Real-Time Processing of Gender and Number Agreement by Native and Heritage Russian Speakers

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Grammatical agreement

- Grammatical agreement (=concord; accord):
  - Gender and Number in DP/NP (Spanish):

Det-Noun		Det- Adj – Noun	
la pelota	*el carro*	*el zapato viejo*	'the$_{\text{Masc-Sg}}$ old$_{\text{Masc-Sg}}$ shoe$_{\text{M-Sg}}$'
'the ball'	'the carriage'	| | |	
		target source target	

  - Gender and Number between Subject-Predicate (French):

Lise était déjà arrivée quand.. 'Lise$_{\text{Fem-Sg}}$ had already arrived $_{\text{Fem-Sg}}$ when…'

  - Number agreement is more frequently attested cross-linguistically than gender agreement.

Grammatical Agreement in Russian (NP)

- Russian does not have articles, but:
  - 3 genders (Masc, Fem, Neut)
  - 2 numbers (Sg and Pl); gender distinction is neutralized in Pl
  - [6 cases]
  - Adjectives are prenominal [but there is Split Scrambling]

- Gender and Number in NP:

serebristyj samolet '[a/the] silver$_{\text{Masc-Sg-Nom}}$ plane$_{\text{Masc-Sg-Nom}}$'

serebristaya ptica '[a/the] silver$_{\text{Fem-Sg-Nom}}$ bird$_{\text{Fem-Sg-Nom}}$'

serebristoe oblako '[a/the] silver$_{\text{Neut-Sg-Nom}}$ cloud$_{\text{Neut-Sg-Nom}}$'

serebristye oblaka '[a/the] silver$_{\text{Pl-Nom}}$ clouds$_{\text{Pl-Nom}}$'

Grammatical Agreement in Russian (S-V)

- Freedom of word order [but constrained by discourse]
  - Discourse-opening sentences with unergative verbs are [Locative]-Verb-Subject (Loc-V-S)

- Gender and Number between Subject and Verb:
  - But: Only in the Past Tense:

letel serebristyj samolet 'flew$_{\text{Masc-Sg}}$ silver$_{\text{Masc-Sg}}$ plane$_{\text{Masc-Sg}}$'
letela serebristaya ptica 'flew$_{\text{Femc-Sg}}$ silver$_{\text{Fem-Sg}}$ bird$_{\text{Fem-Sg}}$'
leteli serebristye oblaka 'flew$_{\text{Pl}}$ silver$_{\text{Pl}}$ clouds$_{\text{Pl}}$'

- The study crucially depends on the fact that the agreement targets (V and Adj) precede the source (N)

Goals of the Study

- Is the grammatical agreement information (Gender and Number) predictive?
  - Time course of the grammatical agreement information
  - Can heritage bilinguals identify the referent Noun before they hear it? Or, do they use the grammatical agreement only during the integration stage (after they have heard the Noun)?
- Hierarchy of features, Number vs. Gender:
  - Is Number 'stronger' (interpretable?) than Gender?
- Hierarchy of values in Gender, Masc vs Fem:
  - Default/markedness/universality/dominant language transfer?

Methodological Challenges

- **Number agreement:** well studied in production (attraction errors); in comprehension (violations with ERP); children
- **Gender agreement:** its influence on spoken word recognition (the Cohort effect with VWP eye-tracking):
  - --Det-Noun & Det-Adj-Noun in French, Spanish, German
- **Accounts:**
  - Linguistic (representational vs. processing deficits; interpretable vs. uninterpretable features; feature accessibility)
  - Processing (slowed processing; the morphological bottleneck; automaticity; age of arrival)

Grammatical Agreement in Bilingualism

- Production ~ comprehension asymmetry
- Online comprehension of written sentences:
  - Gender agreement in Spanish L2 and heritage speakers (Alarcón, 2011; Foote, 2011; Montrul et al., 2008).
  - But: reading comprehension, gender recognition, grammaticality judgment
- Heritage speakers:
  - Reading is difficult or impossible
  - Complex tasks (e.g., cloze tasks and grammaticality judgments) are challenging

Overcoming Methodological Challenges

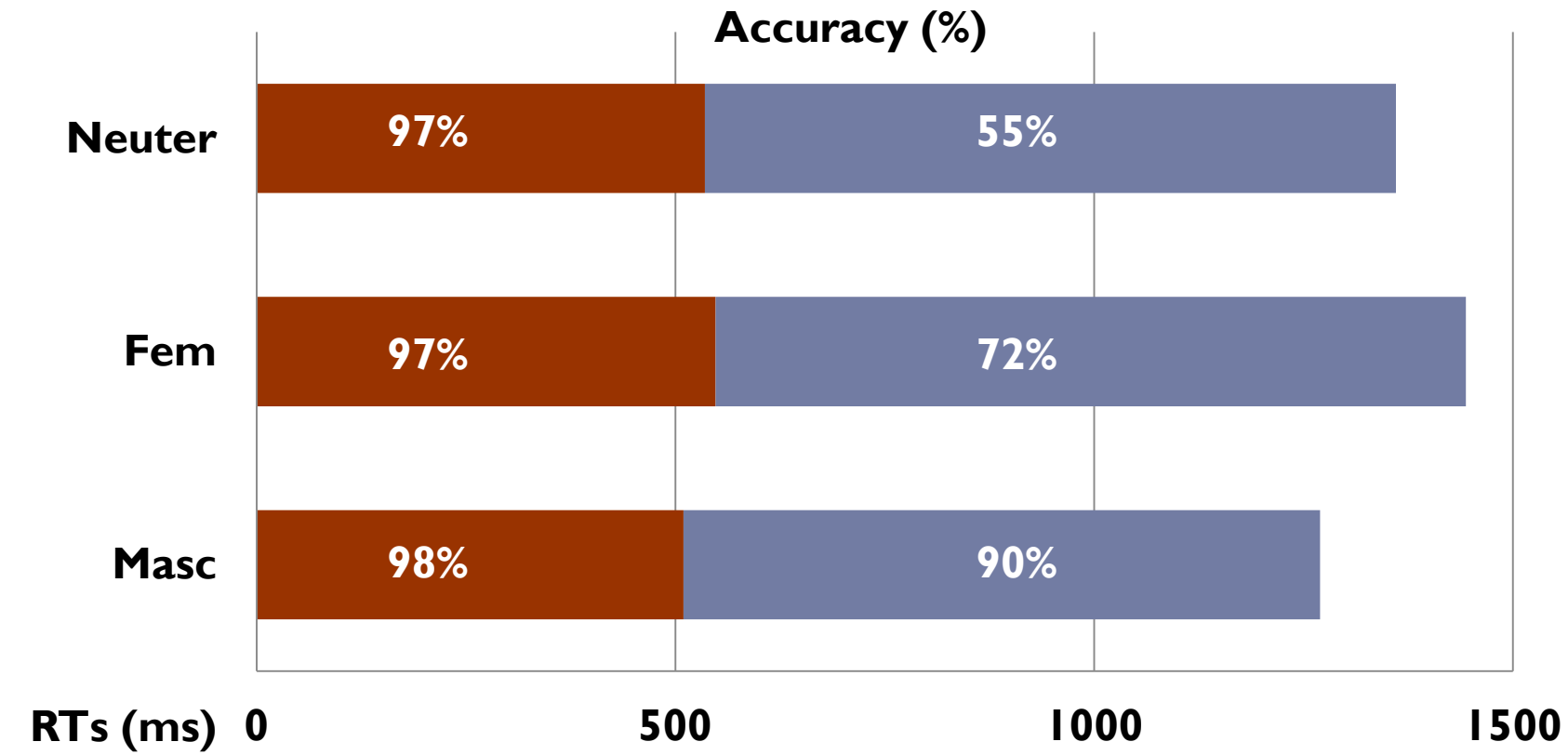
- The Visual World Eye-tracking paradigm (VWP) is perfect:
  - Grammatical gender effects have been studied in the VWP to investigate spoken word recognition in French and Spanish
  - "*Click on [Det-NP]*" where the gender of the Det facilitated recognition of nouns of the same gender (Dahan et al., 2000; Lew-Williams & Fernald, 2007, 2010; cf. Kroff et al., 2010)

- But:
  - Spoken word recognition, not sentence processing
  - The forced-choice task is restrictive
  - L2 speakers, not heritage speakers

Previous Studies with Russian HL

- **POLINSKY (2008):** Low proficiency Russian HL speakers
  - Produce gender-agreeing forms, primarily Adj-N but gender agreement in Subj-Verb is often missing;
  - **EXP. 2**: 12 HL speakers were presented with Adj-N pairs in various combinations (3 genders: gender-matching vs. mismatching); task → grammaticality judgment (GJT):
- **CONCLUSION**: HL speakers do not show comprehension problems, their gender system is structured adequately enough

Matching Gender (Exp. 2) (Polinsky, 2008)



	Masc	Fem	Neuter
Monoling	510	548	535
Heritage	760	896	825

How this Study Meets the Methodological Challenges

1. Investigated online processing of grammatical agreement in Gender and Number with advanced Russian HL speakers
   - No structural ambiguities (no garden-path sentences)
   - No syntactic complexity (simple Loc-V-S sentences)
   - No morphological complexity
   - [Relatively] simple lexical content
   - No metalinguistic gender-matching task; instead, an easy sentence-picture matching task (mouse-clicking)

Participants

- Monolingual Controls:

  N=25 (mean age: 20; all women; students at the Moscow State Pedagogical University)

- Bilingual Heritage Russian Speakers:
  - *N*=40 (mean age: 19.4; 12 men; students at the CUNY College of Staten Island)
  - Mean age of arrival: 5 (birth-16)

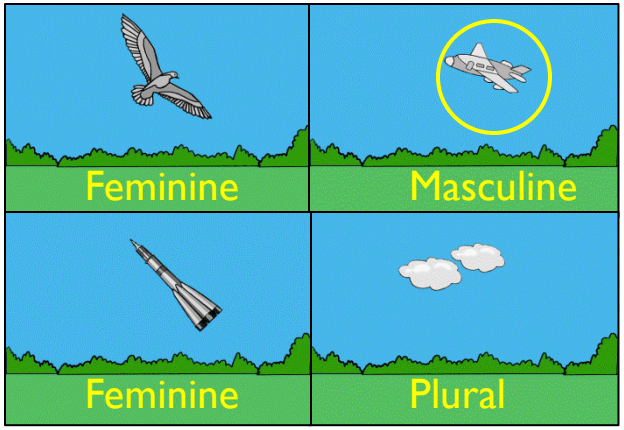
born in the US:	8
arrived before age 6:	20
arrived between 7-16:	12

Design and Materials

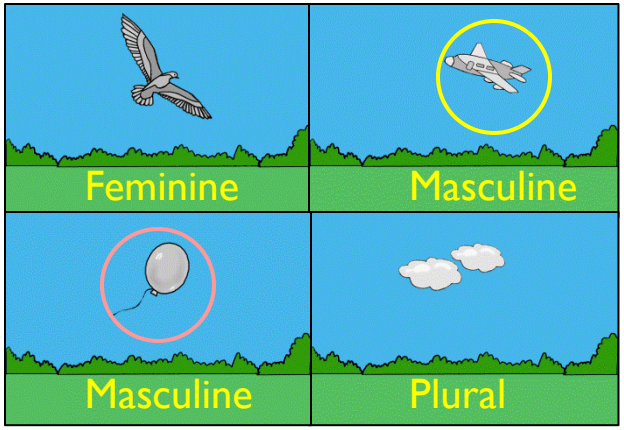
- Ideally, it should have been 3 genders (Masc, Fem, Neut) x 2 numbers (Sg, Pl) x 2 Visual Context (Same, Different)
- In practice: 2 x 2 + 1 = 5 conditions
  - Gender in neutralized in Pl in Russian (adjectives in Pl are the same for all genders)
  - Neut nouns account for about 14% of all nouns; they are rarely concrete; heritage Russian has a reduced system of 2 genders
- Thus, in Sg, Gender (Masc, Fem) was crossed with Visual Context (Same-gender, Different-gender competitor)
- In Pl, only one condition

Visual Context X Gender; Pl

Different Gender



Same Gender



'In the sky, flew$_{Masc}$ a silver$_{Masc}$ plane$_{Masc}$.'

MASC-DIFF

TARGET: *plane$_{Masc}$*
2 Distractors: Fem *bird* and *rocket*
1 Pl Distractor: *clouds*

MASC-SAME

TARGET *plane$_{Masc}$*
1 Gender Competitor: *balloon$_{Masc}$*
2 Distractors: Fem and Pl

PL

'In the sky, flew$_{Pl}$ silver$_{Pl}$ clouds$_{Pl}$.'
TARGET: *clouds*
Distractors: everything else

Materials

- 30 items
- Word order: Loc-V-Adj-Noun
- 15 different unergative verbs, repeated twice with a new set of people/animals/objects and locations:

  fly, run, walk, swim, play, stroll, stay, climb, dance, crawl, jump, ride, sleep, hang, lie

- Agents (Subj NP): Locations:
  - People *in the sky, in the woods, in the street*
  - Animals *in the river, in the park, on the table*
  - Insects *up the tree, on the stage, in the box*
  - Dynamic and static objects *in the puddle, on the road*

Procedure and Measures

- Sentence-picture matching task with animated pictures:
  - Listen to the sentence and click on the correct picture (Target)
- Duration: 10 min
- Measures:
  - Accuracy
  - RT (mouse-clicking)
  - Eye movements, with 33-ms time resolution (ISCAN ETL-500 remote eye-tracker)

Predictions

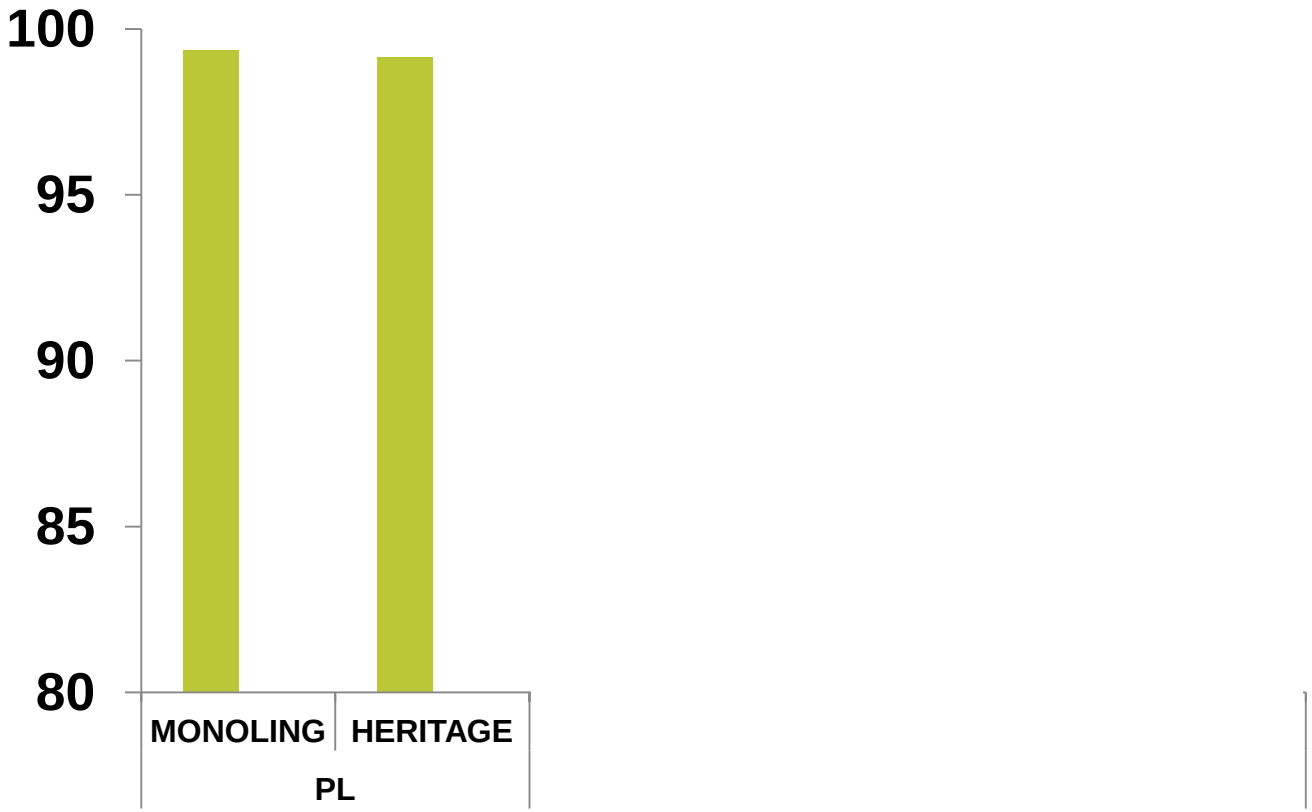
- Accuracy should be at ceiling for all groups
- RTs: monolinguals should be faster than heritage speakers
- Eye movements:
  - Identification of TARGET should be faster in the PL and DIFF-GENDER than in the SAME conditions (a divergence of looks to T vs. D/C) → during the Adj region
  - Number should be more predictive than Gender
  - Masc should more predictive than Fem

Accuracy

Control participants:
99.6%
At ceiling (3 errors)

Heritage speakers (55):
95.3%

Fem_SAME	8
Fem_DIFF	7
Masc_SAME	15
Masc_DIFF	23
PL	2



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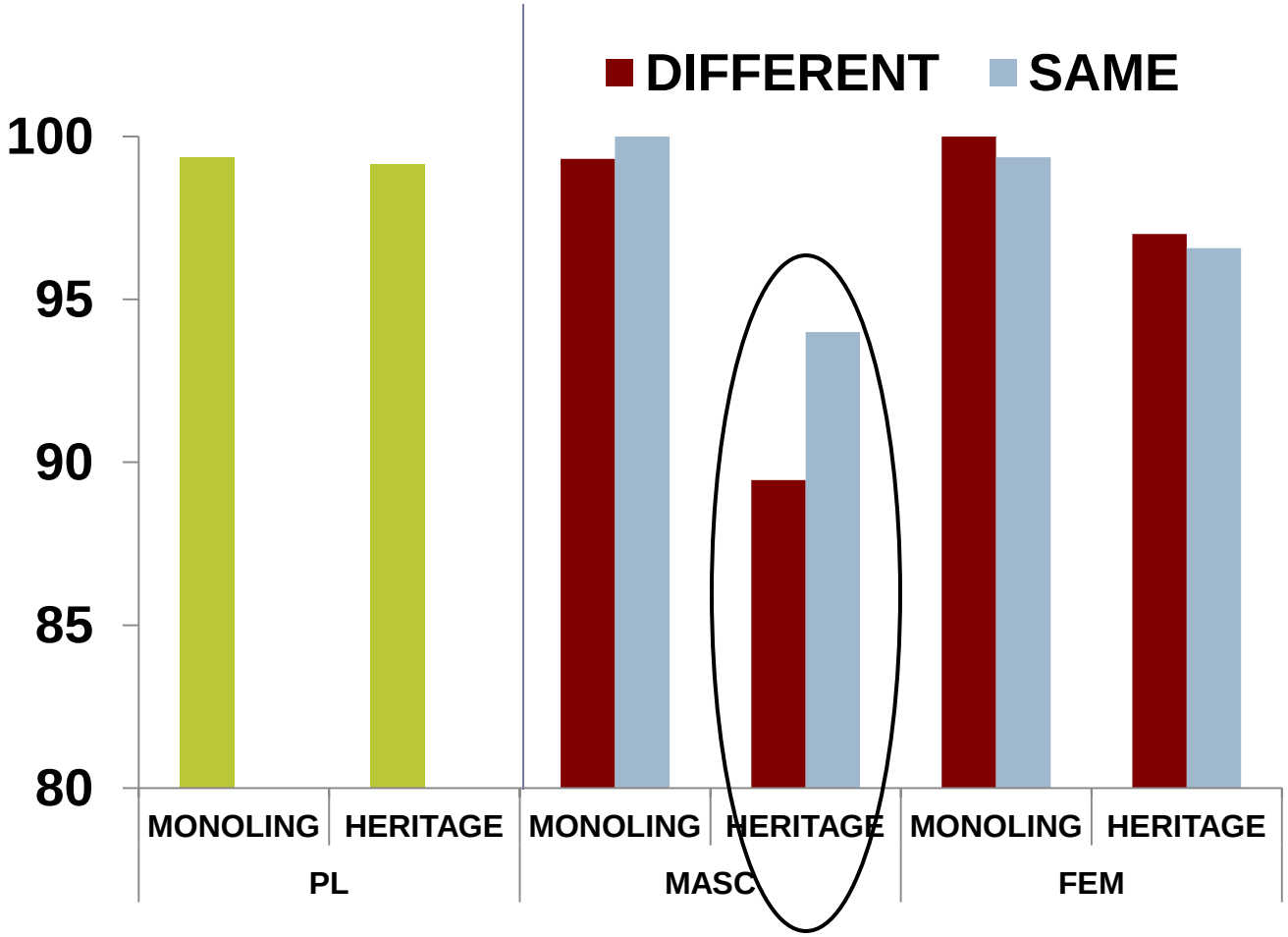
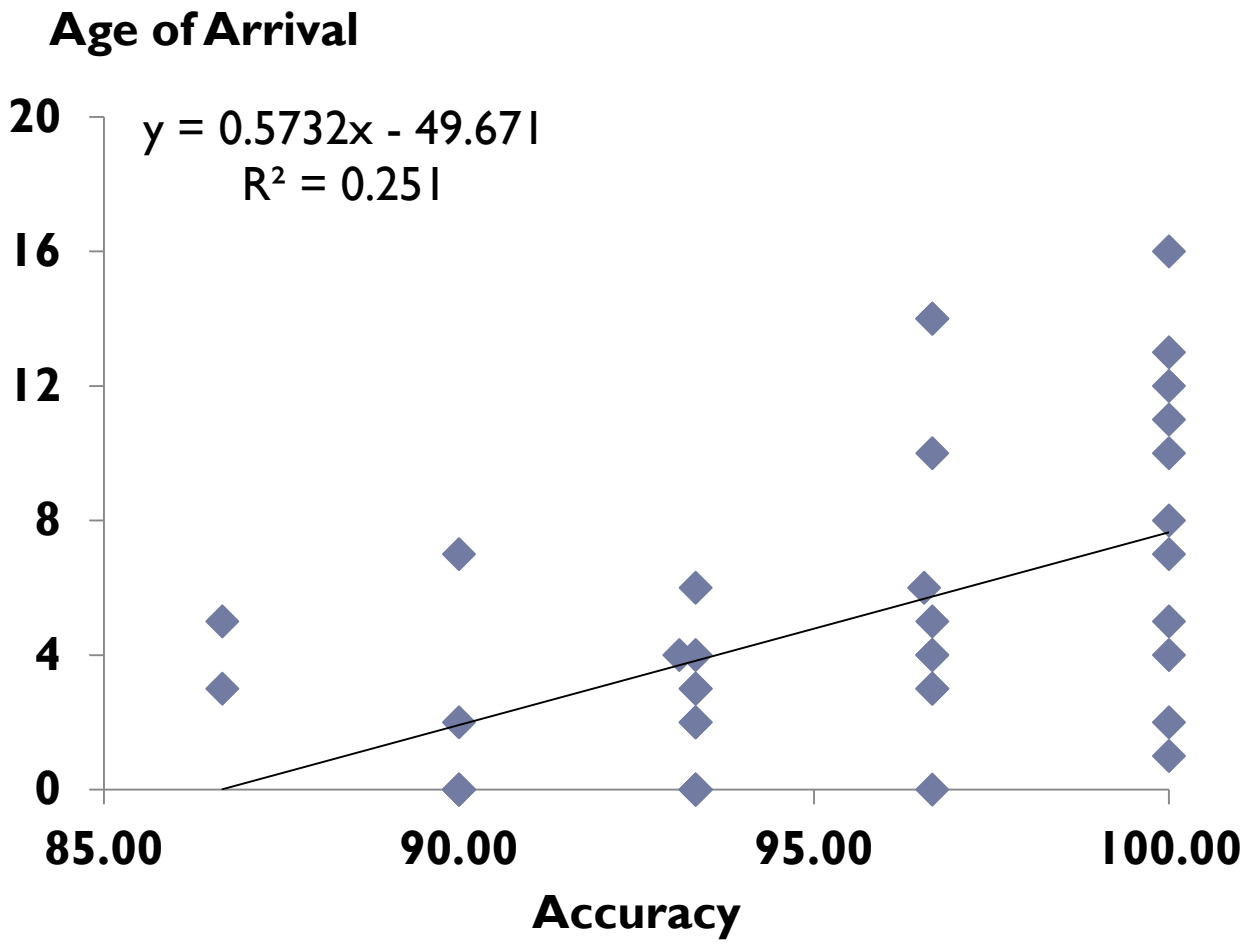
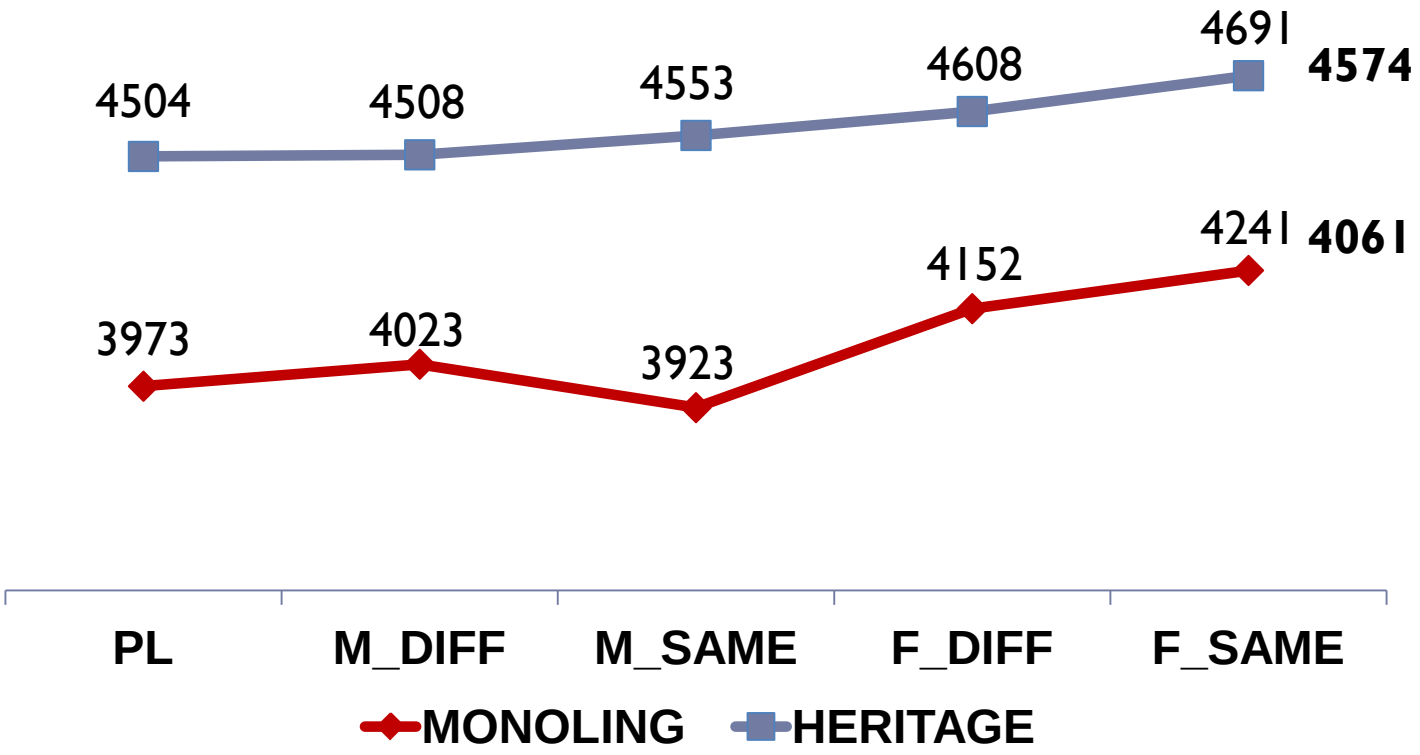


Accuracy and Age of Arrival Regression

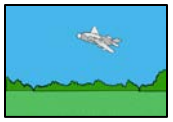


RTs (ms)


4504
4508
4553
4608
4691
4574
3973
4023
3923
4152
4241
4061
PL
M_DIFF
M_SAME
F_DIFF
F_SAME
MONOLING
HERITAGE

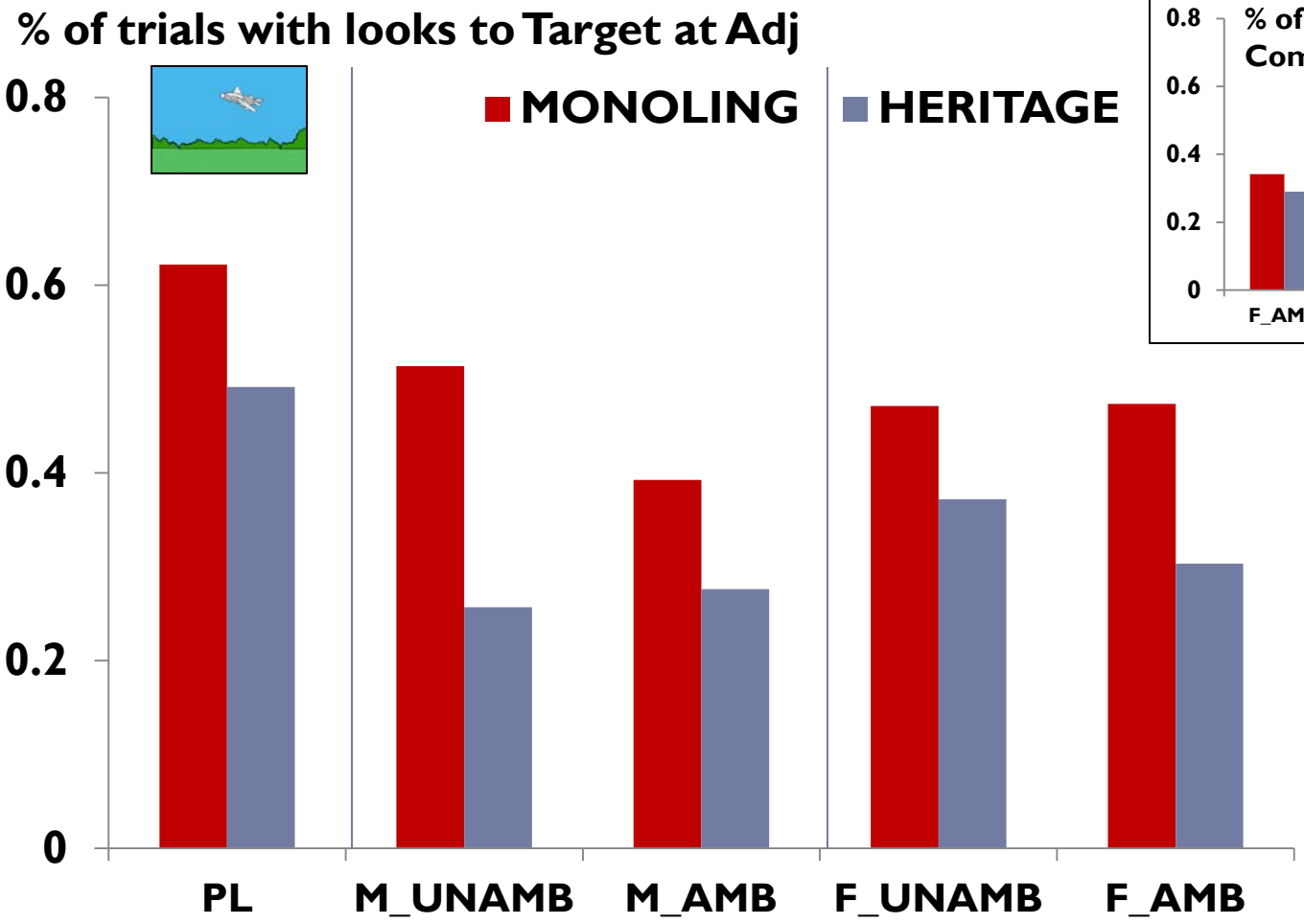
Eye-Movement Analysis

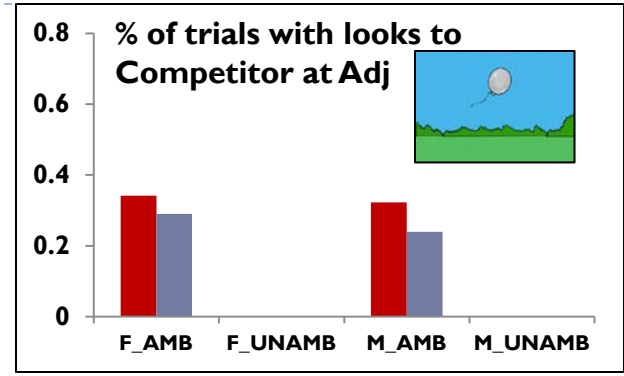
- Coarse-grain:
  - Proportions of trials with looks to the Target and/or Competitor separately for each region of interest (ROI)
  - 5 ROI:

In the sky	*flew*$_{MASC/FEM/PL}$	*silver*$_{MASC/FEM/PL}$	*Noun*	
733 ms	733 ms	633 ms	533 ms	
Locative	Verb	Adjective	Noun	Silence
 25%	25%	>50%	~100%	

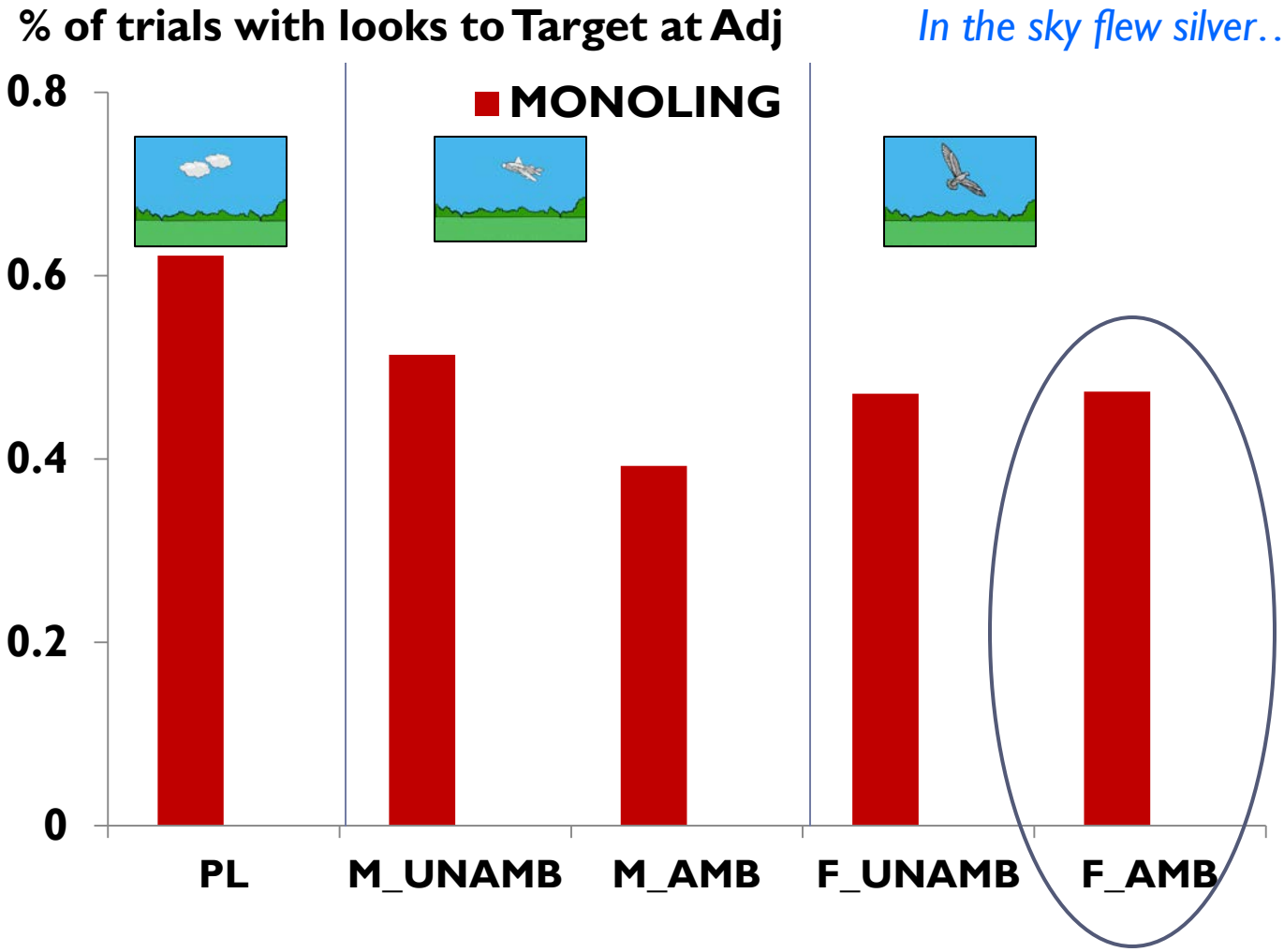
- Predictions: If Number/Gender agreement information is predictive, the effect should be found already on Adj

Coarse-Grain Eye-Movement Analysis

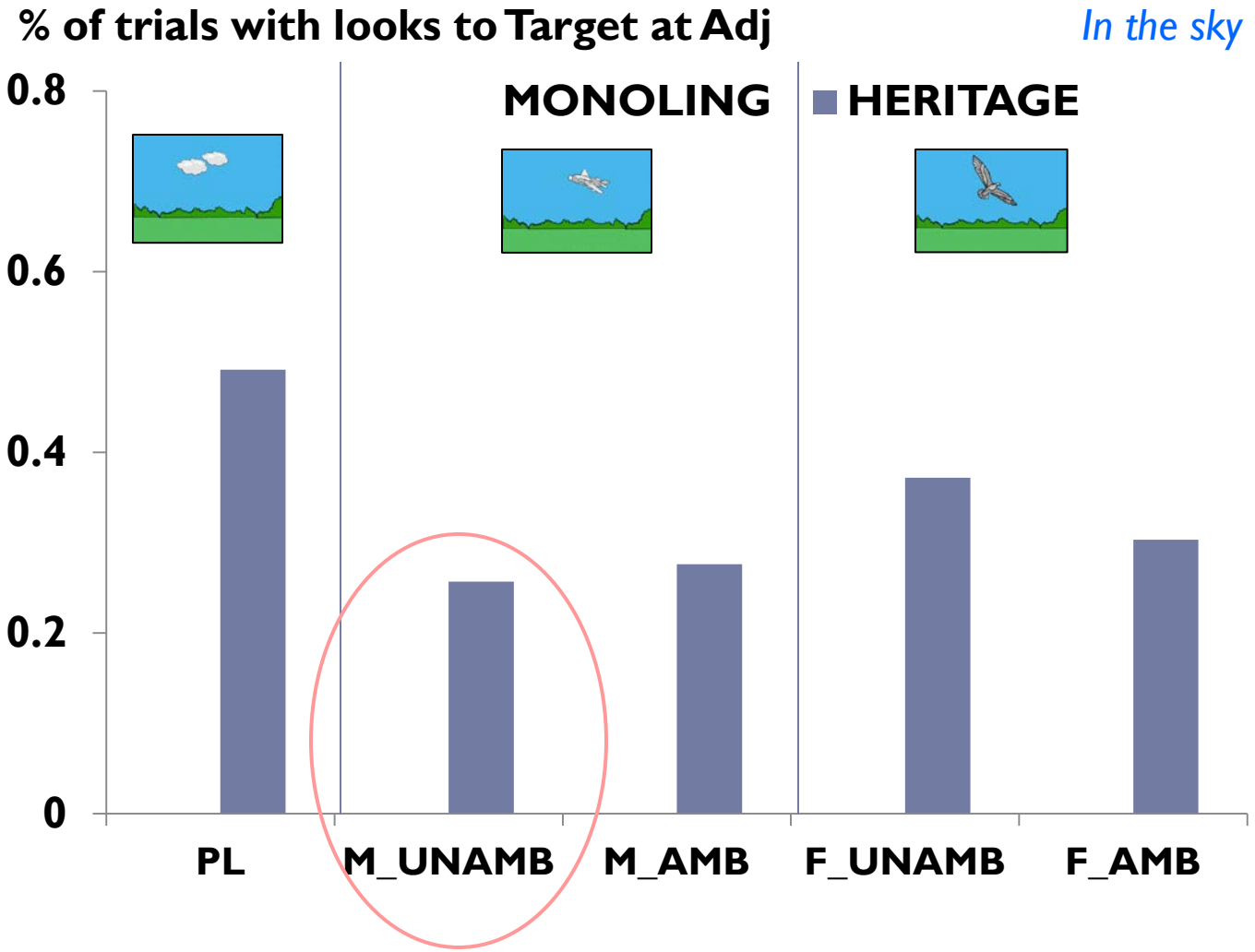




Coarse-Grain Eye-Movement Analysis



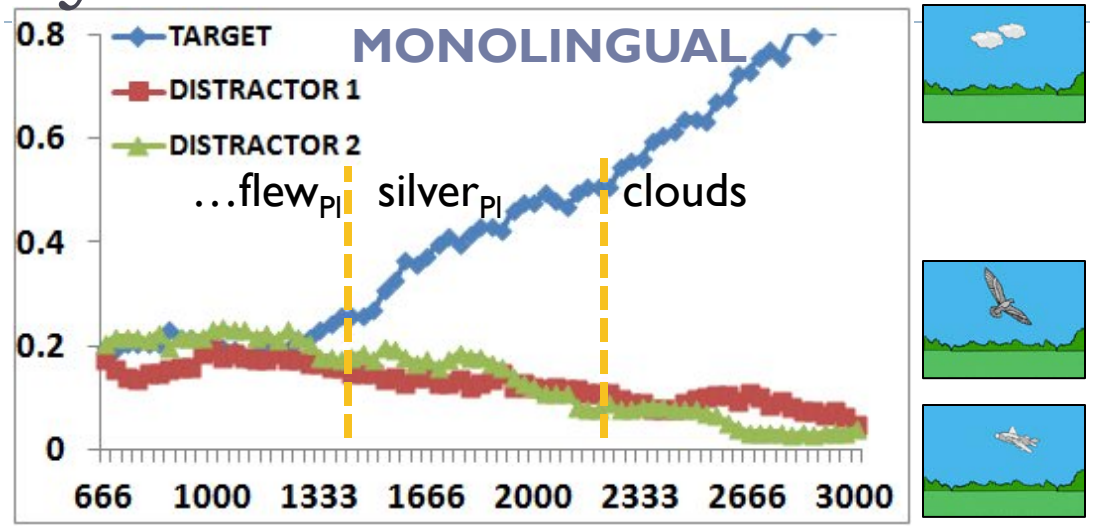
Coarse-Grain Eye-Movement Analysis

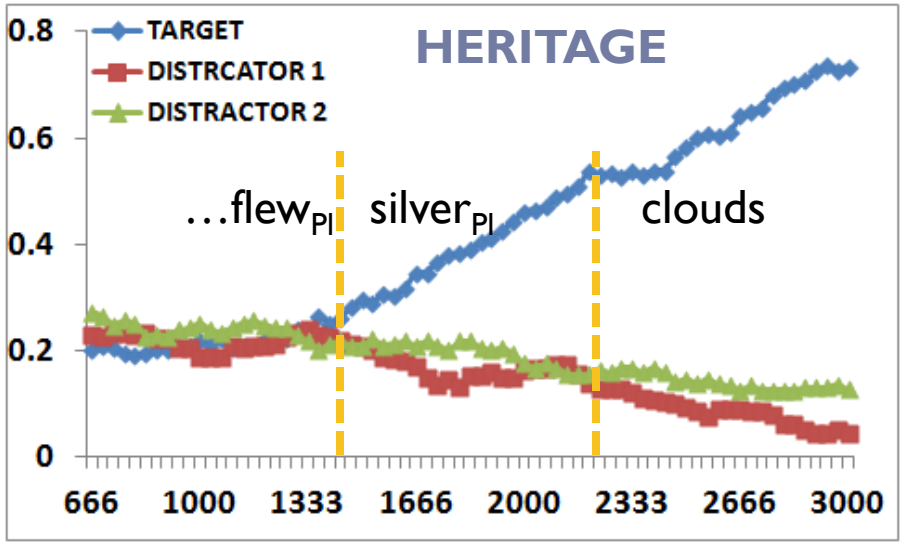


Fine-Grain Eye Movements: PL

- Early divergence (Adj) of looks to Target for both groups

=> PL is a strong cue



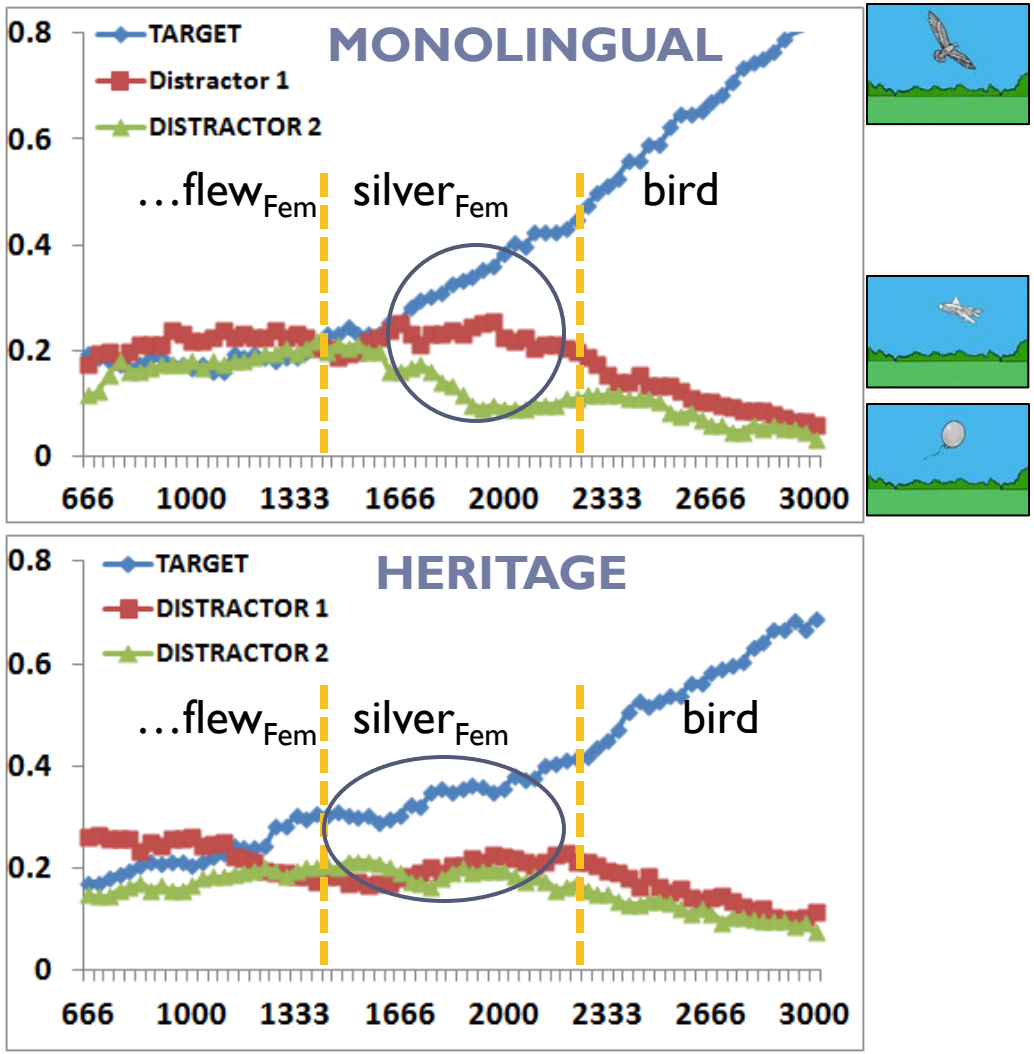


Eye Movements: Fem-DIFFERENT

- Divergence (Adj) of looks is LATER than in PL for:
--monolinguals

- But EARLIER for:
--heritage speakers

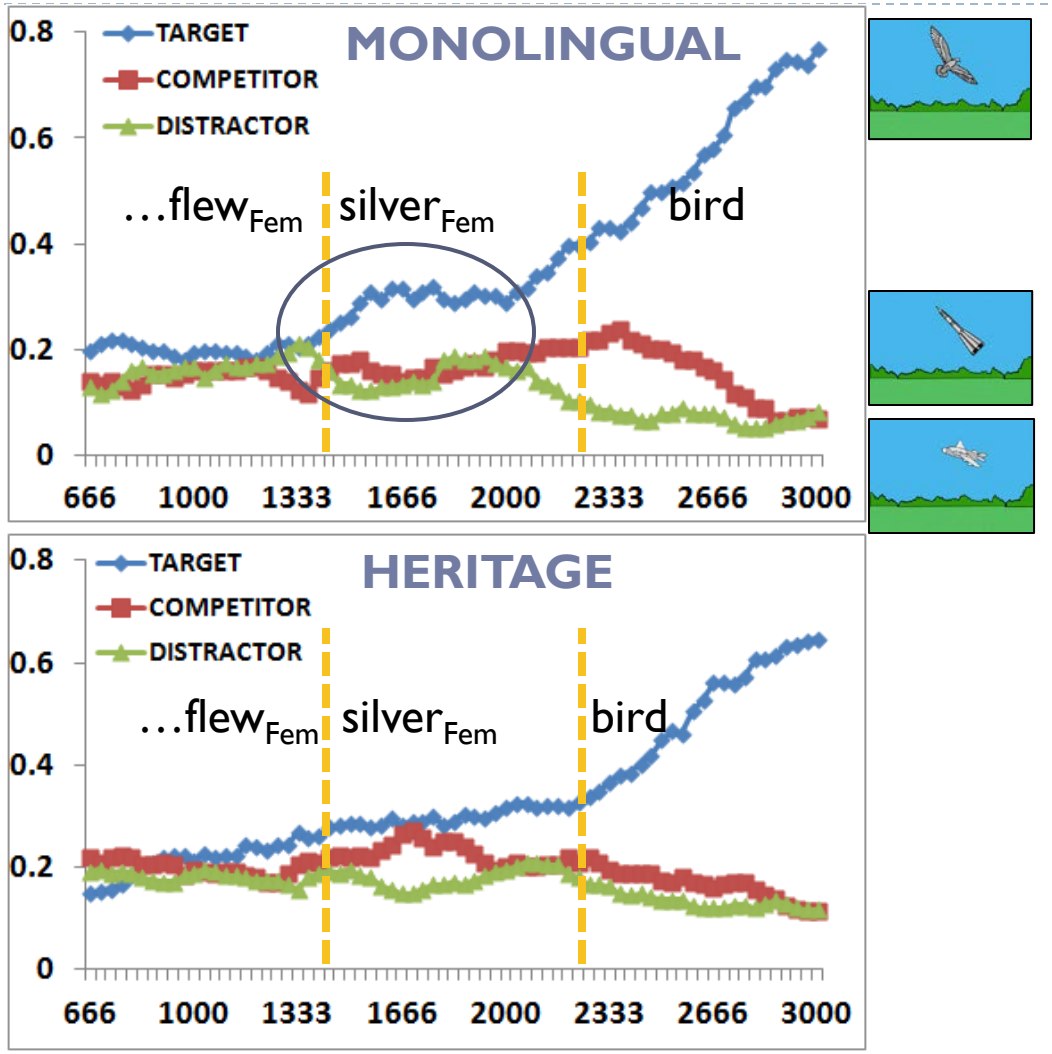
=>FEM ≈ PL



Eye Movements: Fem-SAME

- Early divergence (Adj) of looks to Target for:
--monolinguals (a surprise)

- NOT for
-- heritage speakers

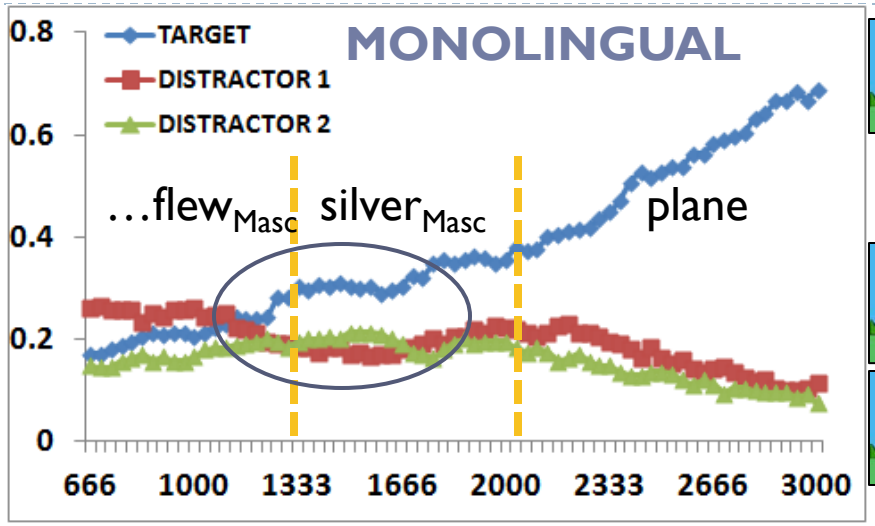


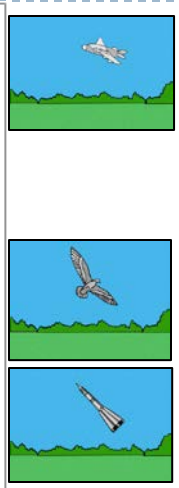
Eye Movements: Masc-DIFFERENT

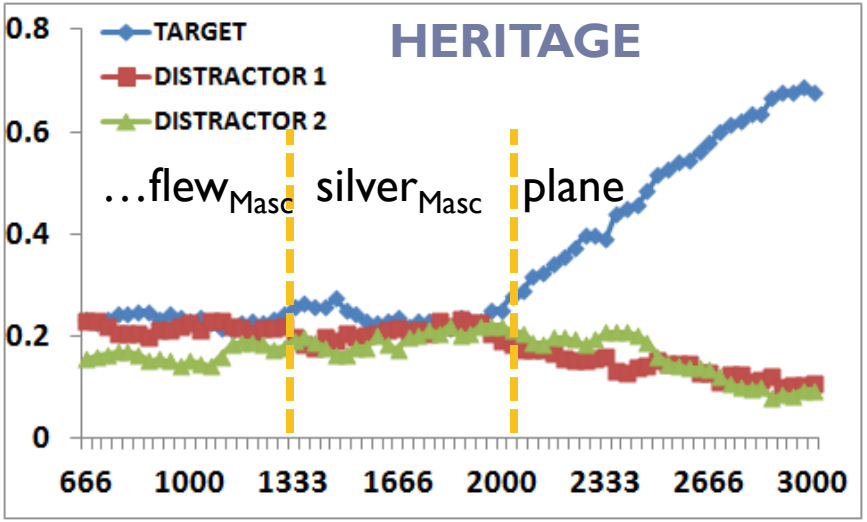
- Early divergence (Adj) of looks to Target for:
--monolingual

- But: NOT for
-- heritage speakers

=> Masc < Fem

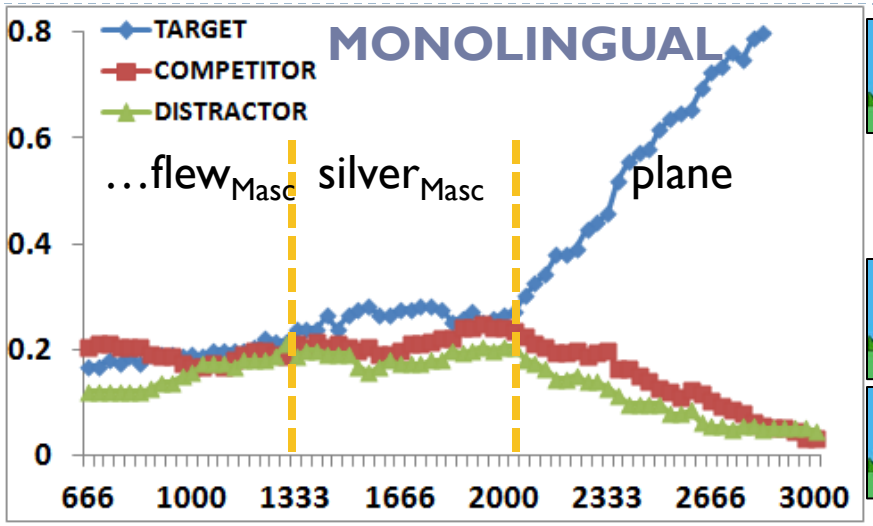


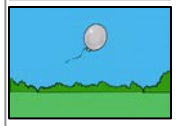


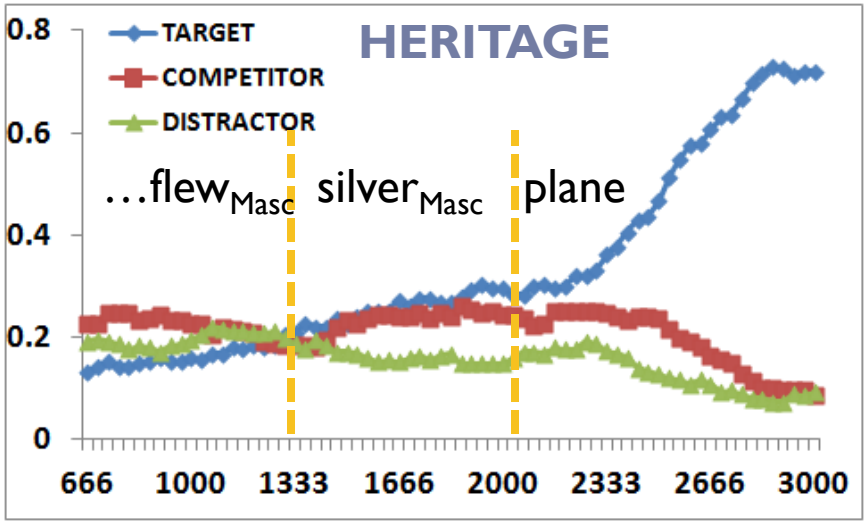


Eye Movements: Masc-SAME

- Late divergence (N) of looks to Target for both groups







Back to Specific Goals: Monolinguals

- Is the grammatical agreement information (Gender and Number) predictive?
  - Yes: in 3 referentially unambiguous conditions (PL, Masc-DIFF, and Fem-DIFF) [and even surprisingly, in Fem-SAME]
  - Identification of the Target referent starts at ~200 ms into the Adj (PL and Masc-DIFF) and ~400 ms (Fem-DIFF)
- Hierarchy of features, Number vs. Gender: Num > Gen
  - Identification of the Target referent is earlier and faster in PL than in Fem (but the same in Masc)
- Hierarchy of values in Gender: Masc > Fem
  - Identification of the Target referent is earlier and faster in Masc-DIFF than in Fem-DIFF (but, Fem-SAME?)

Back to Specific Goals: Heritage

- Heritage speakers are less accurate and slower than monolingual controls
- Is the grammatical agreement information (Gender and Number) predictive?
  - Yes: in PL and Fem-DIFF (but not in Masc-DIFF)
- Hierarchy of features, Number vs. Gender: Num > Gen
- Gender asymmetry: Fem > Masc
  - Identification of the Target referent is earlier and faster in Fem- than in Masc
  - Default/markedness ~ neutralization/perceptual salience/automaticy/dominant L transfer?

Group Comparison

	MONOLING	HERITAGE
Accuracy:	√	errors
Speed:	√	slower
Agreement is predictive:	√	differential
Number (PL):	√	√
Gender (Fem):	weaker	√
Gender (Masc):	√	no

Theoretical Connections: General

- Heritage: production ~ comprehension asymmetry (Garrod & Pickering, 2007)
- Processing deficits
  - Bilingual:
    - Missing Surface Inflection Hypothesis (White)
    - Mapping Deficits
    - Interface Vulnerability Hypothesis (Sorace)
    - Morphological Bottleneck (Slabakova)
    - Automaticity
- Grammatical Agreement:
  - Feature Strength Hypothesis; Accessibility Feature Hierarchy (Carminati, 2005): Num (Sg > Pl) > Gender

Theoretical Connections: Gender

- Monolinguals:
  - Masc is default, Fem is marked (Corbett; more errors in Fem in gender priming (Bates and colleagues); in attraction (Bock))
- Heritage:
  - Overgeneralization of Masc in written Spanish gender recognition (Alarcón, 2011)
  - Masc is not predictive while Fem is (Kroff et al., 2010; Klein et al., 2007)
- Partial guidance vs. Discovery learning
  - Novices vs. experts ("The Worked-Example" effect reversed, Kalyuga et al., 2001)
  - Controlled vs. automatic processes

Thank you!

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The Overview of the Project

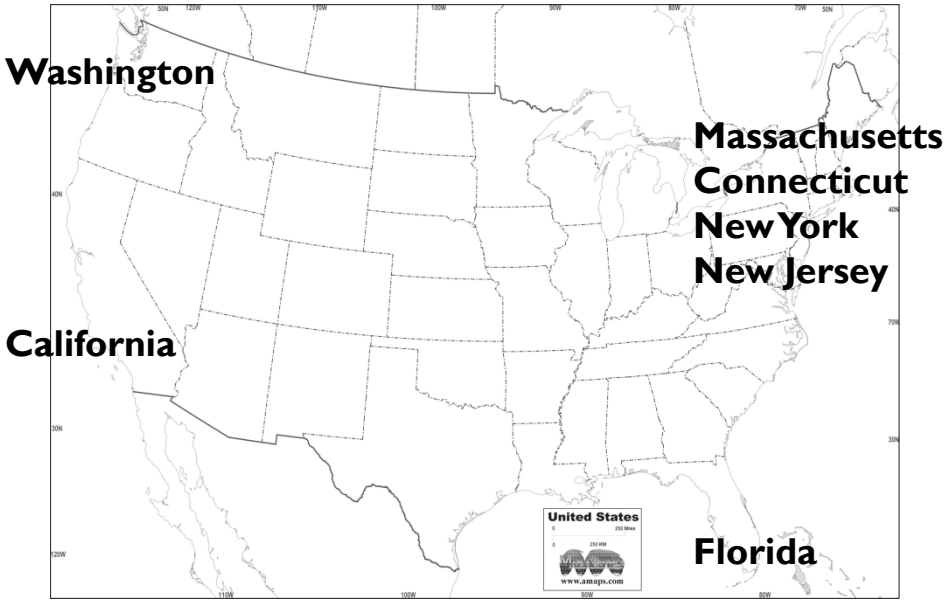
	TYPICAL		ATYPICAL (Monoling)
	Monolingual	Bilingual	
ADULTS	*N*=25	*N*=40	Aphasic patients (*N*=6)
CHILDREN	*N*=40 [data coding]	[tricky and almost impossible]	[tricky but possible]

Why Should We Care?

- Cognitive:
  - Pervasive parallels between special groups of participants in language performance along several dimensions
    - Life span: children ~ young adults ~ older adults
    - Language status: monolinguals ~ bilinguals (L2, balanced, heritage)
    - Abnormal: normal/typically developing ~ aphasia, SLI

- Psycholinguistic:
  - Production/comprehension asymmetries
  - "Sticky" areas: morphology; interfaces; pragmatics

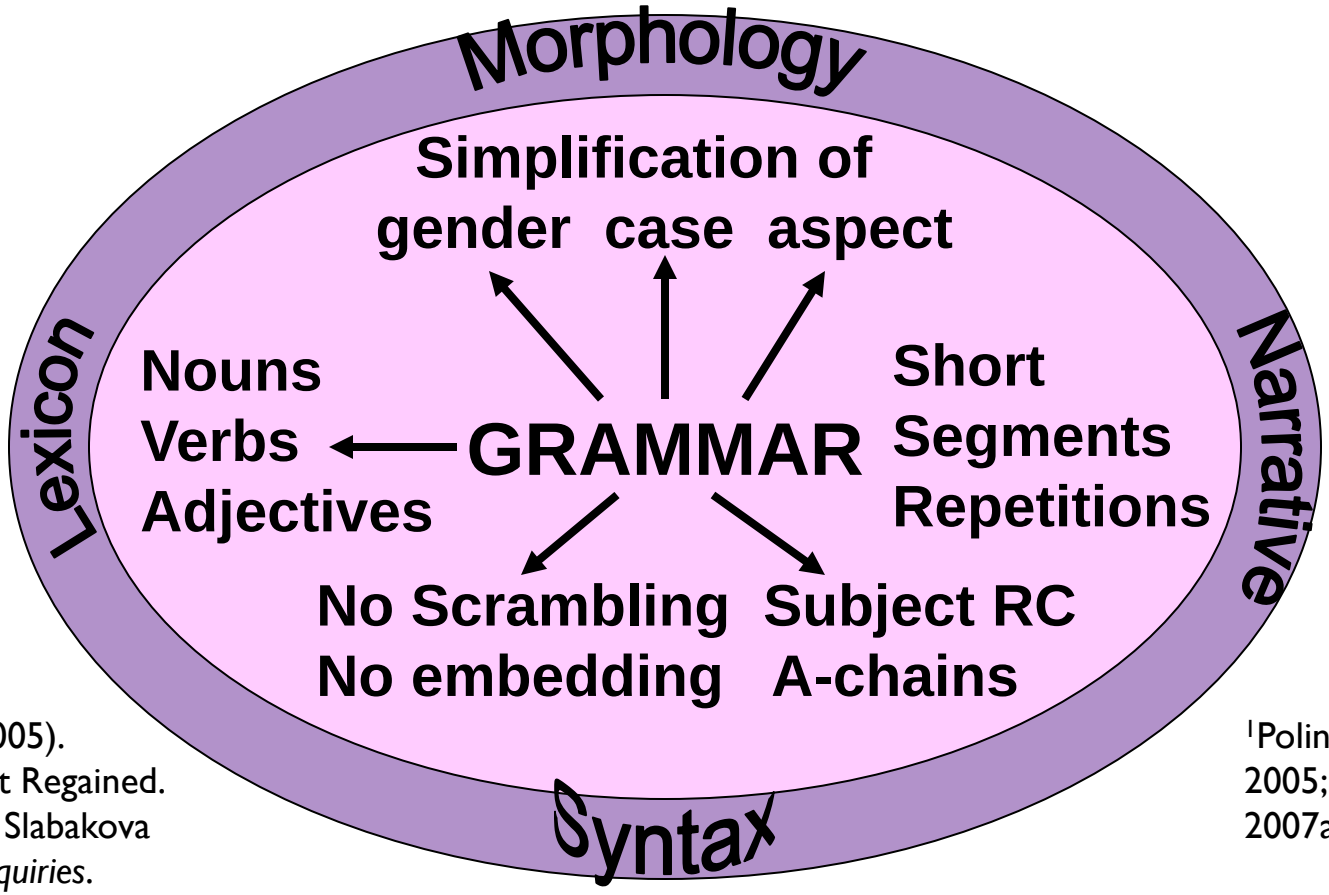
Heritage Russian Speakers



- 706,242 people speak Russian, 9th most spoken language[1]
- Geographic distribution[2]
- New York State: 220,000 (1%) of the population, 3rd most spoken language

[1] Census 2000. U.S. Census Bureau. *Language Use and English-Speaking Ability: 2000*.
[2] MLA Language Map, retrieved from http://www.mla.org/resources/map_main.

Competence (Grammar) of Russian HL[1,2]



[2] Pereltsvaig, A. (2005). Aspect lost, Aspect Regained. In Kempchinsky & Slabakova (Eds.), *Aspectual Inquiries*.

[1] Polinsky, 2000; 2005; 2006a,b; 2007a, b