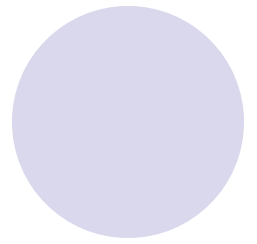
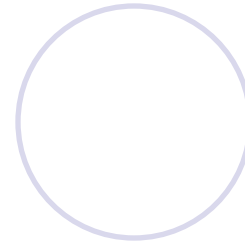
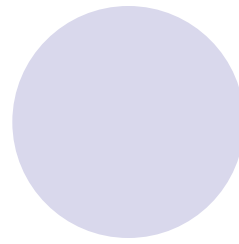
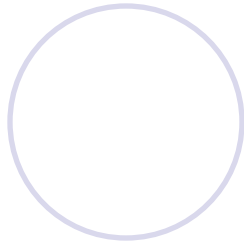
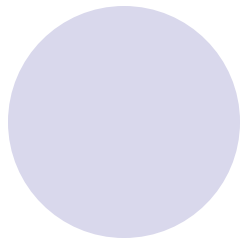




Does age of acquisition matter for processing L2 morphosyntax?

Nuria Sagarra
Rutgers University



Children have no difficulty acquiring morphology (Meisel, 1992, 1997), but adult learners have persistent difficulty processing inflectional morphology (e.g., plural suffix –s in “cars”) absent in their L1. (e.g., Hopp, 2010; Slabakova, 2008).

Spanish has **gender** and **number** on nouns, and adjectives agree in **gender** and **number** with nouns:

niño**o** alto**o**

niño**os** alto**s**

niña**a** alta**a**

niña**as** alta**s**

edificio**o** alto**o**

edificio**os** alto**s**

mesa**a** alta**a**

mesa**as** alta**s**

But English only has **number** on nouns, and adjectives don't agree with nouns:

niño**o** alto**o** = *tall boy* niño**os** alto**os** = *tall boys***s**

niña**a** alta**a** = *tall girl* niña**as** alta**as** = *tall girls***s**

edificio**o** alto**o** = *tall bldg* edificio**os** alto**os** = *tall bldgs***s**

mesa**a** alta**a** = *tall table* mesa**as** alta**as** = *tall tables***s**

Do you think that English native speakers who start learning Spanish after age 12 can acquire gender and number agreement in Spanish or is the game over (critical period)?

An orange circle containing the word "Think" in white, sans-serif font.

Think

GOAL: to investigate the role of:

1) AOA:

can adults acquire L2 morphosyntax in a native-like way?

2) Cognitive load:

gender vs. number agreement; gender agreement with animate vs inanimate nouns

3) Cognitive resources:

does WM affect intermediate L2 learners' sensitivity to gender/number agreement violations?

GOAL: to investigate the role of:

1) AOA:

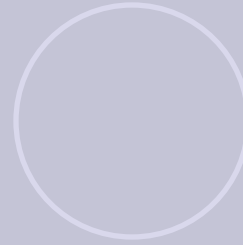
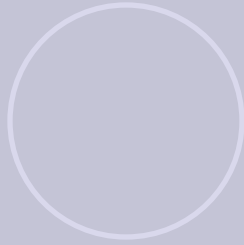
can adults acquire L2 morphosyntax in a native-like way?

2) Cognitive load:

gender vs. number agreement; gender agreement with animate vs inanimate nouns

3) Cognitive resources:

does WM affect intermediate L2 learners' sensitivity to gender/number agreement violations?



DEFICIT ACCOUNTS

Adult learners *cannot* acquire grammatical features absent in the L1 after a critical period.

WHY IS IT IMPOSSIBLE?

DEFICIT ACCOUNTS

REPRESENTATIONAL ACCOUNTS:

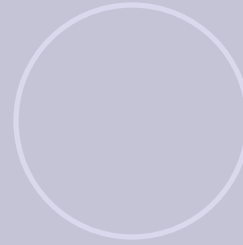
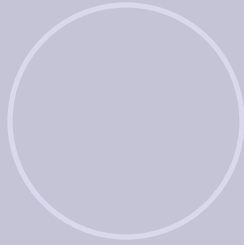
(Representational Deficit Hypothesis : Hawkins & Franceschina, 1997, 2004; Franceschina, 2001, 2005):

Grammatical features absent in the L1 are unavailable after the critical period. Therefore, Anglophones can transfer number on nouns but not gender /number on determiners and adjectives in L2 Spanish.

COMPUTATIONAL ACCOUNTS

(Shallow Structure Hypothesis: Clahsen & Felser, 2006):

Late bilinguals' online representations lack structural depth and grammatical detail because they prefer shallow to deep processing (lexical, semantic and pragmatic information as opposed to syntactic information)



ACCESSIBILITY ACCOUNTS

Late bilinguals *can* acquire representation and computation that is qualitatively comparable to native grammars.

WHY IS IT DIFFICULT?

ACCESSIBILITY ACCOUNTS

REPRESENTATIONAL ACCOUNTS

(Full Transfer Full Access, Missing Inflection Hypothesis, etc.)

Adults can transfer L2 grammatical features absent in L1 because interlanguage grammar is restructured with increased input. L2 errors are due to a default inflection (Bruhn de Garavito & White, 2002; White et al., 2004), difficulties in mapping grammatical features to Phonetic Form (Lardiere, 2000), or (re)assembling features in the L2 (Lardiere, 2007, 2008).

COMPUTATIONAL ACCOUNTS L2 errors due to:

- **language experience:**
 - with L1: L1-L2 similarity (e.g., Hopp, 2009; Jeong et al., 2007; Sabourin et al., 2008; Tokowicz & MacWhinney, 2005); reliance on semantic rather than morphophonological and syntactic information (Lew-Williams & Fernald, 2007).
 - with L2: proficiency level (e.g., Ellis, 2007; Hopp, 2007; Ojikama et al., 2005)
 - L2 exposure (Pliatsikas & Marinis, 2013)
- **capability of general cognitive resources** (e.g., Hopp, 2007; Sorace, 2011)

ACCESSIBILITY ACCOUNTS

REPRESENTATIONAL ACCOUNTS

(Full Transfer Full Access, Missing Inflection Hypothesis, etc.)

Adults can transfer L2 grammatical features absent in L1 because interlanguage grammar is restructured with increased input. L2 errors are due to a default inflection (Bruhn de Garavito & White, 2002; White et al., 2004), difficulties in mapping grammatical features to Phonetic Form (Lardiere, 2000), or (re)assembling features in the L2 (Lardiere, 2007, 2008).

COMPUTATIONAL ACCOUNTS L2 errors due to:

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- with L2: proficiency level (e.g., Ellis, 2007; Hopp, 2007; Ojikama et al., 2005)

- L2 exposure (Pliatsikas & Marinis, 2013)

- **capability of general cognitive resources** (e.g., Hopp, 2007; Sorace, 2011)

AGREEMENT VS. VIOLATION

BEHAVIORAL ONLINE L2 STUDIES:

Higher proficiency learners sensitive to:

- Gender agreement violations
(e.g., Foucart & Frenck-Mestre, 2012; Lew-Williams & Fernald, 2007; Sagarra & Herschensohn, 2010)
- Number agreement violations
(e.g., Sagarra & Herschensohn, 2010)

Lower proficiency learners are not sensitive:

- (e.g., Alarcón, 2009; Keating, 2009; Sagarra & Herschensohn, 2010).

AGREEMENT VS. VIOLATION

NEUROCOGNITIVE L2 STUDIES (ERPs):

Higher proficiency learners sensitive to:

- Gender agreement violations (LAN and/or P600)
(e.g., Barber et al., 2004; Barber & Carreiras, 2005; Foucart & Frenck-Mestre, 2011, 2012; Gunter et al., 2000; Rossi et al., 2006)
- Number agreement violations (LAN and/or P600)
(e.g., Osterhout et al., 2008; Rossi et al., 2006)

Lower proficiency learners are not sensitive:

- No LAN (Hahne & Friederici, 2001)
- No P600 (Weber-Fox & Neville, 1996)
- Delayed P600 (Rossi et al., 2006)
- N400 (Morgan-Short et al., 2010)

GOAL: to investigate the role of:

1) AOA:

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2) Cognitive load:

gender vs. number agreement; gender agreement with animate vs inanimate nouns

3) Cognitive resources:

does WM affect intermediate L2 learners' sensitivity to gender/number agreement violations?

GENDER VS. NUMBER: it is unclear whether there are differences, and if they are, in what direction

	Gender costier than Number			Gender = Number		
	Study	Tech	prof	Study	Tech	prof
L1 Spanish Studies	Faussart et al (1999)	Lex decision		NO SPANISH STUDIES		
	Barber & Carreiras (2003)	ERP				
	Barber & Carreiras (2005)	ERP				
L2 Spanish Studies	Sagarra & Herschensohn (2010)	SPR	interm	Cominguez (2016), but diffs in lasting effects	SPR	Adv
	Gillon Dowens et al (2010)	ERP	Adv	Gillon Dowens et al (2011)	ERP	Adv
	Rossi et al. (2014)	ERP	? Self-ratings			

Number costier than Gender: Tokowicz & MacWhinney (2005) (ERPs) found that beginners were sensitive to D-N GenderViol, but not NumberViol.

NATURAL (animate N) vs. GRAMMATICAL (inanimate N) GENDER

No studies on the topic, but we predict that it will be easier for the learners to process gender agreement with animate nouns (boy, girl) than inanimate nouns (building, table), because the former implies biological gender (a boy is male but a building is not).

GOAL: to investigate the role of:

1) AOA:

can adults acquire L2 morphosyntax in a native-like way?

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gender vs. number agreement; gender agreement with animate vs inanimate nouns

3) Cognitive resources:

does WM affect intermediate L2 learners' sensitivity to gender/number agreement violations?

WM AND L2 SYNTACTIC PROCESSING:

WM EFFECTS	NO WM EFFECTS
Miyake & Friedman (1998), Havik (2009), Dussias & Piñar (2010)	Felser & Roberts (2007), Juffs' work (see Juffs & Harrington, 2011, for a review), Rodríguez (2008) Fareta-Stutenberg (2014), Gabriele et al (2015), Hopp(2014)

WM AND L2 MORPHOSYNTACTIC PROCESSING:

WM EFFECTS	NO WM EFFECTS
Sagarra (2008), Sagarra & Herschensohn (2010)	Foote (2011), Sagarra & Herschensohn (2010, 2011)

HOW DO WE EXPLAIN THESE MIXED RESULTS?

WM AND L2 SYNTACTIC PROCESSING:

WM EFFECTS Lower proficiency	NO WM EFFECTS Higher proficiency
Miyake & Friedman (1998), Havik (2009),	Felser & Roberts (2007), Juffs' work (see Juffs & Harrington, 2011, for a review), Rodríguez (2008) Fareta-Stutenberg (2014),

Dussias & Piñar (2010) but L2 RTS

Gabriele no WM in beginners bc GJ not taxing
Hopp (2014) WM int to near-natives bc complex str

WM AND L2 MORPHOSYNTACTIC PROCESSING:

WM EFFECTS Lower proficiency	NO WM EFFECTS Higher proficiency
Sagarra (2008), Sagarra & Herschensohn (2010)	Foote (2011), Sagarra & Herschensohn (2010, 2011)

GRAMMATICAL VS NATURAL GENDER AGREEMENT

SPR: Sagarra & Herschensohn (2010)

Lingua

Eyetracking: in progress

PARTICIPANTS



63 Spanish monolinguals (south Spain)

Adult L2 learners:

69 beginning English learners of Spanish

64 intermediate English learners of Spanish

All groups comparable in terms of:

- a) Working memory
- b) Age (18-32 yrs old)
- c) Education (university students)

MATERIALS & PROCEDURE

Screening tasks

Lg backgr
Lg prof

WM
test

Vocab &
grammar

Experimental tasks

Online task
(moving windows)

Offline task
(GJs)

MATERIALS & PROCEDURE

Screening tasks

Lg backgr
Lg prof

WM
test

Vocab &
grammar

Experimental tasks

Online task
(moving windows)

Offline task
(GJs)

Participants read 114 ss on a computer screen (4 practice, 60 fillers, 40 experimental: 10 per condition) and answered a yes-no comprehension question after each sentence. Sentences were counterbalanced.

	GRAMMATICAL GENDER	NATURAL GENDER
AGREEMENT	El padre tiene el proyecto _M perfecto _M para su hija	El padre tiene el esposo _M perfecto _M para su hija
VIOLATION	*El padre tiene el proyecto _M perfecta _F para su hija	*El padre tiene el esposo _M perfecta _F para su hija

EI

-----.

__ padre _____

____.

_____ quiere _____

_____.

-----el-----

-----.

----- proyecto -----

-----.

perfecto

.

_____ para

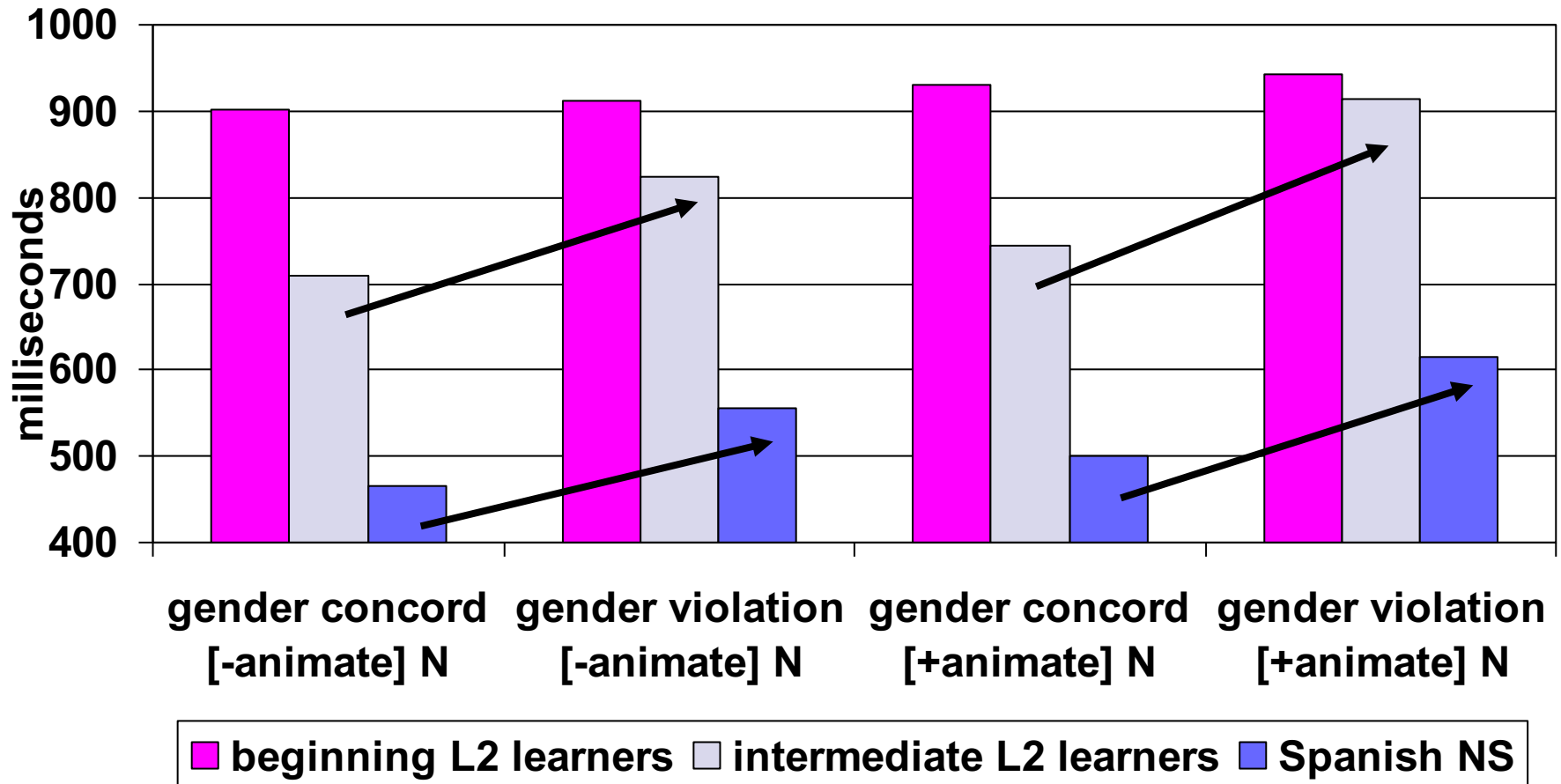
_____.

su _ _ _ _.

-- hija.

RESULTS

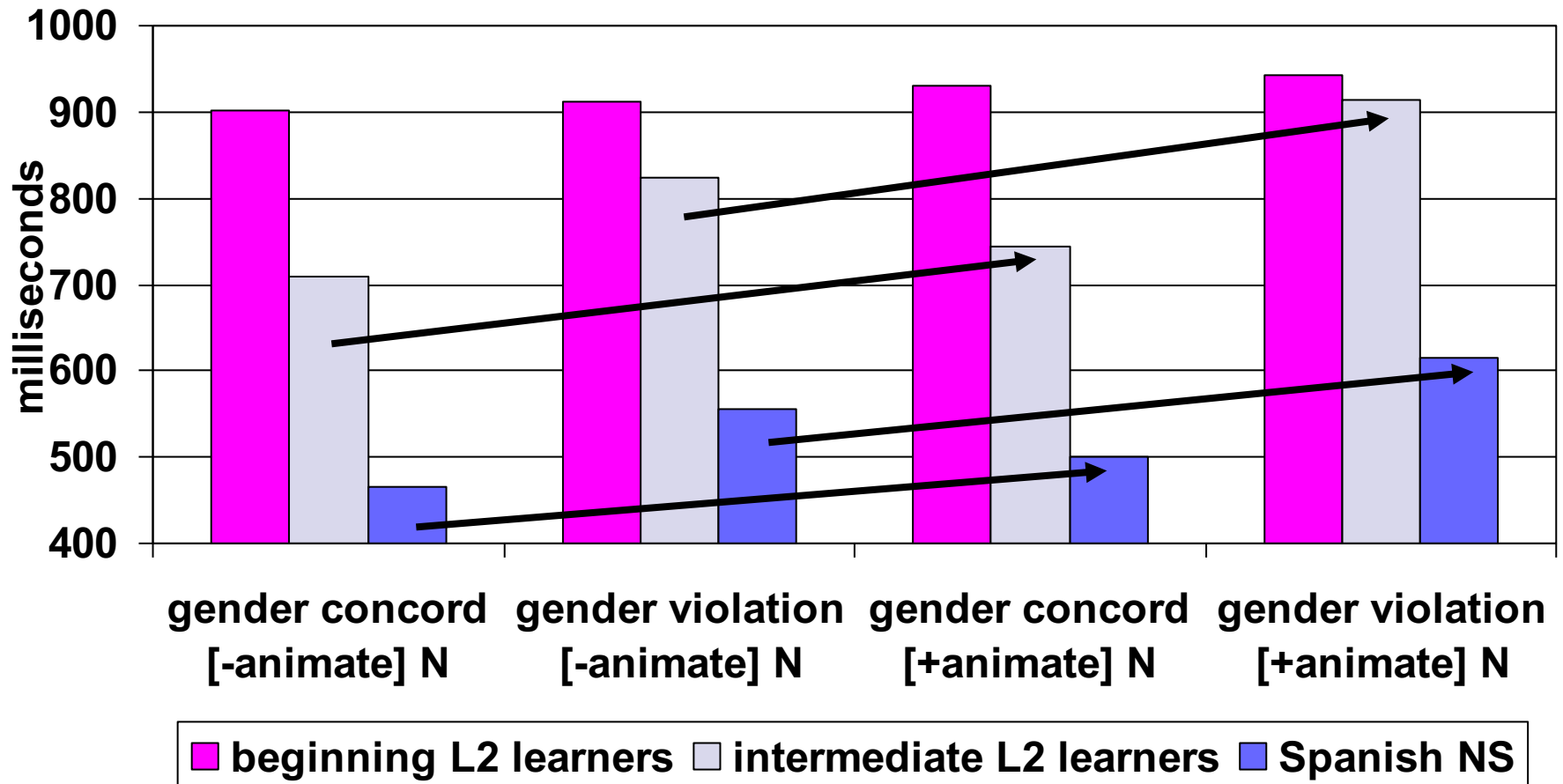
Agreement vs violation



All participants were sensitive to all violations, except the beginners.

GJ data: lower accuracy in violation than agreement sentences in intermediates (monolinguals at ceiling, and beginners at chance).

Grammatical vs natural gender



Intermediates and monolinguals: longer RTs with animate than inanimate N.

GJ data: intermediates and monolinguals: lower acc with animate than inanimate N.

CONCLUSIONS



AOA:

Data support accessibility models. Adult learners of a certain proficiency level show processing and performance patterns qualitatively similar to those of native speakers.

PROFICIENCY X COGNITIVE LOAD/RESOURCES:

Processing animate nouns is cognitively more demanding than inanimate nouns for intermediate learners and Spanish monolinguals. Also, intermediates with more working memory capacity showed shorter RTs with animate than inanimate nouns (for gender agreement and disagreement).

Why are animate nouns (esposo)
more difficult to process than
inanimate nouns (trabajo)?

An orange circle containing the word "Think" in white text.

Think

Why would animate N be more difficult?

Lexical account (gender is an inherent feature of N):

to process animate nouns like *nieta*, we also activate *nieta* but inanimate nouns like *auto* cannot prime **auta*.

Syntactic account (gender is affixal):

the processor needs more time to choose between the masc affix –o and the fem affix –a in animate nouns than to access single gendered inanimate nouns like *auto*.

The results of Experiment 1 could be due to the task being cognitively taxing: non-cumulative moving window tasks do not allow participants to regress, forcing them to rely on their memory.

Our predictions for a cognitively simpler task like eye-tracking are:

Beginners may be sensitive to violations, particularly if they have WM span.

The animacy differences may disappear, now that participants have more resources to process animate N and number agreement.

SAME EXPERIMENT, BUT READING
USING EYE-TRACKING.

PARTICIPANTS

Similar to Exp 1:

32 Spanish monolinguals (south Spain)

32 beginning English learners of Spanish

32 intermediate English learners of Spanish

METHOD AND PROCEDURE

Identical to Exp 1, except technique: eye-tracking.

EYE-TRACKING TECHNIQUE

Eye-tracking uses infrared technology to measure eye positions (we we are looking and for how long) and eye movements.



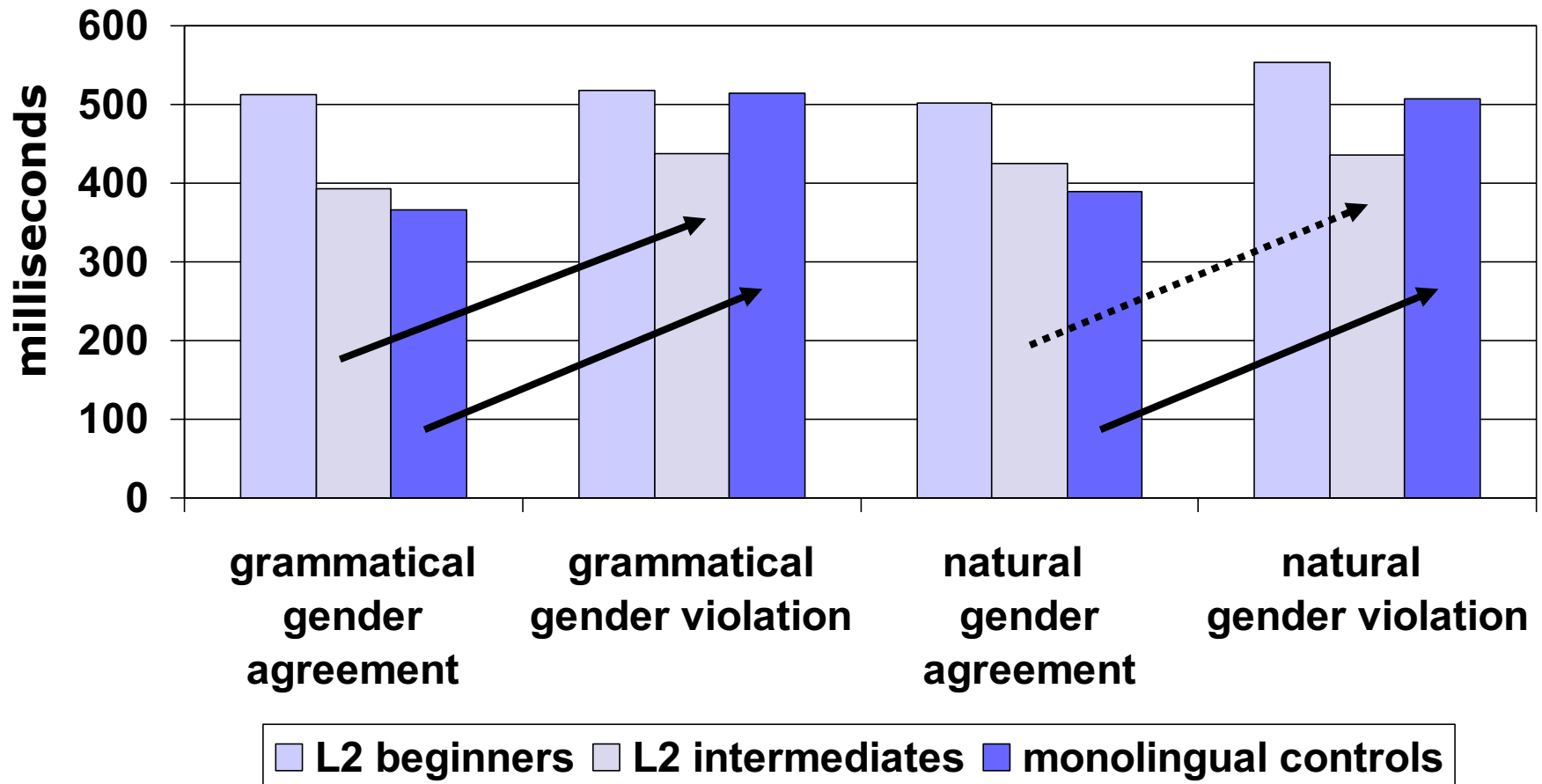
Eye-tracker:
EyeLink 1000 Plus
(SR Research)

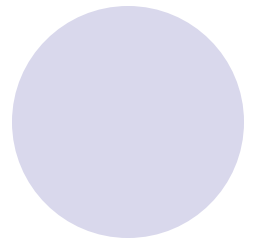
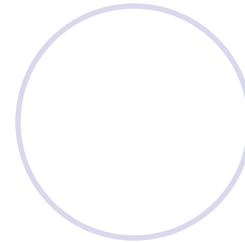
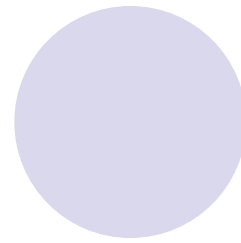
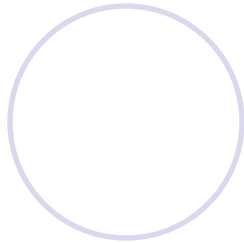
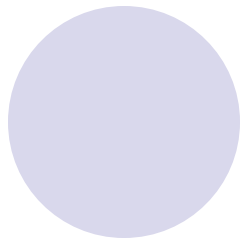
We recorded
monocular data
every 1 millisecond.

RESULTS

TOTAL TIME ON ADJECTIVE

El padre tiene el proyecto perfecta para su hija





SENSITIVITY X PROFICIENCY:

intermediates, but not beginners, are sensitive.

ANIMACY:

animacy effects for intermediates but very subtle, and no animacy effects for monolinguals (see also Barber & Carreiras, 2005)

WORKING MEMORY:

no WM effects for any group. This makes sense because WM differences are only expected in “complex cognitive tasks” (Baddeley, 2003, 2007).

GRAMMATICAL GENDER VS NUMBER AGREEMENT

SPR: Sagarra & Herschensohn (2011)
Language Learning

Eyetracking: Sagarra (under review)

PARTICIPANTS, METHOD, PROCEDURE AND TECHNIQUE

Identical to Exp 1.

MATERIALS & PROCEDURE

Screening tasks

Lg backgr
Lg prof

WM
test

Vocab &
grammar

Experimental tasks

Online task
(moving windows)

Offline task
(GJs)

Subjects read 148 ss on a computer screen (6 practice, 80 fillers, 60 experimental: 20 per condition: $\frac{1}{4}$ ms, $\frac{1}{4}$ mpl, $\frac{1}{4}$ fs, $\frac{1}{4}$ fpl) and answered a yes-no comprehension question after each sentence. Sentences were counterbalanced with a Latin square design. Conditions:

GENDER/NUMBER AGREEMENT:

El ingeniero presenta el **prototipo_{MS}** **famoso_{MS}** en la conferencia.

GENDER AGREEMENT VIOLATION:

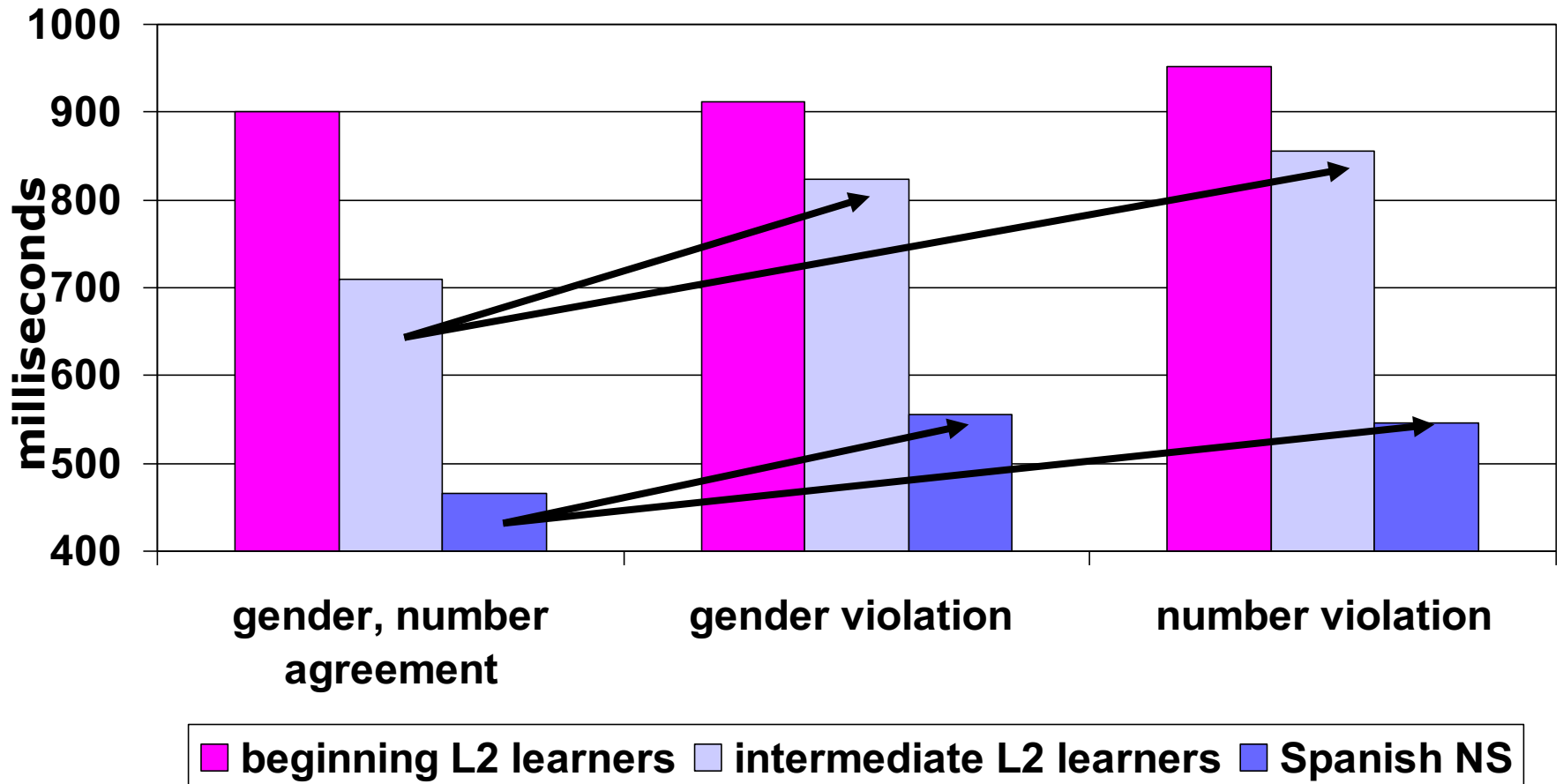
El ingeniero presenta el **prototipo_{MS}** ***famosa_{FS}** en la conferencia.

NUMBER AGREEMENT VIOLATION:

El ingeniero presenta el **prototipo_{MS}** ***famosos_{MP}** en la conferencia.

RESULTS

Agreement vs violation



All participants were sensitive to all violations, except the beginners.

Gender vs number



No differences between gender and number violation for any group, but WM and GJ data suggest that gender agreement was more difficult than number agreement:

- 1) **GJ data**: lower accuracy with gender than number agreement violations in L2 learners (monolinguals at ceiling)
- 2) **WM data**: intermediates with higher WMC were more sensitive to gender, but not number, agreement violations (= gender agreement consumes more cognitive resources)

Why is gender agreement more difficult than number agreement?



Why is gender agreement more difficult than number agreement?

Evidence with monolinguals: Barber & Carreiras, 2005; Antón-Méndez et al. 2002; Bruhn de Garavito & White, 2002; Faussart, Jakubowicz & Costes, 1999; Franceschina, 2005; Gillón-Dowens et al., 2008; McCarthy, 2008; Nicol & O'Donnell, 1999; Vigliocco et al., 1996; White et al. 2004).

Lexical account (gender is an inherent feature of nouns):

gender disagreement forces the processor to return to the lexical identification stage (gender is a stem inherent feature) but number failure merely requires checking of the final processes of syntactic recognition (number is affixal) (e.g., Domínguez et al., 1999; Igoa et al., 1999).

Syntactic account (gender is affixal):

gender's large variability (many words have irregular endings) makes it more demanding than more regular number agreement (Hernández et al., 2007).

CONCLUSIONS



AOA:

Data supports accessibility models. Adult learners of a certain proficiency level show processing and performance patterns qualitatively similar to those of native speakers.

PROFICIENCY X COGNITIVE LOAD/RESOURCES:

Processing gender disagreement is cognitively more demanding than number disagreement for intermediate learners and Spanish monolinguals.

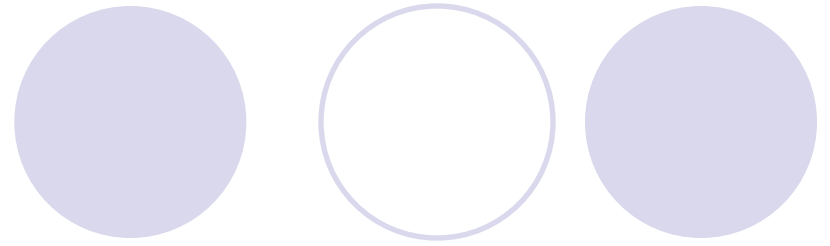
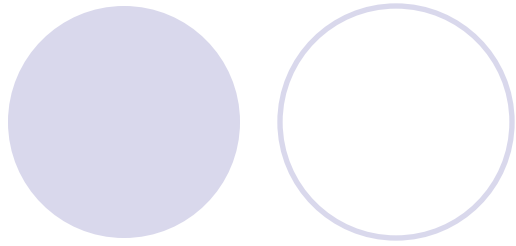
Replicated experiment using
eye-tracking.

Remember: SPR more
cognitively taxing than eye-
tracking.

PARTICIPANTS

- 17 Spanish native speakers from Andalusia, Spain.
- 24 adult intermediate English learners of Spanish.
- Both groups were comparable in terms of:
 - WM
 - Reading
 - Vocabulary and grammar test: all scored at ceiling
 - Age: between 18 and 32 years old
 - Education: all undergraduate university students

RESULTS

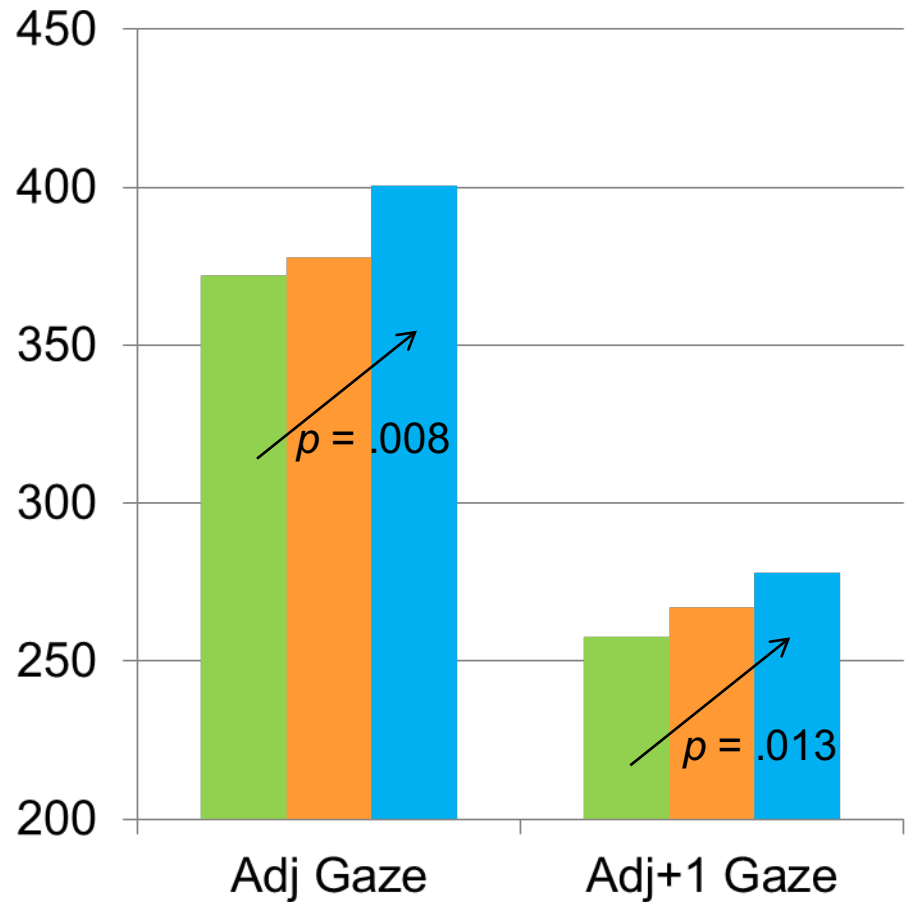
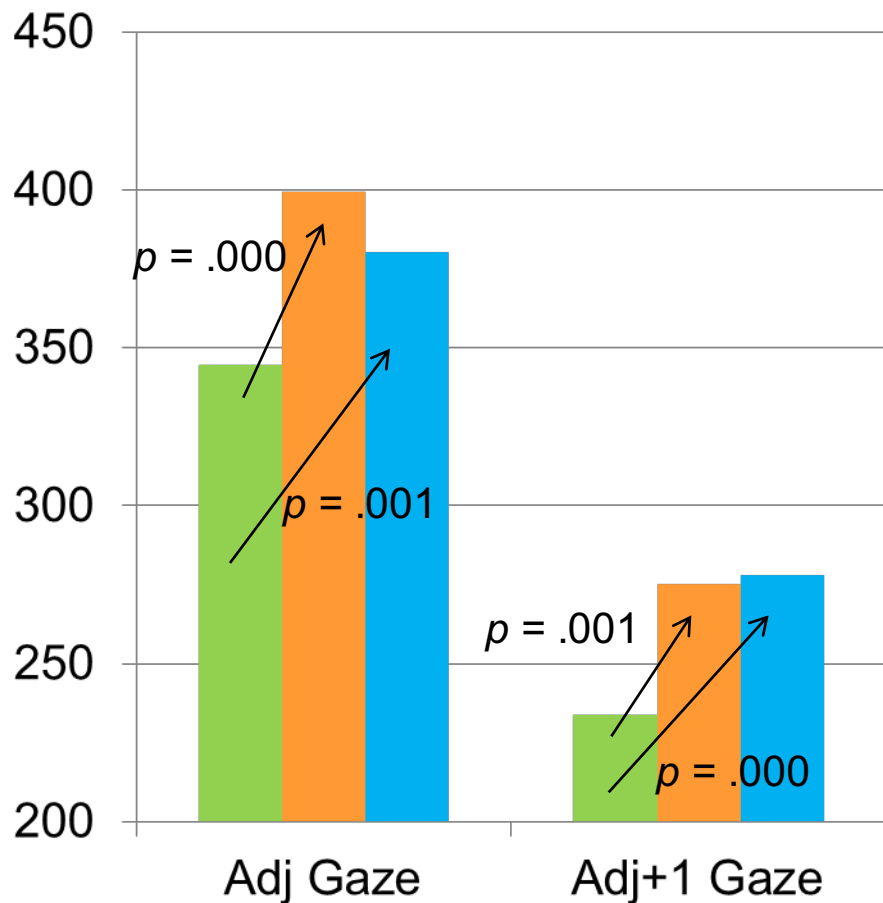


GAZE DURATION (early processing)
on Adj, Adj+1: time spent in a word
before moving on or looking back
(first pass reading).

NATIVES

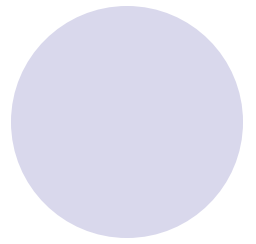
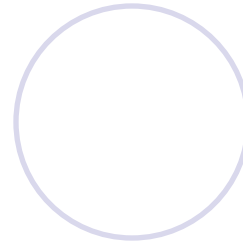
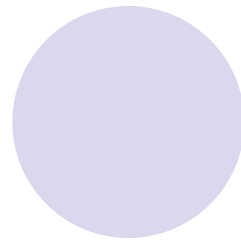
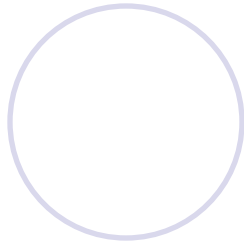
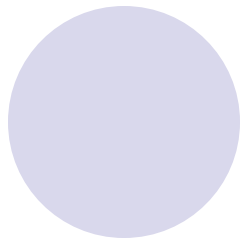
LEARNERS

- Agreement
- GenderViol
- NumberViol



GAZE DURATION: ADJ/ADJ+1:

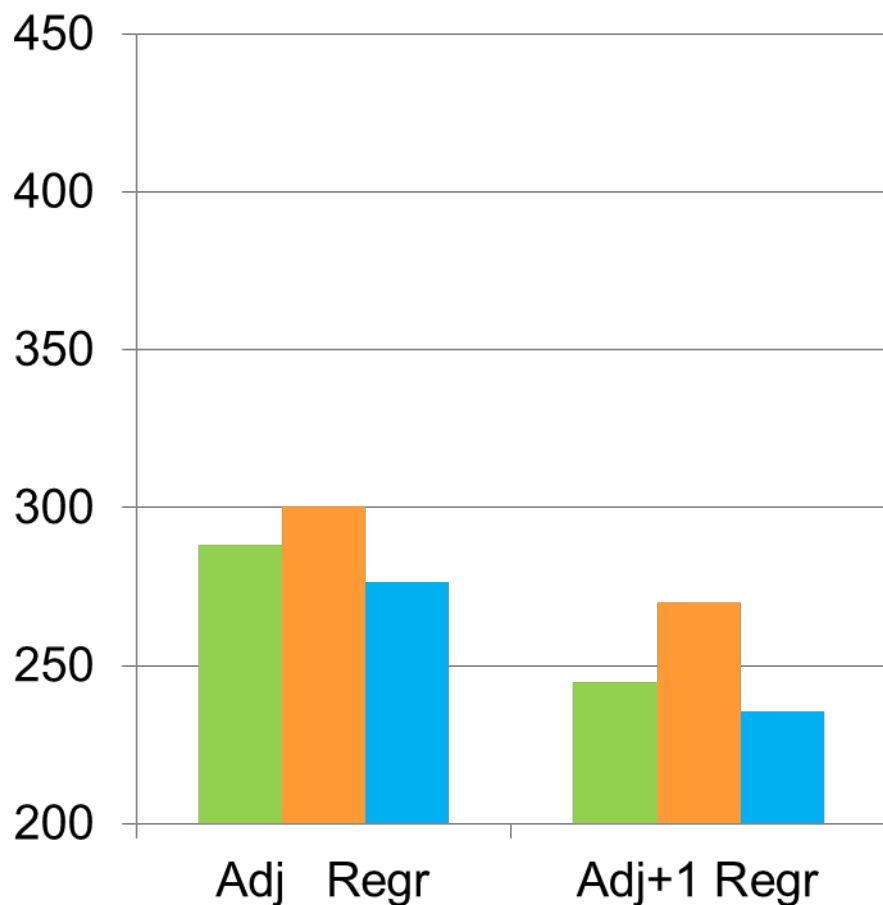
Sig main effect Cond: all looked longer at Adj/Adj+1 in GV/NV than Agr ($p = .000$)
 BUT sig inter CondXGroup: all looked longer at Adj/Adj+1 in NV than Agr, but only the natives looked longer at Adj/Adj+1 in GV than Agr



REGRESSION DURATION

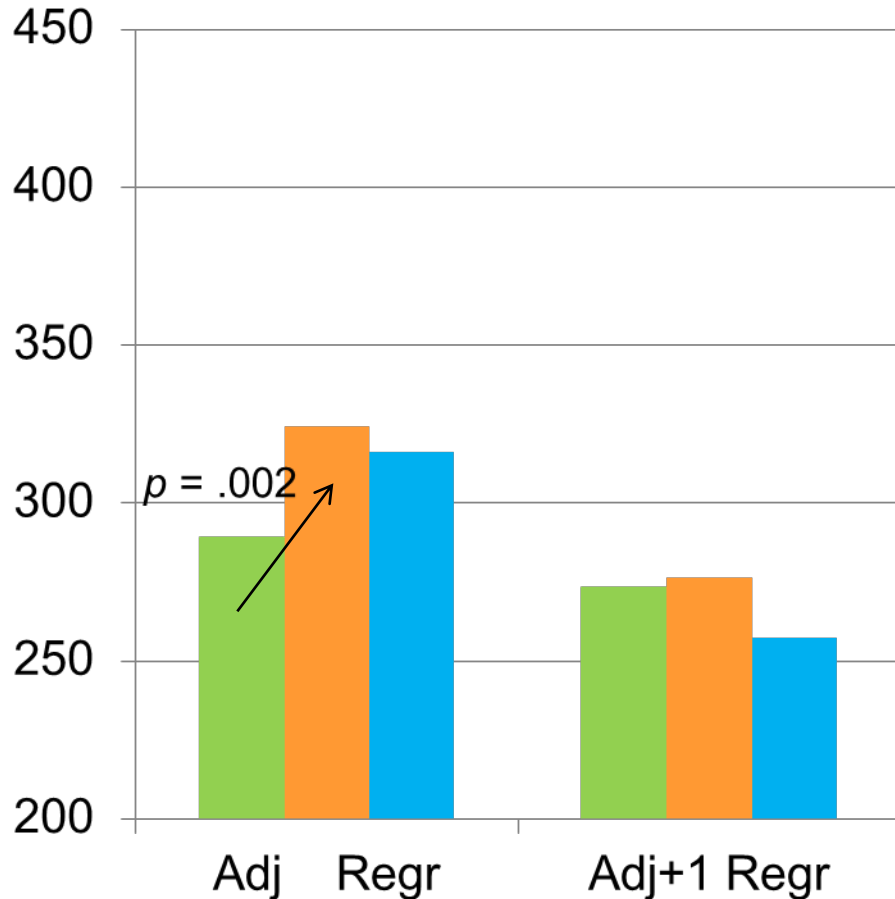
(late processing) on Det, N, Adj, Adj+1:
duration of all fixations in a word
excluding those that form part of gaze
duration.

NATIVES



LEARNERS

Agreement
GenderViol
NumberViol

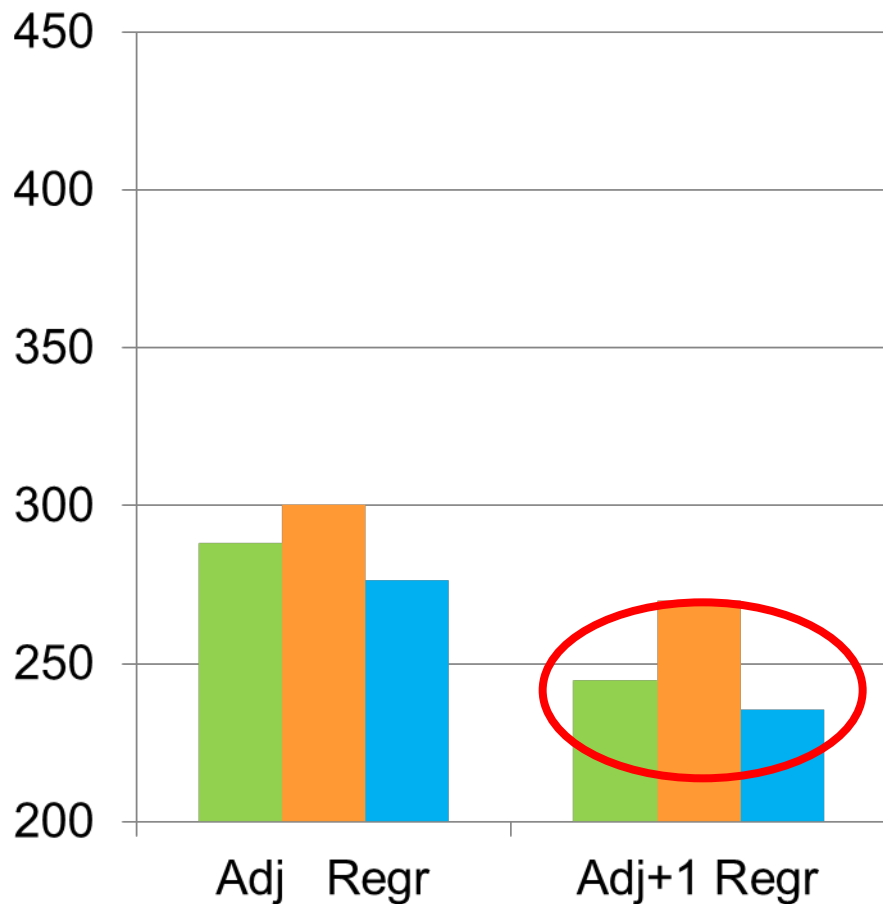


REGRESSION DURATION (nothing interesting for N, and all Ss + regr to Det in NV than GV, and NV than Ngr, but + regr to Adj in GV than N):

ADJ: sig main effect Cond: all regressed longer to Adj in GV than Agr ($p = .004$)

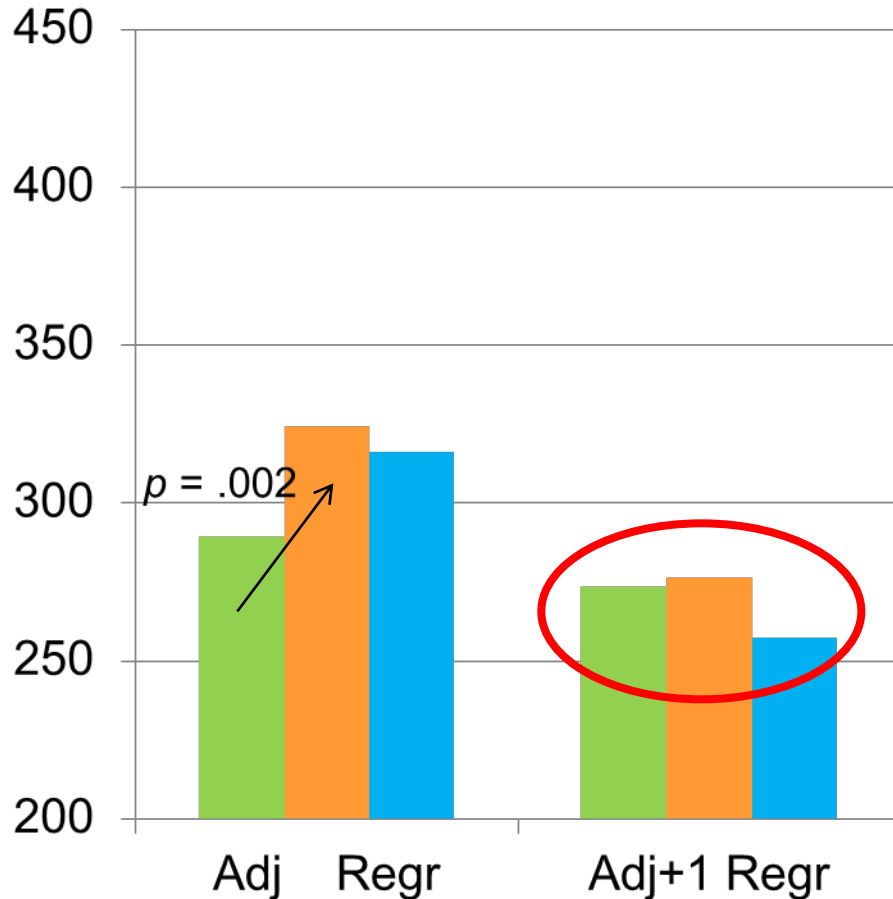
BUT sig inter CondXGroup: only L2ers regressed longer to Adj in GV than Agr

NATIVES



LEARNERS

Agreement
 GenderViol
 NumberViol



REGRESSION DURATION:

ADJ: sig main effect Cond: all regressed longer to Adj in GV than Agr ($p = .004$)
 BUT sig inter CondXGroup: only L2ers regressed longer to Adj in GV than Agr
 ADJ+1: sig main effect Group: L2ers regressed longer to Adj+1 than natives

FOLLOW-UP STUDY 1: THE ROLE OF STUDY ABROAD

(Sagarra & Sanz, in progress)

Subjects: We added another intermediate L2 group. This new group consisted of 30 students who took the test after having studied abroad one semester.

Results: study abroad learners patterned closer to monolinguals: the non-study abroad learners regressed more and were less sensitive to the most difficult type of violation (gender agreement violation). These results show that immersion experience facilitates L2 morphosyntactic processing and accelerates SLA.

CONCLUSIONS

- **AOA**: beginners are insensitive to the violations, but intermediates are sensitive, and study abroad learners even better. This means that language experience shapes L2 processing, and that adult L2 learners can process morphosyntax native-like, favoring accessibility accounts, and challenging deficit accounts.

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- **COGNITIVE RESOURCES**: learners with higher working memory span were more sensitive to more difficult structures. This suggests that individual differences in working memory affect L2 processing.