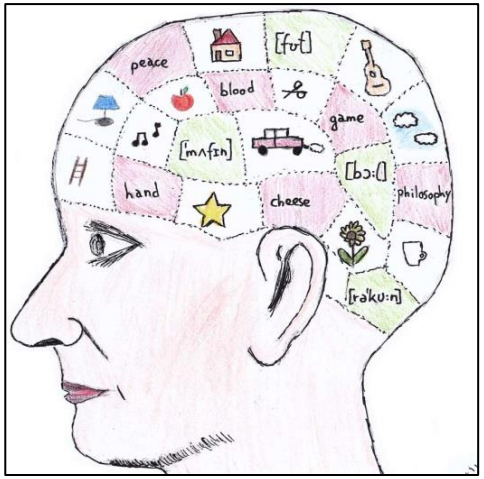
Morpheme by Morpheme:
The Processing of French Verbs

Ph.D Student: Gustavo L. Estivalet
Thesis Advisor: Fanny Meunier

Nice, December 3rd 2015.

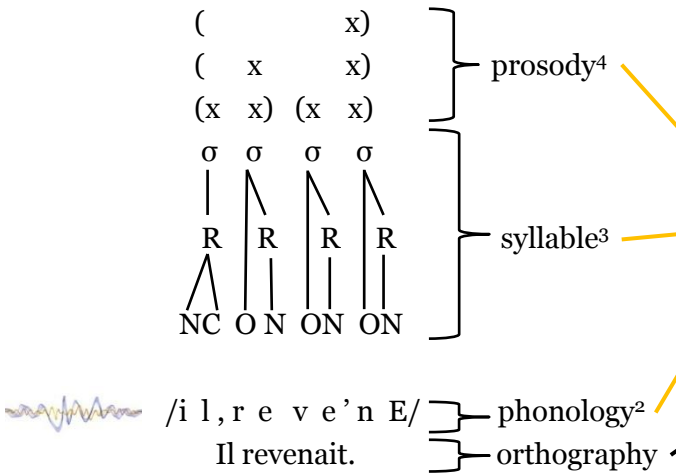
Outline

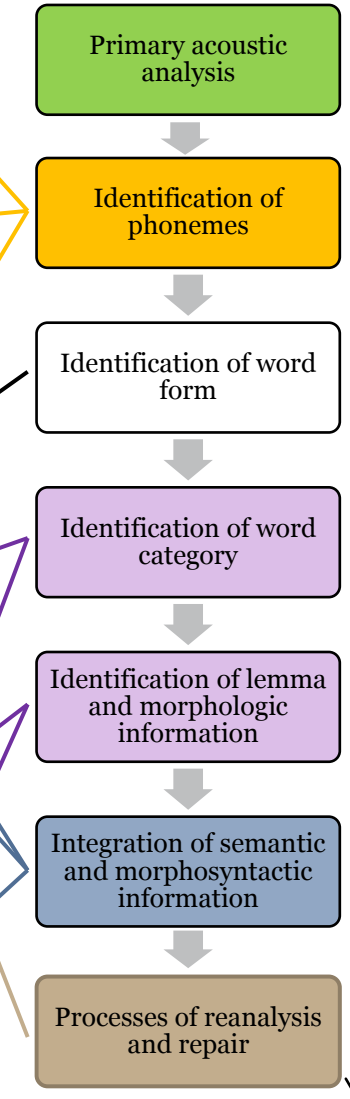
- 0. How language can be?
- 1. Verbal morphology
- 2.1. Study 1: Pseudoverbs
- 2.2 Study 2: Frequency effects
- 2.3 Study 3: Priming effects
- 4. Discussion
- 5. Future perspectives

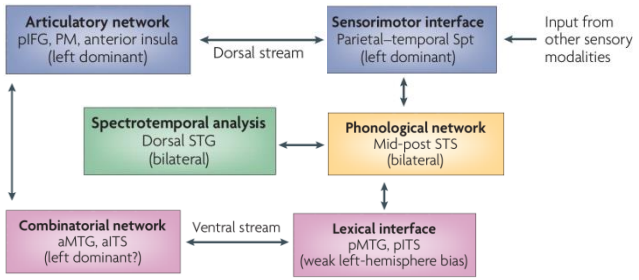


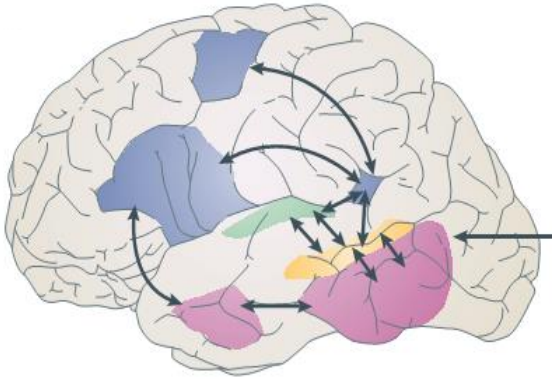
How language can be?

Representation[1]	Level	Processes	ERP[8]	Neuroanatomical[9]









[1,7]Jackendoff. (1999). The representational structures of the language facultay. In Brown, & Hagoort. *The Neurocognition of Language.*
[2,5]Chomsky. (1965). *Aspects of the theory of syntax.*
[3,4]Goldsmith. (1990). *Autosegmental and Metrical Phonology: An Introduction.*
[6]Halle, & Marantz. (1993). Distributed morphology and the pieces of inflection. In Hale & Keyser. *The view from building 20: essays in linguistics in honor of Sylvain Bromberger.*
[8]Friederici. (2002). Towards a neural basis of auditory sentence processing. *TRENDS in Cognitive Sciences, 6.*
[9]Hickok, & Poeppel. (2007).The cortical organization of speech processing. *Nature Reviews Neuroscience, 8.*

Mental Lexicon

Word List

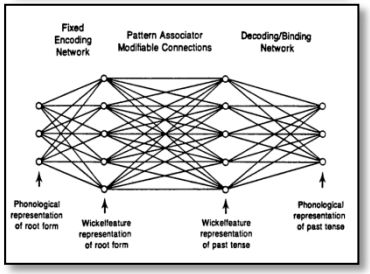
aimer
aimons
aimions
…

Morphemes

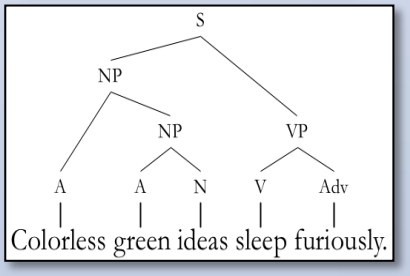
aim Σ ons
i

Empiricism Vs. Rationalism

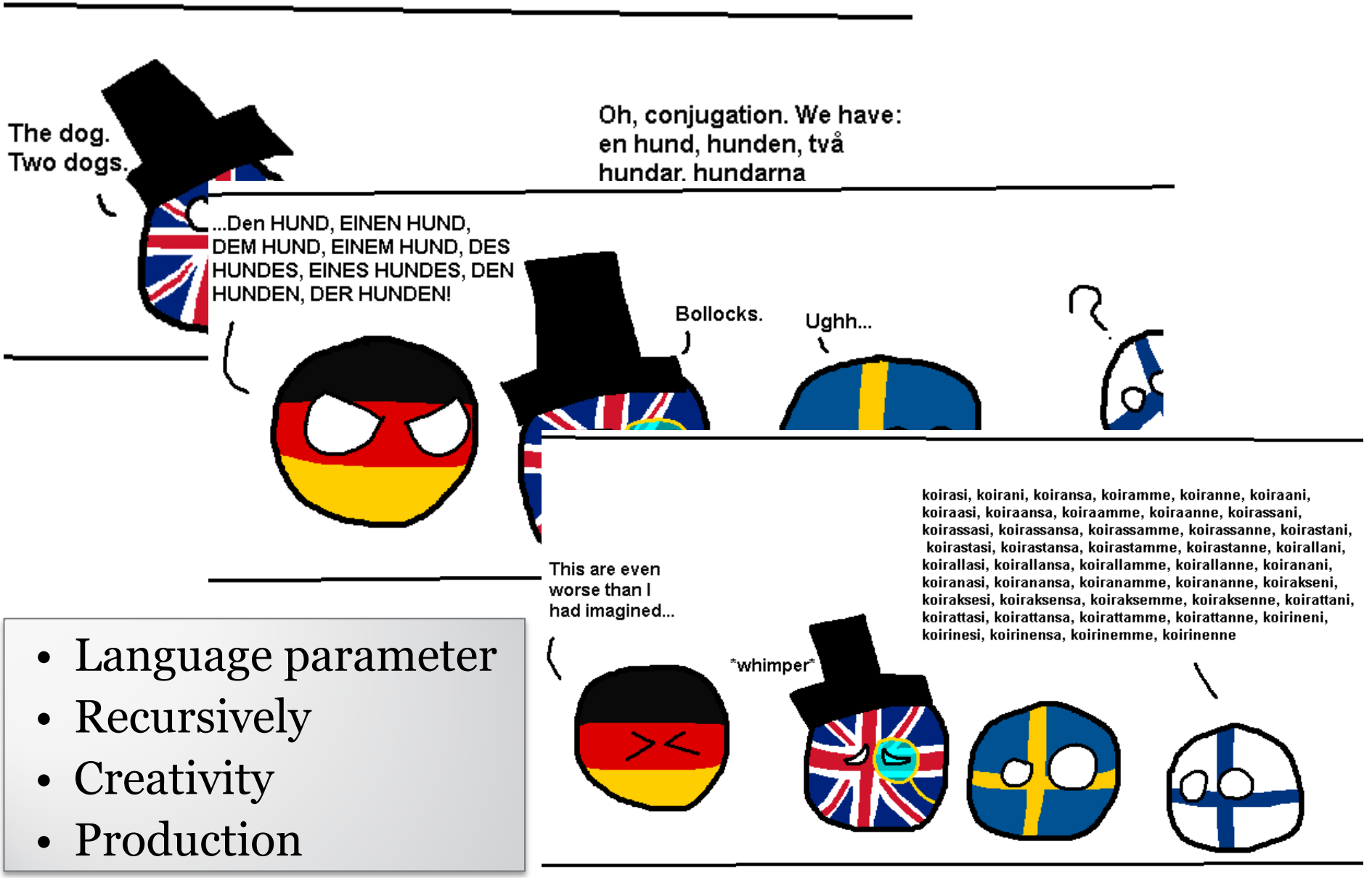
Association (experience)



Symbolic combination



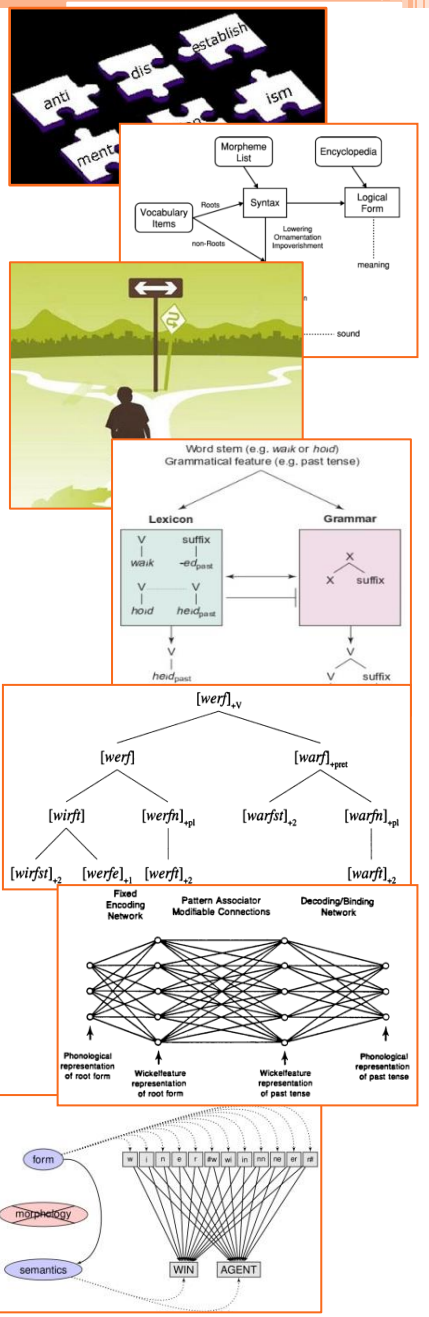
Morphology!



- Language parameter
- Recursively
- Creativity
- Production

Morphological Models

- **Whole-Word Access (WWA):** whole-word representations (Jackendoff, 1975; Manelis & Tarp, 1977)
- **Obligatory Decomposition (OD)**: representation in morphemic and lexical levels (Taft, 1979)
- **A-Morphous Morphology:** word and paradigm representation and processing (Anderson, 1992)
- **Distributed Morphology (DM):** underspecification, syntax all-the-way-down, late insertion (Halle & Marantz, 1993)
- **Augmented Address Model (AAM):** whole-word access or morphemic activation (Caramazza, Laudanna, & Romani, 1988)
- **Lexeme-Morpheme Base Morphology (LMBM):** lexicalist hypothesis (Beard, 1995)
- **Race Model (RM):** parallel whole-word and morphemic activation (Baayen, Dijkstra & Schreuder, 1997)
- **Words and Rules (W&R):** regular and irregular words in a declarative/procedural system (Pinker, 1999; Pinker, & Ullman, 2002)
- **Minimalist Morphology (MM):** structured combinatorial constituents, early insertion (Wunderlich, 1996)
- **Connexionnist models (PDP):** interaction between orthography, phonology, and semantics in hiden units (Rumelhart, & McClelland, 1982)
- **Supralexical Morphology:** early whole word and late morphemic processing (Grainger, & Giraudo, 2001)
- **Naive Discriminative Learning (NDL):** direct mapping from form onto meaning without specific representations (Baayen et al., 2011)

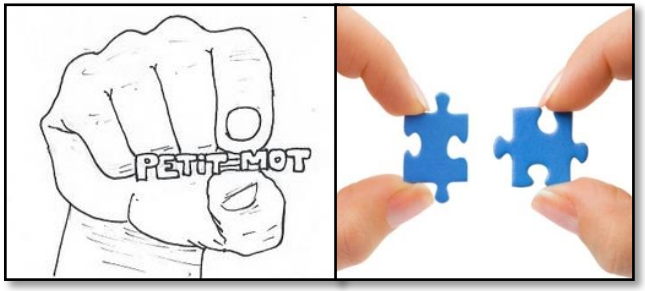


Romance Languages Review

Language	Reference	Results and Model
Spanish	Dominguez et al., 2000 Bermúdez-Otero, 2013	1st class = fully-combinatorial, 2nd/3rd classes = lexically represented (AAM), but Arregi (2000) (DM)
Catalan	Rodriguez-Fornells et al., 2001	Lexical and combinatorial access by different morphological structures (Dual-mechanism), but Oltra-Massuet (1999) (DM)
Italian	Orsolini, & Marslen-Wilson, 1997	Productivity and lexical specificity (Full-decomposition), but Say, & Clahsen (2002) (W&R)
Portuguese	Verissimo, & Clahsen, 2009	1st class = structured root-based, 3rd class/vowel change = structured stem-based (Dual-mechanism), but Bassani, & Lunguinho (2011) (DM)
French	Meunier, & Marlen-Wilson, 2004 Kilani-Schoch, & Dressler, 2005 Bonami et al., 2008	1st class = fully-regular, 2nd class = fully-regular, 3rd class = allomorphy and idiosyncrasy structured morpheme-based (full-decomposition)

French Verbal Inflection

- How verbs are represented and processed in the mental lexicon?
- How words are activated and accessed?
- How verbal stems and inflectional suffixes are processed?



Person	Present	Simple Past	Imperfect	Future	Conditional	Subjunctive
1st sg	parl-e	parl-ai	parl-ai-s	parl-e-r-ai	parl-e-r-ai-s	parl-e
2nd sg	parl-e-s	parl-as	parl-ai-s	parl-e-r-as	parl-e-r-ai-s	parl-e-s
3th sg	parl-e	parl-a	parl-ai-t	parl-e-r-a	parl-e-r-ai-t	parl-e
1st pl	parl-ons	parl-â-mes	parl-i-ons	parl-e-r-ons	parl-e-r-i-ons	parl-i-ons
2nd pl	parl-ez	parl-â-tes	parl-i-ez	parl-e-r-ez	parl-e-r-i-ez	parl-i-ez
3th pl	parl-ent	parl-è-r-ent	parl-ai-ent	parl-e-r-ont	parl-e-r-ai-ent	parl-ent

Person	Present	Simple Past	Imperfect	Future	Conditional	Subjunctive
1st sg	boi-s	bu-s	buv-ai-s	boi-r-ai	boi-r-ai-s	boiv-e
2nd sg	boi-s	bu-s	buv-ai-s	boi-r-as	boi-r-ai-s	boiv-e-s
3th sg	boi-t	bu-t	buv-ai-t	boi-r-a	boi-r-ai-t	boiv-e
1st pl	buv-ons	bû-mes	buv-i-ons	boi-r-ons	boi-r-i-ons	boiv-i-ons
2nd pl	buv-ez	bû-tes	buv-i-ez	boi-r-ez	boi-r-i-ez	boiv-i-ez
3th pl	boiv-ent	bu-r-ent	buv-ai-ent	boi-r-ont	boi-r-ai-ent	boiv-ent

Study 1: Pseudoverbs

caligrama
revista de estudos românicos

Processing of the French verb by lexical decomposition

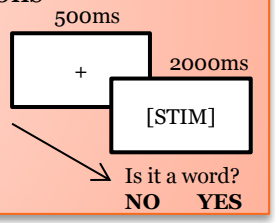
Gustavo L. Estivalet[1,2,*]; Fanny Meunier[1,2]

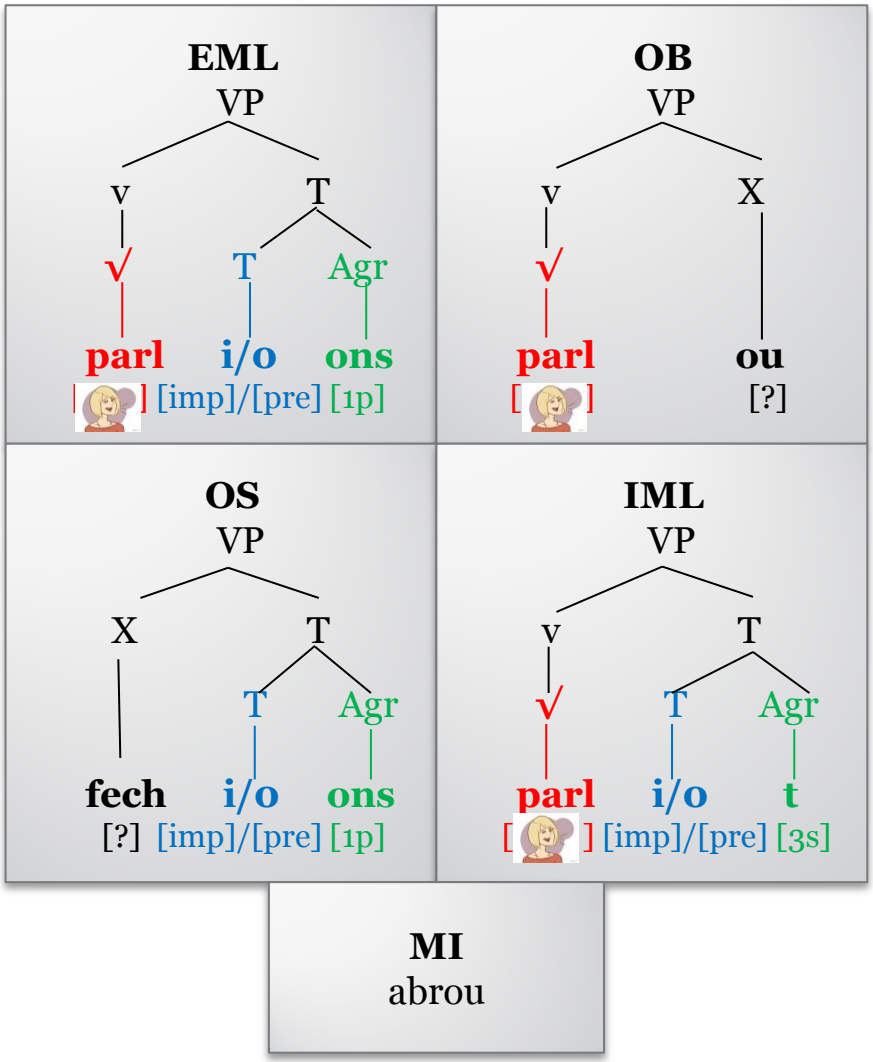
[1]Université Claude Bernard Lyon 1 (UCBL)
[2]Laboratoire sur le Langage, le Cerveau et la Cognition (L2C2, CNRS UMR5304)

Objective
Investigate the morphological decomposability of the French verbs and the the processing of different morphologial structures.

Questions
a. Which is the cognitive cost (RT) for processing the different morphemes ?
b. Is there a difference in function of the number of suffixes?
c. Which is the morphological processing hierarchy?

Method
Subjects: N=36, 18 women, mean age 21.48, Fr L1
Experience: lexical decision task in visual modality
Study: 5 cond. of structure X 2 cond. operations
1) 50 only suffix (OS)
2) 50 only base (OB)
3) 50 existent morphological legal (EML)
4) 50 inexistent morphological legal (IML)
5) 50 morphological illegal (MI)





Study 1: Pseudoverbs

Predictions

Whole Word Access (WWA) (Manelis & Tharp, 1977):
(EML) < MI = OB = OS = IML

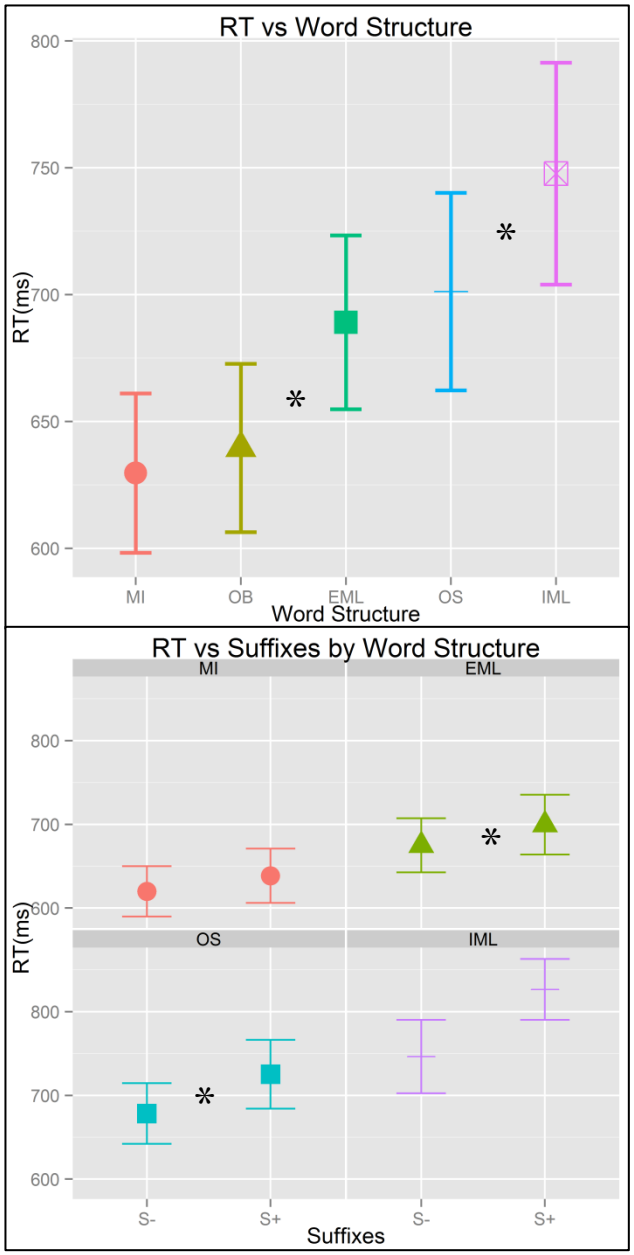
Obligatory Decomposition Model (OD) (Taft, 1979):
MI = OB < OS < (EML) < IML

Augmented Addressed Model (AAM) (Caramazza et al., 1988):
MI < (EML) < OB = OS < IML

Discussion

MI = OB < EML = OS < IML

- ✓ WWA immediately rejected.
- ✓ AAM rejected because OB ≠ OS, list size and frequency.
- ✓ OD prediction! MI do not allow decomposition being promptly rejected; OB decomposed with fast suffix rejection; OS long base list; IML inhibited, recombination crashes; EML decomposed and recombined.
- ✓ EML and OS = operation affect.

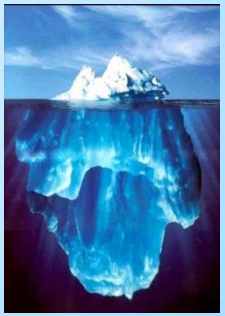


Study 2: Frquency effects

Objective
Investigate the stem representation of French verbs in function of the surface and base frequencies (Taft, 1979).

Surface frequency (SF)
aime=52, aimez=18

Base frequency (BF)
aime+aimez+aimons…
52+18+6+…=795



frontiers in
HUMAN NEUROSCIENCE

ORIGINAL RESEARCH ARTICLE
published: 20 January 2015
doi: 10.3389/fnhum.2015.00004

Decomposability and mental representation of French verbs

Gustavo L. Estivalet[1,2] and Fanny E. Meunier[1,2]*

[1] Centre National de la Recherche Scientifique UMR5304, Laboratoire sur le Langage, le Cerveau et la Cognition, Lyon, France
[2] Université de Lyon, Université Claude Bernard Lyon 1, Lyon, France

Method
Subjects: N=32, 16 women, mean age 20.31, Fr L1
Experience: lexical decision task in visual modality
Study: 4 verb types, 4 conditions
Stimuli: 320 experimental verbs, 320 pseudoverbs

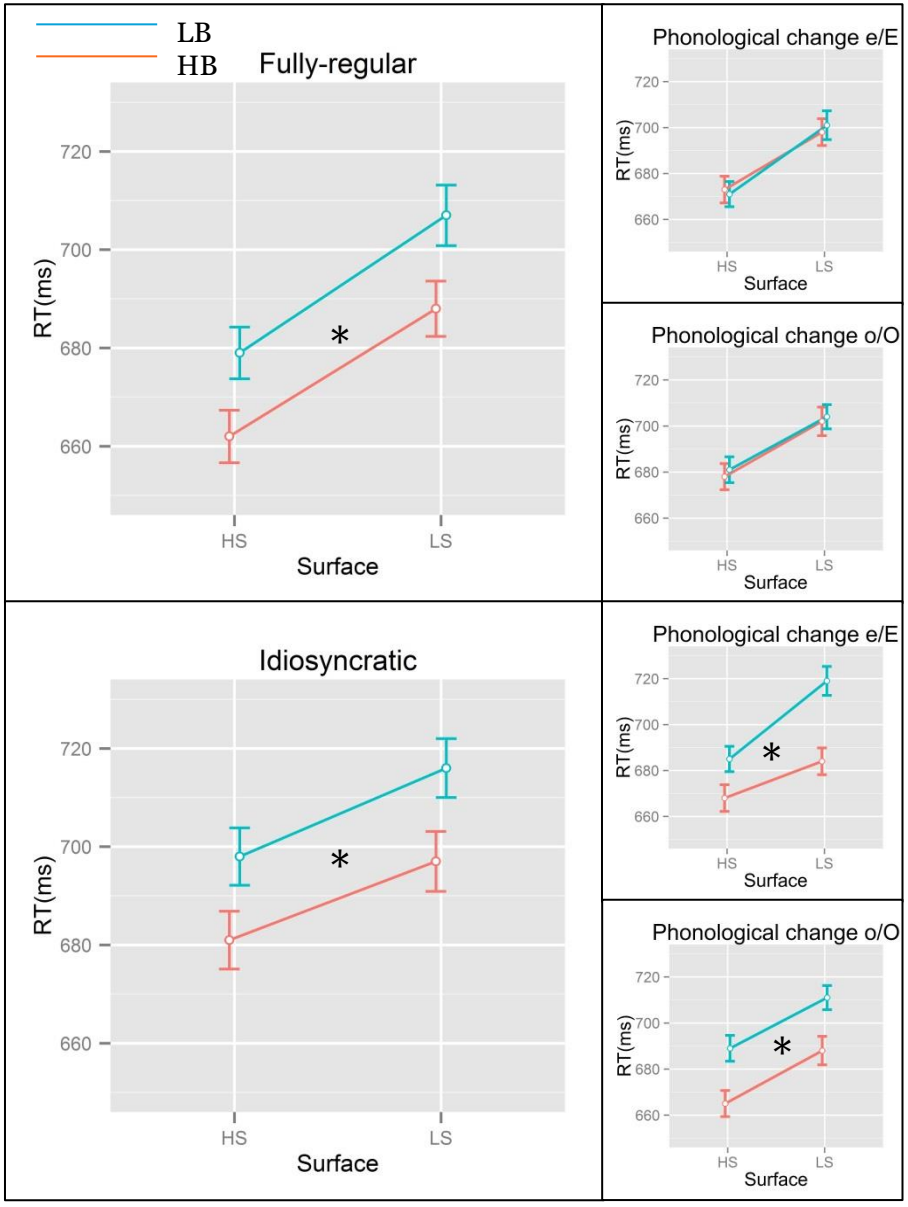
Hypothesis
Ho: SF effect/no BF effect = whole word recognition.

H1a: SF and BF effects = word decomposition. Morphophonological and Irregular stem allomorphs have different representations.

H1b: no BF effect = Morphophonological and Irregular stem allomorphs have an abstract representation.

	+BF		-BF	
	+SF	-SF	+SF	-SF
Regular	entrait	entrez	chantais	chantez
Morpho. e/E	répétait	répétions	répète	répètes
Morpho. o/O	adorais	adoriez	adOrent	adOres
Irregular	buvaient	buviez	boivent	boives

Study 2: Frequency effects

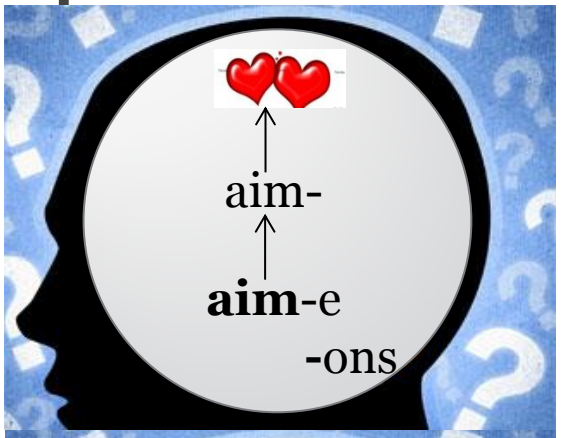


Discussion

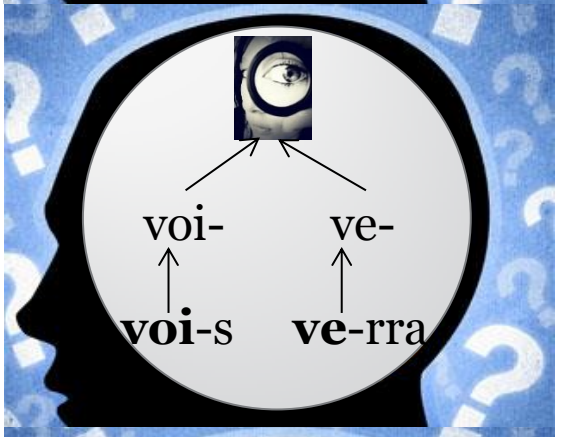
- ✓ **Regulars** = fully-combinatorial
- ✓ **Morphophonological** = phonological underspecified representation (late insertion) (Zhou & Marslen-Wilson, 1999)
- ✓ **Idiosyncratic** = different stem representations (Aronoff, 1994)
- ✓ **SF effect** = recombination between stem and affixes (Taft, 1979)
- ✓ **BF effect** = decomposition evidence
- ✓ **Visual modality** = contribute to decomposition (Rastle & Davis, 2008)
- ✓ Obligatory decomposition model (Taft, 2004; Halle & Marantz, 1993); revised dual-route model (Baayen; Dijkstra & Schreuder, 1997)

Morphological Decomposition

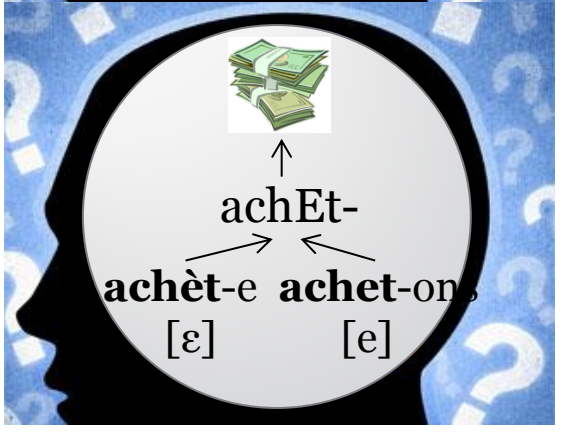
Regulars



Irregulars



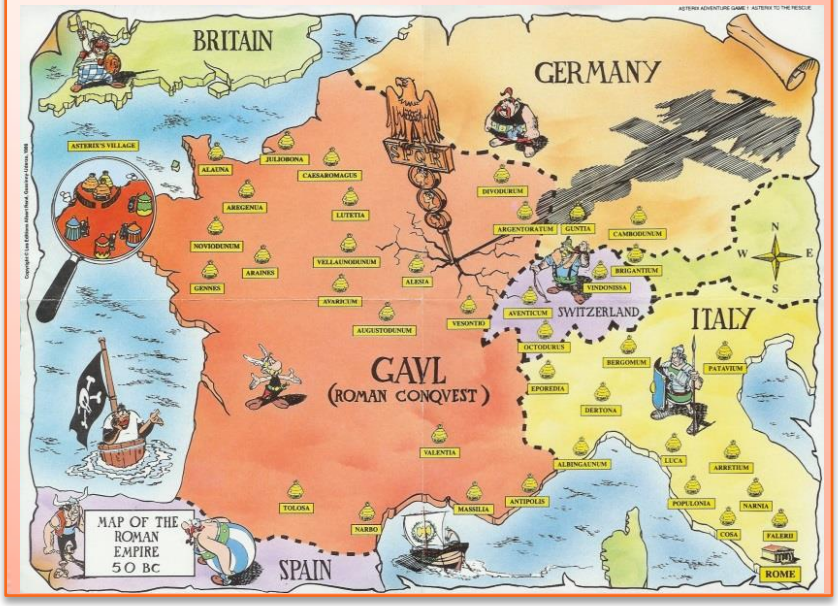
Morphophono.



Study 3: Priming effects

Romance languages

verbal system inherited from Latin (Dubois, 1967)



The Mental Lexicon

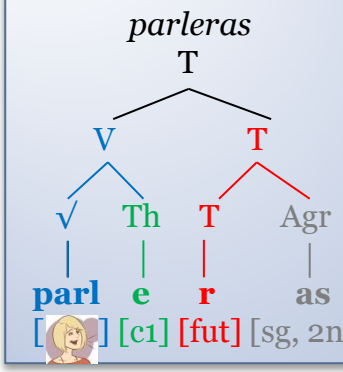
French Stems in Verbal Inflection: Structure, Rules, and Allomorphy

Gustavo L. Estivalet[1,2], Fanny Meunier[1,2]

Stem: form after inflectional suffix stripping (Aronoff, 1994)

Theme vowel (Th): conjugational (class, group) vowel merged with the root in theme (stem) formation

Structure

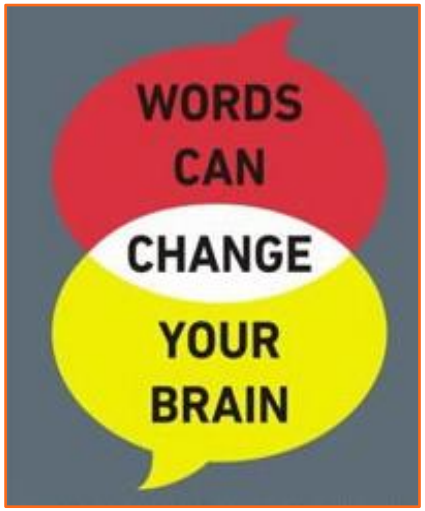


Language	ā	ĕ	ē	ī
Latin	*amāre*	*prendĕre*	*vidēre*	*audīre*
Spanish	amar	prender	ver	oír
Portuguese	amar	prender	ver	ouvir
Italian	amare	prendere	vedere	udire
Catalan	amar	prendre	veure	sentir
French	aimer	prendre	voir	ouïr

Study 3: Priming effects

Questions

- Is there a Th morpheme representation in French? Root? Stem?
- How stems from specific micro-classes are represented and processed:
  a) 1st: [-er]/eE,
  b) 3rd: [-ir]/[-dre]/[-ire]/[-indre] (80%)
- How the morphological and phonological/prosodic systems interact in French?



Main Objective

- Investigate if the Th is represented in the French mental lexicon

Secondary Objectives

- Explore which structures, nodes, and morphemes are stored in the French mental lexicon
- Study how verbal morphological is influenced by the phonological/prosodic systems

Study 3: Method

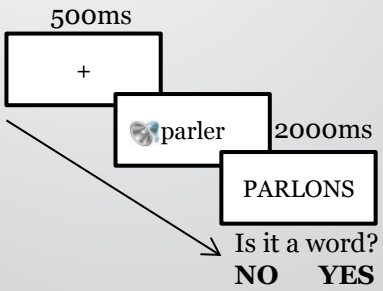
Target: 1st plural present inflected form [-ons]

Prime predictions:
-Identity = same target (full priming)
-Control = different infinitive (no priming)
-Test = target infinitive (?)

Stimuli:
-6 verb types, 3 conditions
-Experimental: 126 pair of verbs
(21 per verb type)
-Fillers: 294 pairs
(84 w-w, 210 w-p (84 phono., 126 unrel.))

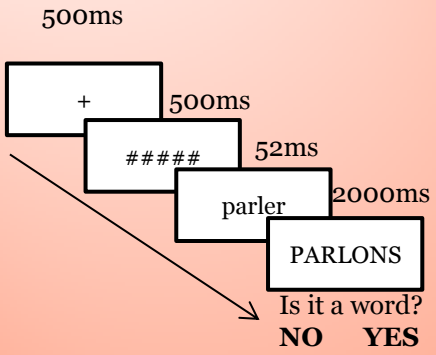
Experiment1: cross-modal priming

Subjects: N=54, 27 women, mean age 21.82, French as L1



Experiment2: masked priming

Subjects: N=54, 27 women, mean age 22.51, French as L1

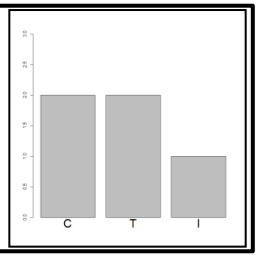


Verb Type	Control	Test	Identity	Target
a) 1st e/E	peser	lever	lèvent	LEVENT
b) 1st [-er]	aimer	parler	parlons	PARLONS
c) 3rd [-ir]	ouvrir	dormir	dormons	DORMONS
d) 3rd [-dre]	prendre	vendre	vendons	VENDONS
e) 3rd [-ire]	construire	écrire	écrivons	ECRIVONS
f) 3rd [-indre]	paindre	joindre	joignons	JOIGNONS
g) Control(MP)	brûler	apprécier(S)	administe(O)	ADMIRONS

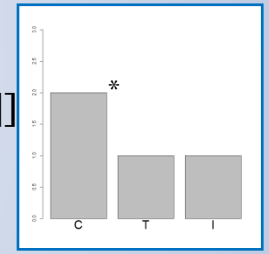
Study 3: Hypothesis

Predictions on Prime Types
-Full priming: Identity = same representation
-No priming: Control = different representation
-Partial priming = different but linked representations

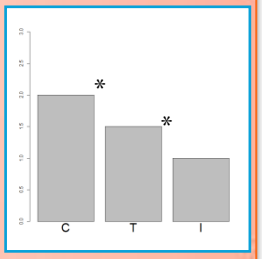
H0: no priming in Test Condition:
a) verb not decomposed: [word]
b) whole-word representation



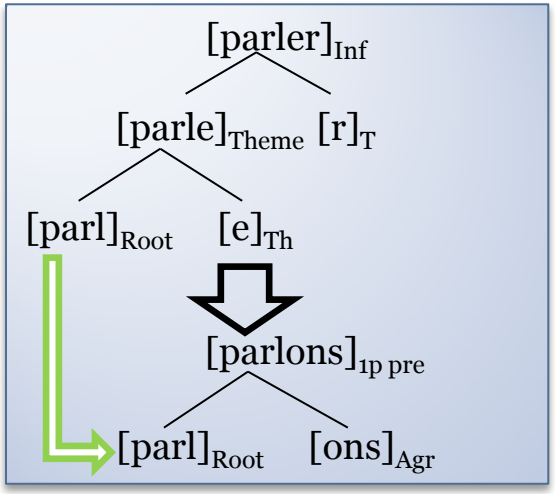
H1: full priming in Test Condition:
a) verb completely decomposed: [[[√][Th]][[T][Agr]]]
b) rule-based stem
c) phonological abstract representation e/E



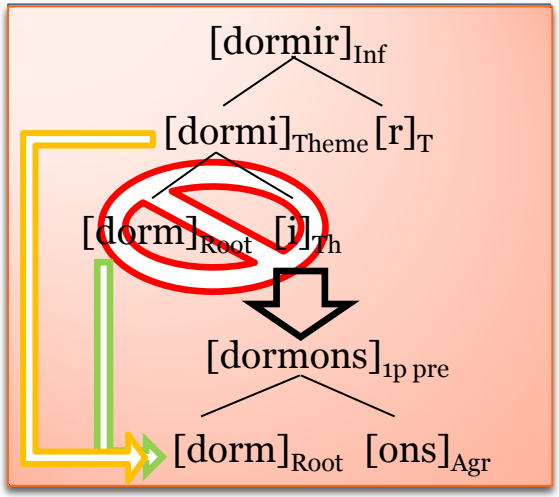
H2: partial priming in Test Condition:
a) verb partially decomposed [[Stem][[T][Agr]]]
b) stem allomorphic storage
c) phonological representation e/E



Prime | Target

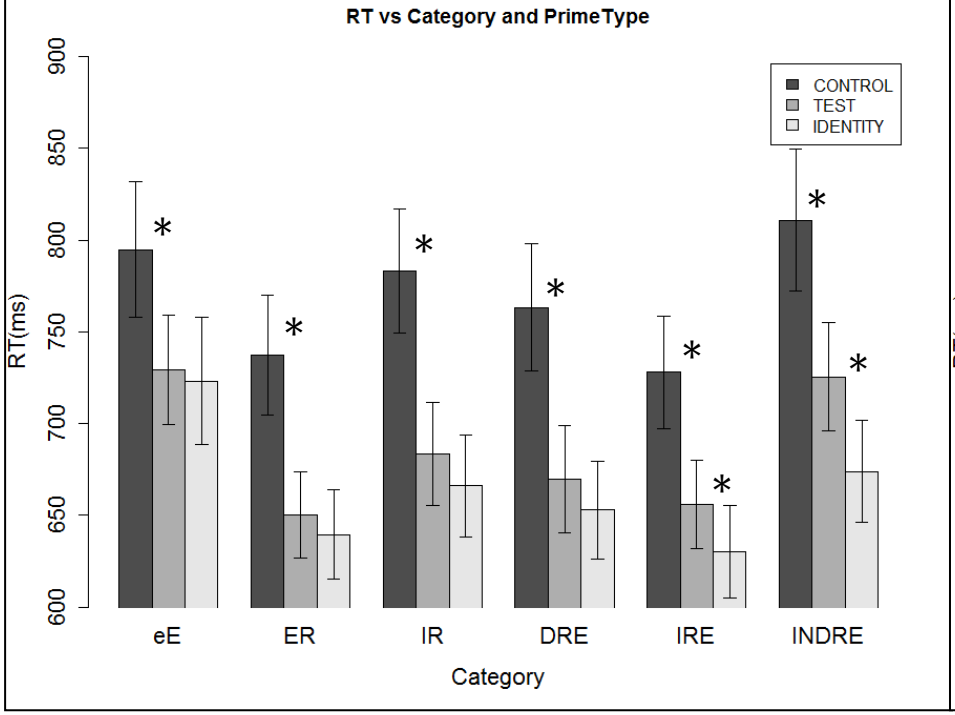


Prime Target

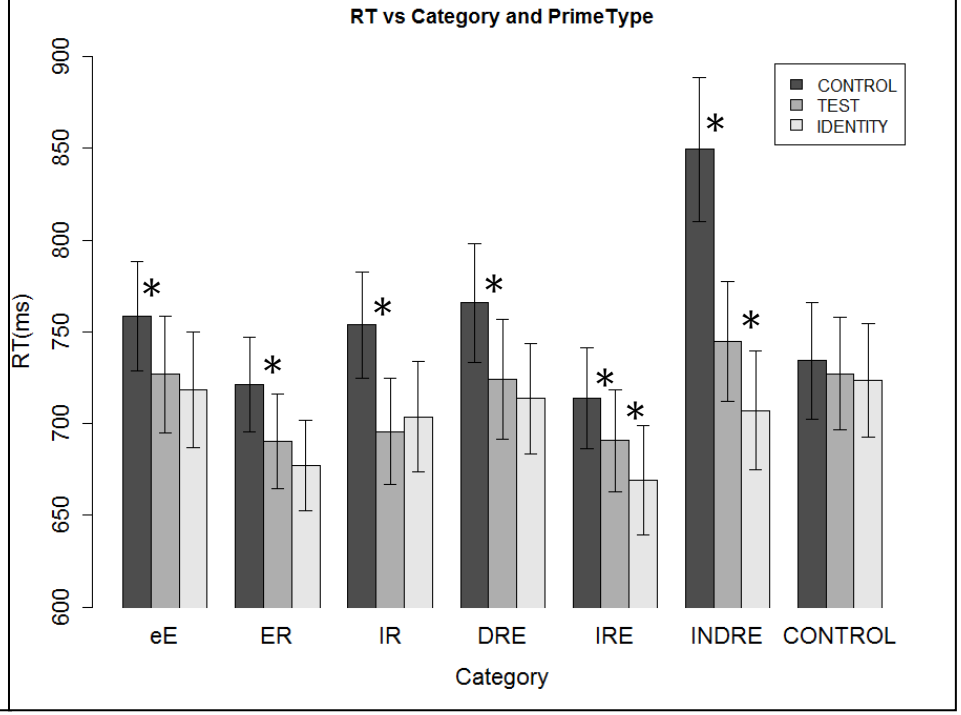


Study 3: Results

Exp.1 – Cross-modal



Exp.2 - Masked

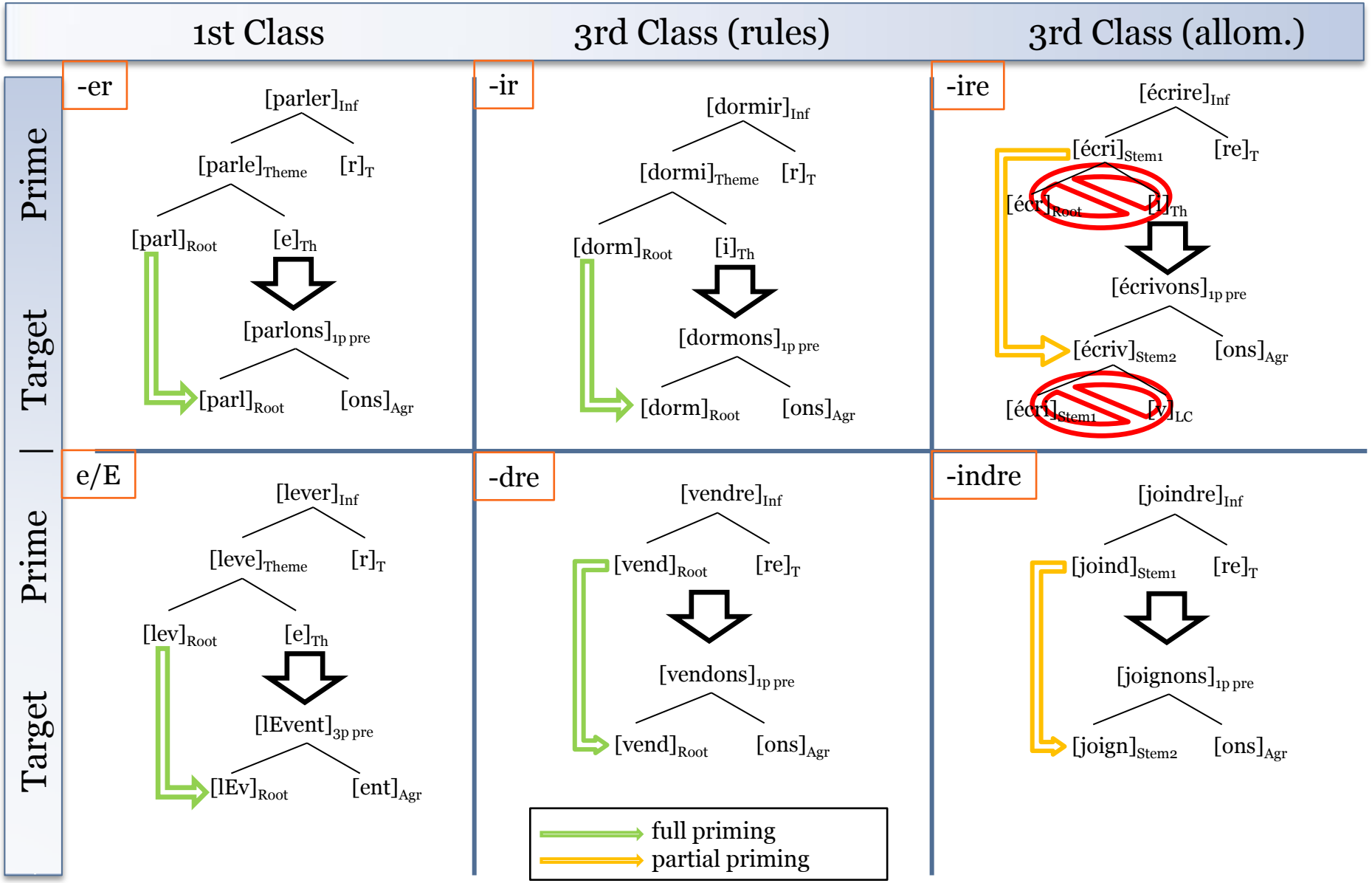


Full priming = -ER, -IR, -DRE, e/E
[-er]/[-ir]: Th representation; same morphological structure
[-dre]: no Th representation
e/E: abstract phonological representation (Marslen-Wilson, & Zhou, 1999)
Completely decomposed
Differences in mc productivity

Partial priming = -IRE, -INDRE
Different stem representations or morphological operations

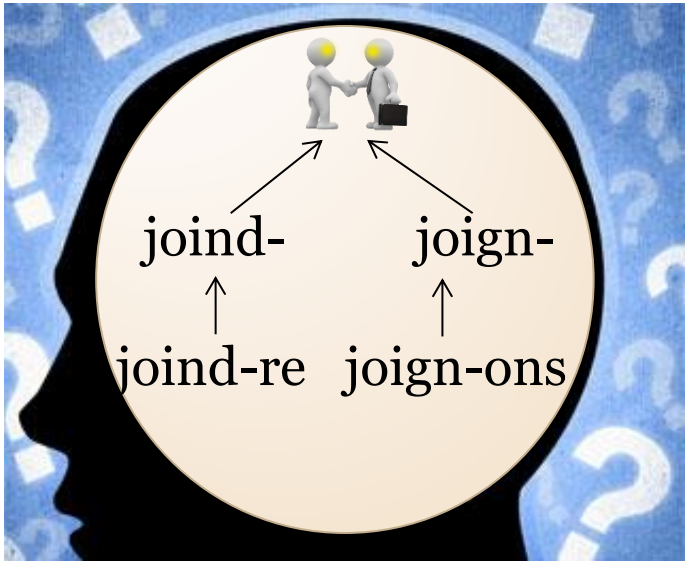
No priming = CONTROL(MP)

Study 3: Verbal Structure Representation

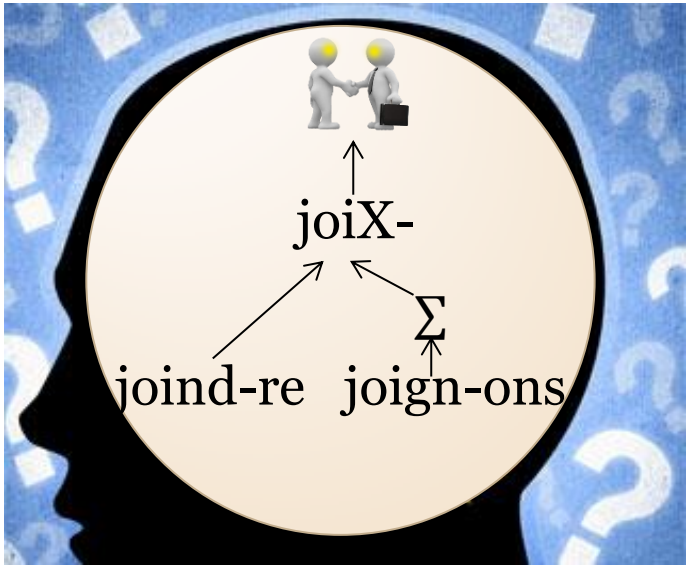


Word and Paradigm Vs. Item and Process

Paradigm



Process



French Verbs in the Mental Lexicon

Metrical Phonology
Halle, & Idsardi, 1996

e/E

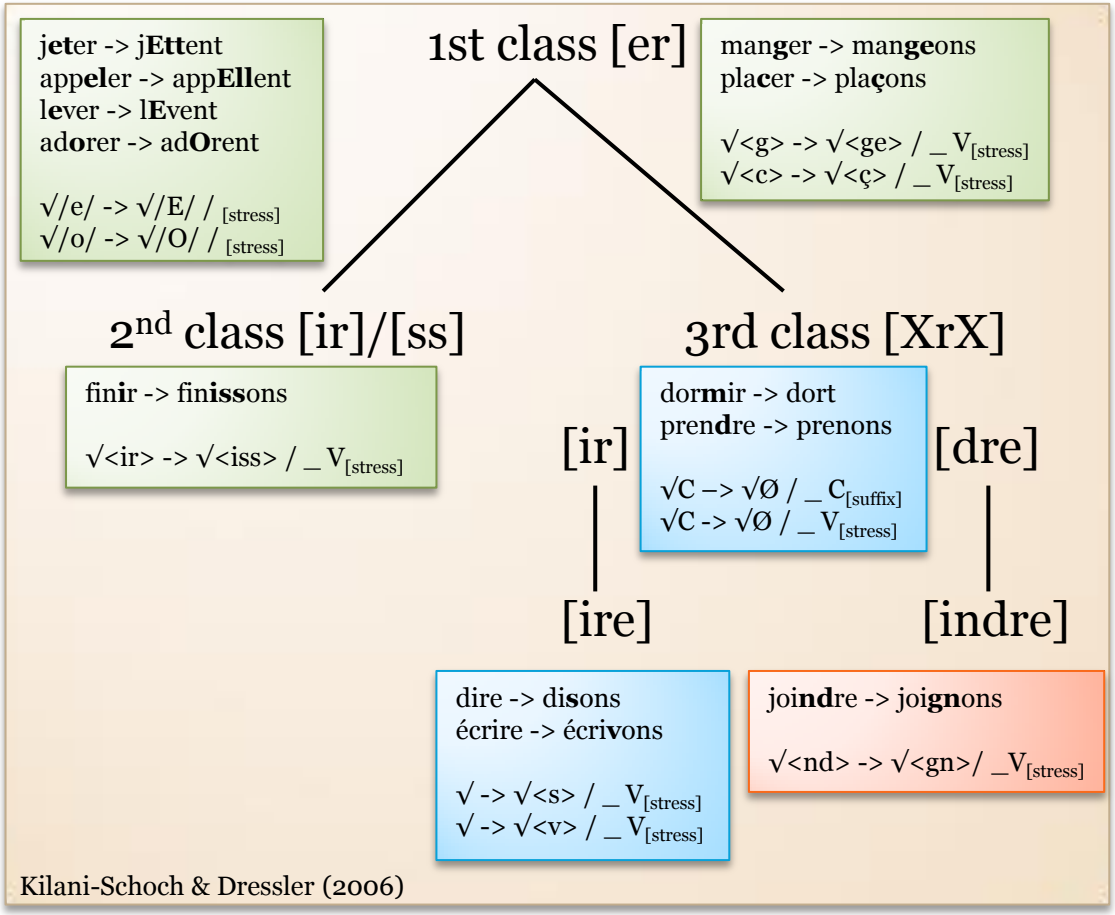
*	* *)	* *)
* *)	*) * *)	* *) * *)
relèves	relevons	relèverons

[-ire]

*	* *)
* *)	*) * *)
écris	écrivons

[-indre]

*	* *)
* *)	*) * *)
rejoins	rejoignons



Auxiliary Verbs
être, avoir, aller

Modal Verbs
pouvoir, vouloir

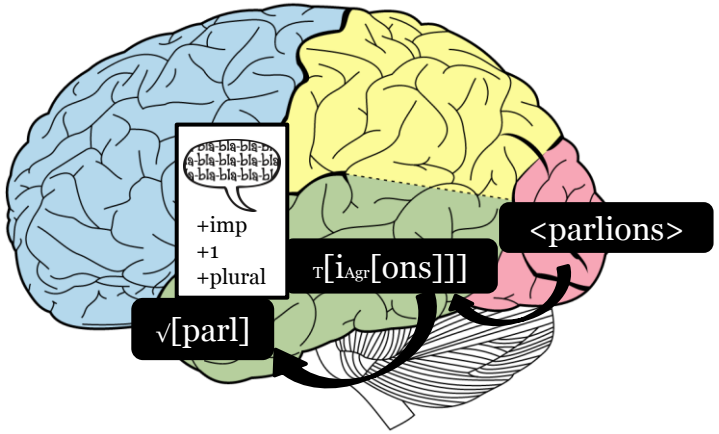
General Discussion

- French verbs are obligatory completely decomposed for morpheme processing
- All 3 verb classes are fully-combinatorial
- Unlike other Romance languages (Spanish, Catalan, Italian, and Portuguese), French has a single combinatorial mechanism
- Th representation, and consequently, root and structure representations in stem formation
- Allomorphic stem representations, or alternatively, morphological operations in stem allomorphy
- French verbs are first decomposed in stem and inflectional suffixes; and after, the stem is decomposed in root and Th, with minimal morphemic activation
- Stems are defined by allomorphy and morphophonological rules driven by suffixal morphemes, phonology, and prosody

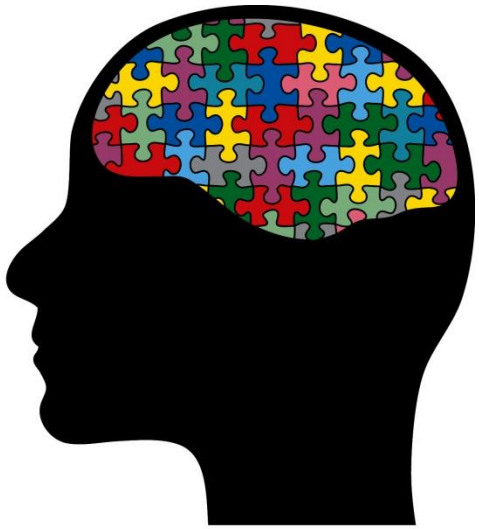
Perspectives

- Rule processing (cost)
- Suffix processing: productivity, relative entropy
- Morphological processing time-course (EEG)

"There is always a minimal computation"
(Chomsky, 1965)



Thank you for the attention!



Bibliography

- Bassani, I.D.S., and Lunguinho, M.V. (2011). Revisitando a flexão verbal do português à luz da Morfologia Distribuída: um estudo do presente, pretérito imperfeito e pretérito perfeito do indicativo. *Revista Virtual de Estudos da Linguagem - ReVEL* edição especial n. 5, 199-227.
- Baayen, R.H., Davidson, D.J., and Bates, D.M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language* 59, 390-412.
- Clahsen, H. (1999). Lexical entries and rules of language: A multidisciplinary study of German inflection. *Behavioral and Brain Sciences* 22, 991-1013.
- Domínguez, A., Cuetos, F., and Segui, J. (2000). Morphological processing in word recognition: a review with particular reference to Spanish. *Psicológica* 21, 375-401.
- Marantz, A. (2013). No escape from morphemes in morphological processing. *Language and Cognitive Processes* 28, 905-916.
- Meunier, F., and Marslen-Wilson, W. (2004). Regularity and irregularity in French verbal inflection. *Language and Cognitive Processes* 19, 561-580
- Kilani-Schoch, M., and Dressler, W.U. (2005). *Morphologie naturelle et flexion du verbe français*. Tübingen: Gunter Narr Verlag Tübingen.
- Oltra-Massuet, M.I. (1999). *On the notion of theme vowel: a new approach to Catalan verbal morphology*. Master of Science in Linguistics, Massachusetts Institute of Technology (MIT).
- Orsolini, M., and Marslen-Wilson, W. (1997). Universals in Morphological Representation: Evidence from Italian. *Language and Cognitive Processes* 12, 1-47.
- Pinker, S., and Ullman, M.T. (2002). The past and future of the past tense. *TRENDS in Cognitive Sciences* 6, 456-463.
- Stanners, R.F., Neiser, J.J., Hernon, W.P., and Hall, R. (1979). Memory representation for morphologically related words. *Journal of Verbal Learning and Verbal Behavior* 18, 399-412.
- Veríssimo, J., and Clahsen, H. (2009). Morphological priming by itself: A study of Portuguese conjugations. *Cognition* 112, 187-194.