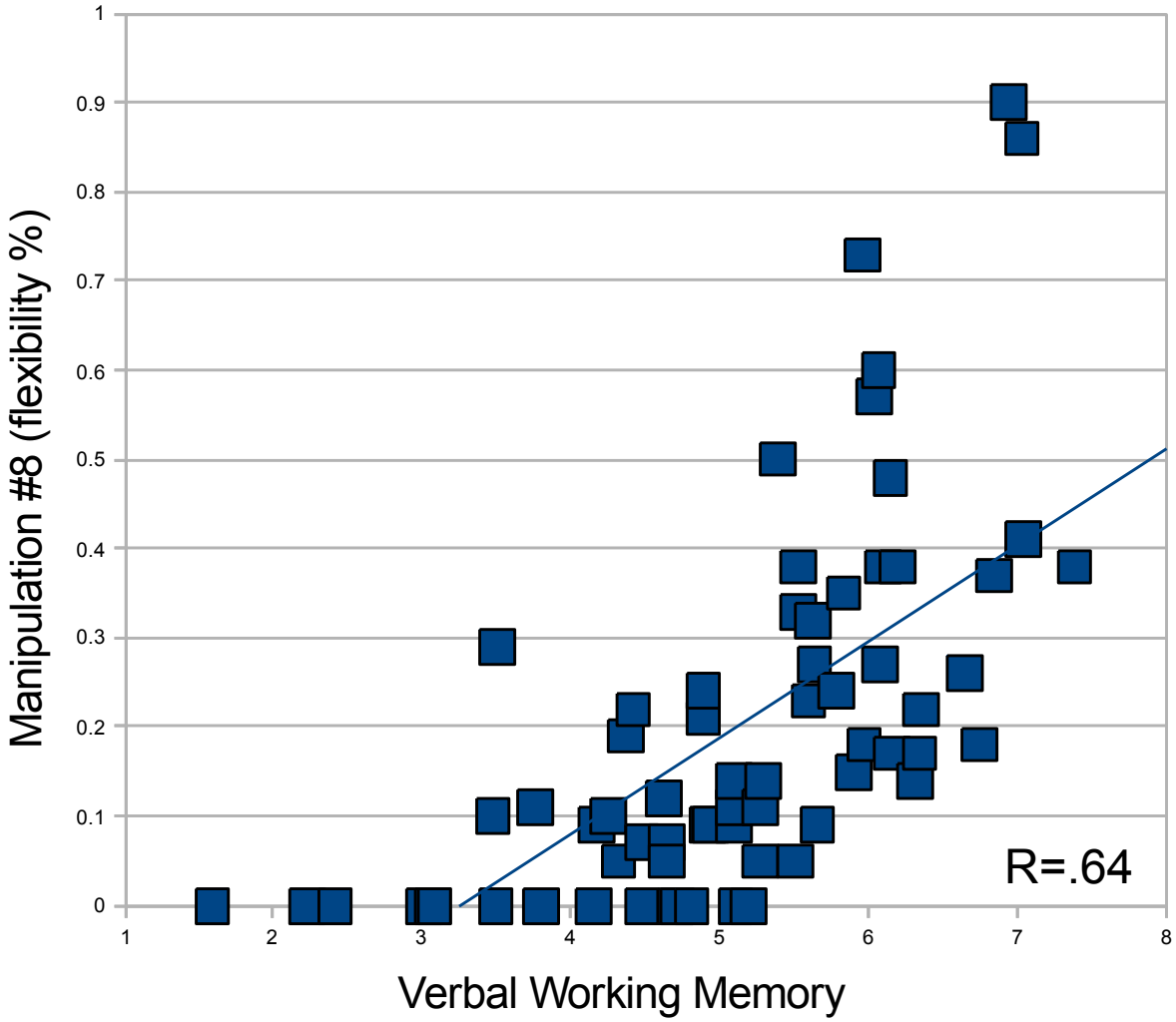
Grammatical manipulations

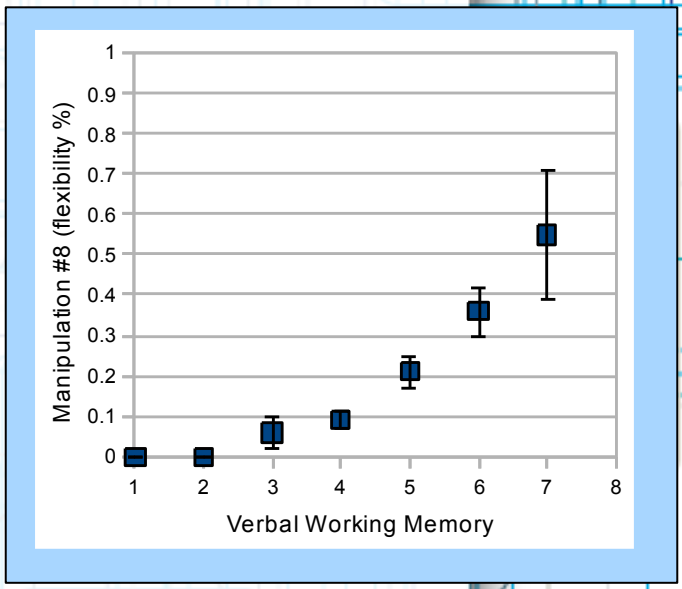
- Performance correlated more strongly with memory than age directly, but age correlates with memory.
- High working memory is consistently an advantage (for adults). Most manipulations are nonlinear: several showed a strong U-shaped curve (2, 4, 9) with an advantage for young children and adults; only one (6) showed only a linear correlation.
- Two manipulations did not produce clear results (3, 5).
- Statistical analysis performed with linear regression models (including polynominals to simulate non-linear regression).

$ax^2+bx+c...$

Manipulations #1, 7, 8, 10 & 6

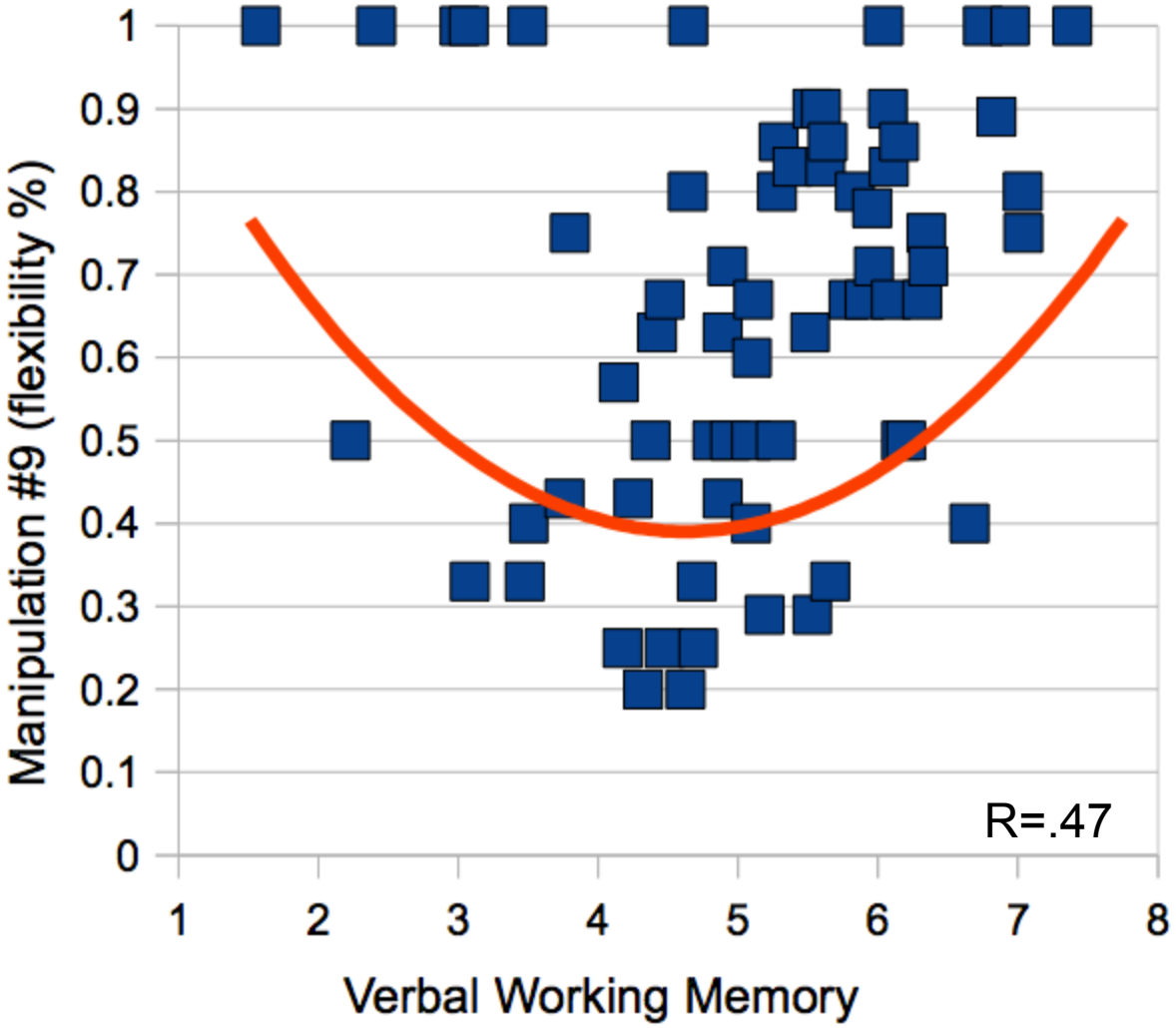
- Positive effect of working memory

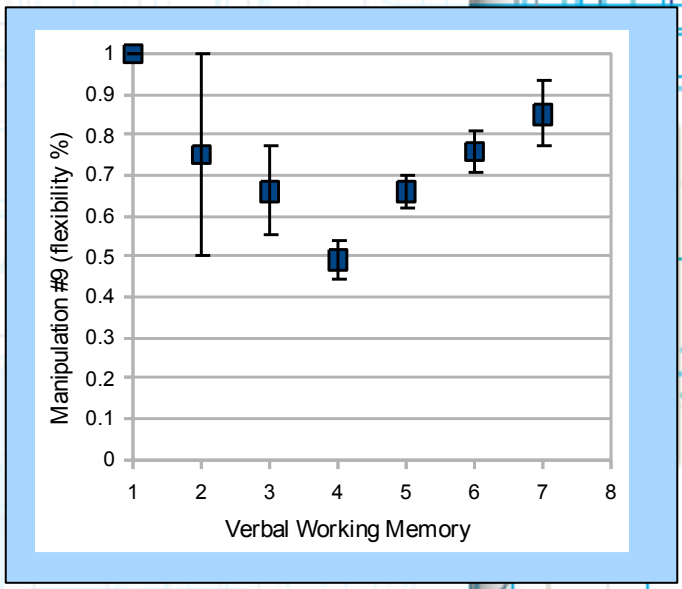




Manipulations #2, 4, 9

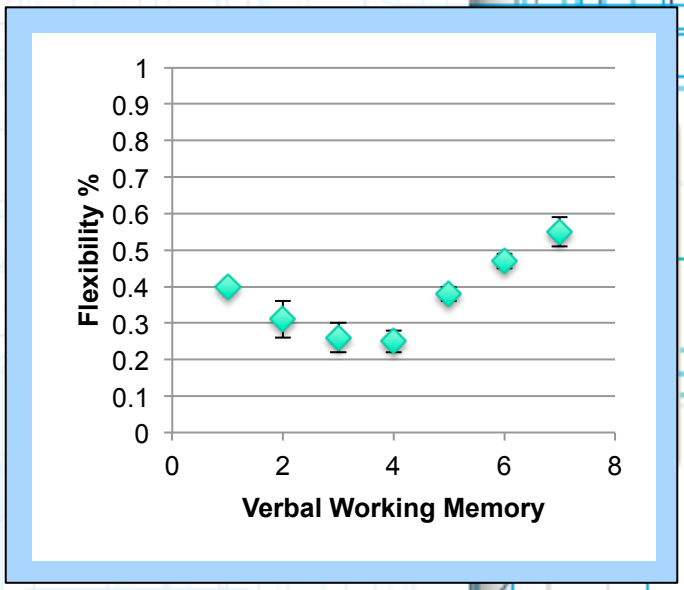
- U-shaped curves for memory vs. ability to accurately repeat the novel forms.





Average across manipulations

- U-shaped curve is general tendency.
- Effect of memory nonlinear with age!



Why a nonlinear curve?

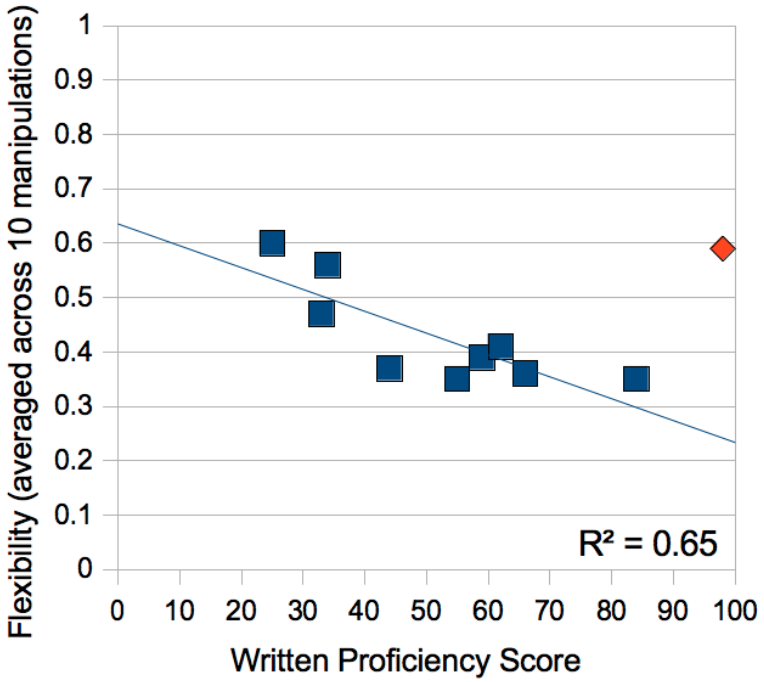
- In some manipulations, participants with either high *or* low memory outperformed those with midrange memory scores, probably for different reasons.
- Strong correlation for age and memory.
- Adults do better due to reliance on verbal working memory, as well as possibly task effects, and this matches the other results and previous research.
- But why do young children outperform older children? Why is verbal working memory less important in the lower range?

Flexibility Results Discussion

- At the lower range, performance does not depend on or increase with working memory.
- In some of the manipulations, the U-shaped curve showed an *advantage* for young children.
- This suggests use of strong procedural memory systems during childhood.
- All manipulations showed an advantage for adults, suggesting declarative memory strategies (rote repetition, metalinguistic analysis, conscious filtering, etc.).
- Those manipulations with more linear curves likely required more memorization and use of declarative memory.

Ongoing Research

- Replicating the previous experiment to consider the effect of proficiency for L2 learners, rather than age for L1 speakers.
- Preliminary results indicate a negative correlation with proficiency.
- University students studying Spanish
- Data available: N=10
- Significant effect of proficiency
- No memory effect



Ongoing Research

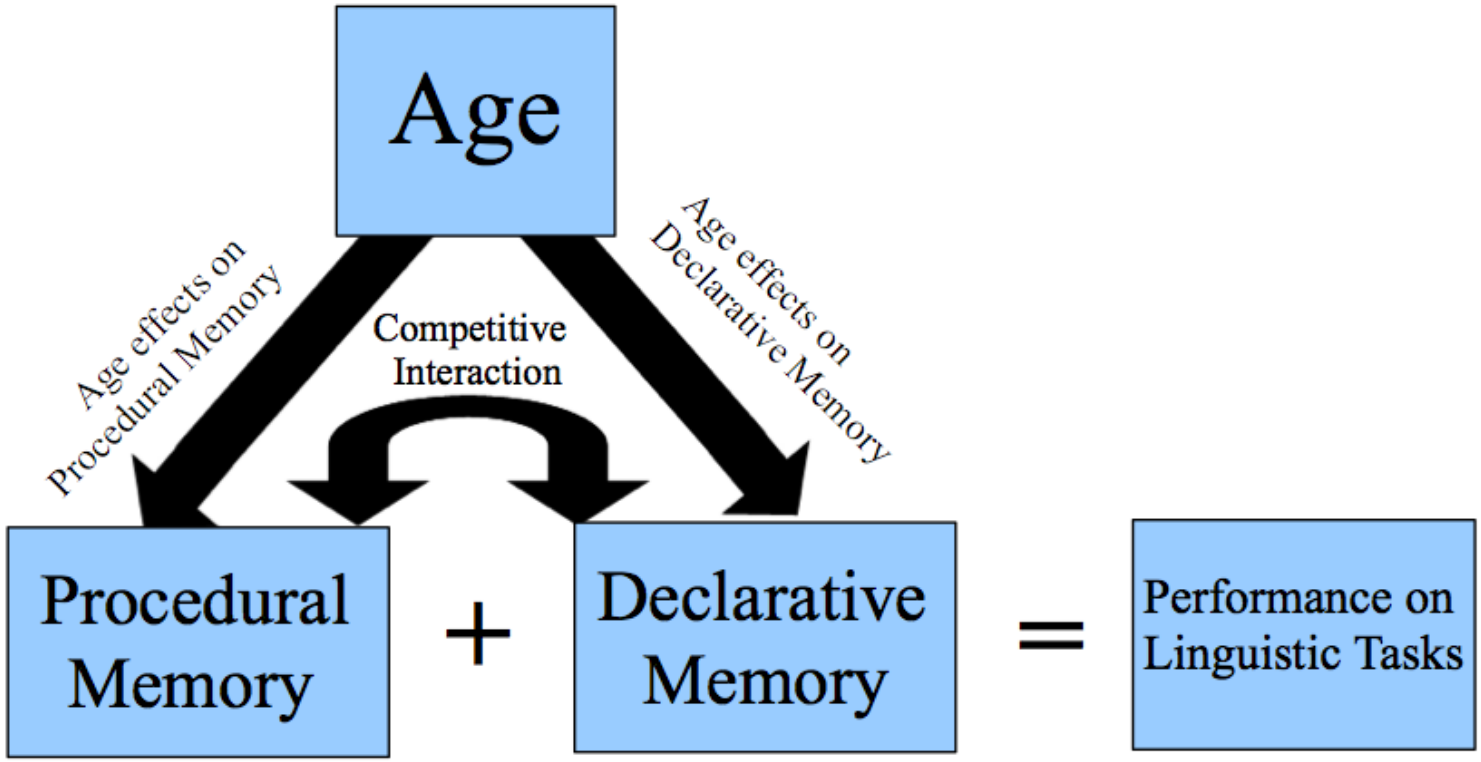
- Additionally, currently developing a new experiment for L1 English children.
- Goals:
  - Replicate results from Spanish study
  - Work with younger children (three years+)
  - Add more data to low memory range
- The important question: what do the effects of age and memory look like in the youngest years, when the children are learning English? Will three year-olds outperform five and six year-olds?

Conclusions

- Useful methodology for comparing the ability to learn across individuals.
- Age effects at least partially due to changes in memory systems: strong procedural memory in children is not available for adults who rely on declarative memory, which does not lead to high ultimate attainment.
- For L2 learners, there may be an effect of proficiency, with less proficient speakers being more flexible, meaning that early experience is crucial in shaping the L2.

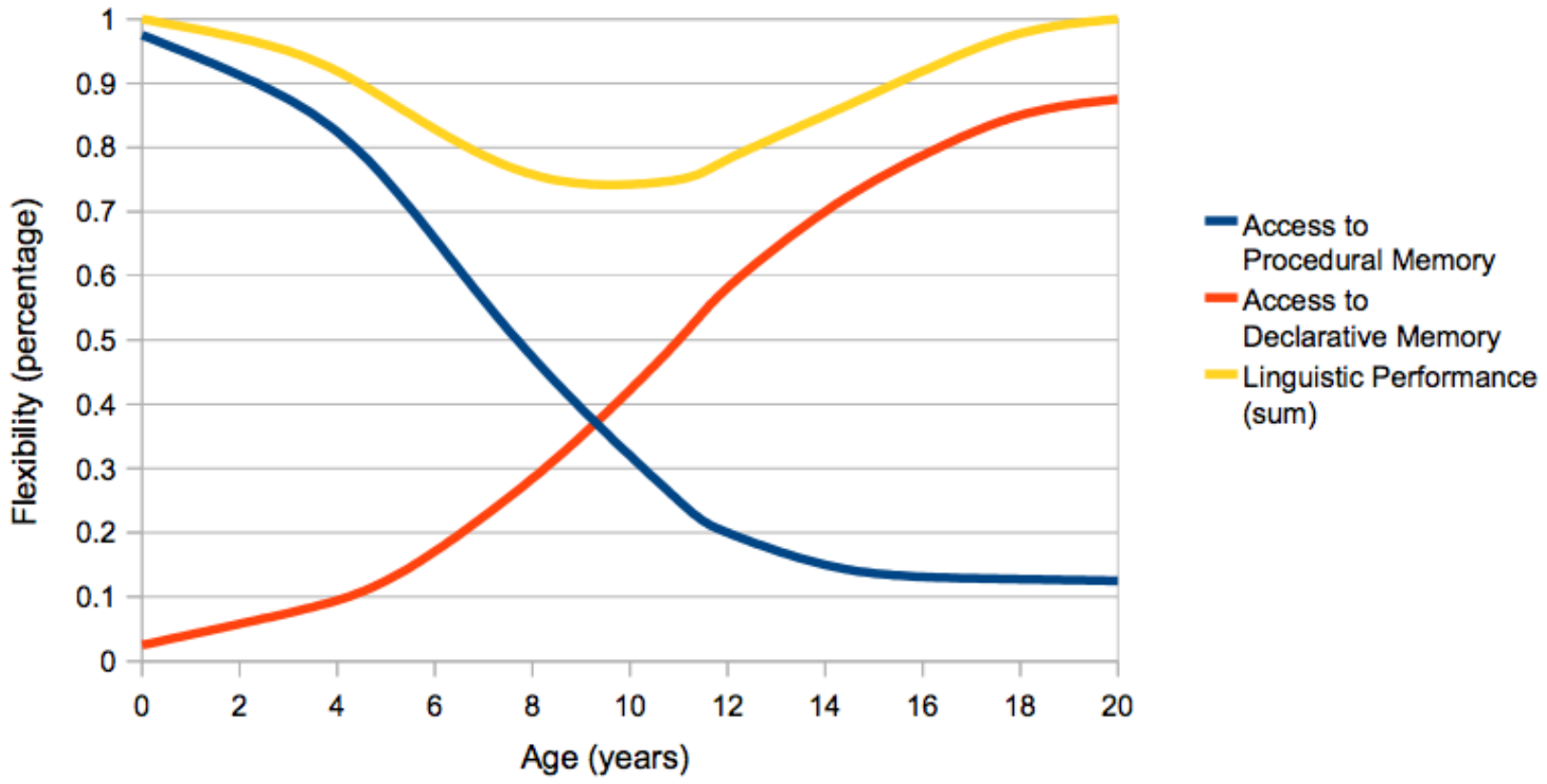
Age effects on language

- Performance on linguistic tasks can be explained indirectly by the effect of age on shifting dominance in memory systems.



Shifting memory systems

- This idealized representation of the effect of shifting memory systems on language may hint at an explanation for the “critical period” in language acquisition.



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Manipulations Comparison

Table 3. *Stories used in the Artificial Dialect Repetition task.*

Story	1	2	3	4
Content	A short personal introduction told in first-person.	A short version of "The Tortoise and the Hare."	A group of treasure-hunters find a mysterious treasure.	A fable-style story about a giraffe and elephant.
Sentences	3	4	6	9
Syllables per Sentence	15, 17, 17	21, 17, 24, 21	18, 17, 17, 21, 17, 18	21, 20, 19, 19, 20, 19, 20, 24, 20
Recording Time	10 seconds	21 seconds	25 seconds	48 seconds

Table 4. *Distribution of tokens for manipulations in artificial dialect stories.*

Manipulation	1	2	3	4	5	6	7	8	9	10	Lexical Items
Instances	21	14	15	60	21	10	14	22	9	8	10

10 lexical items total: *Adila* (or *Adilu*), the name of a woman (or man); *Kitale* (the name of an African town); *despaz* ('slow'); *nanasi* (the name for a type of plant), *tesoradores* ('treasure hunters'); *Isa* (a girl's name); *Samira* (a girl's name); *nacera* ('of birth', as a type of party: 'birthday party'), *Mamba* (the name of a river); and *Usena* (the name of a god).