SUFFIX COMBINABILITY AND THE ORGANIZATION OF THE MENTAL LEXICON

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- Experiment 2 was carried out in the psycholinguistic laboratory of the Adam Mickiewicz University in Poznań.

Research on affix ordering in Vienna

- The research reported herein is part of a larger research project on affix ordering carried out at the University of Vienna
- Languages analyzed so far:
  - Slavic
    - Bulgarian (South Slavic)
    - Russian (East Slavic)
    - Polish (West Slavic)
  - Germanic
    - English
  - Romance
    - Italian

Structure of the talk

- Preliminaries
  - Approaches to affix order
  - Affixation and the theory of grammar
  - Our cognitive approach
- Two psycholinguistic studies
- Discussion
- Ramifications for the theory of grammar
- Conclusions

Approaches to affix order

- Overviews in Muysken (1986), Manova & Aronoff (2010), Rice (2011), and Manova (2014)
- According to the type of information used in affix ordering Manova & Aronoff (2010) define eight different approaches:
    1) phonological
    2) morphological
    3) syntactic
    4) semantic
    5) statistical
    6) psycholinguistic
    7) cognitive
    8) templatic

Affixation and the theory of grammar

- Affixes have an unclear status
  - affixes pair form and meaning
  - affixes do not have semantics, semantics is assigned at the level of word (Realizational morphology, Construction morphology)
  - affixes provide categorical information, roots are categoriless (Distributed morphology)
- Affixation is the attachment of an affix to a morphological base (root):
  - […[[ROOT+SUFF1]+SUFF2]+…+SUFFX]
- Research on affix ordering usually analyzes combinations of affixes without bases

Affixes without bases 1

- **Semantic scope** (Rice 2000, among many others)
  - an affix with a broader scope follows an affix with a narrower scope, e.g.:

Instrument-Diminutive

  - based on scope, affixes are arranged in sequences
  - affixes that are not in a scopal relationship are ordered templaticaly, e.g., the CARP **template** in Bantu (Hyman 2003):

Causative-Applicative-Reciprocal-Passive

Affixes without bases 2

- **Complexity-Based Ordering (CBO)** (Hay 2002, 2003, Hay & Plag 2004, Plag & Baayen 2009)
  - More parsable affixes do not occur within less parsable affixes, since the attachment of a less separable affix to a more separable one is difficult to process.
  - Suffixes are ordered on a hierarchy, e.g. A, B, C, D, E, and suffixes that follow—say C on the hierarchy—can be added to words already suffixed by C, whereas suffixes preceding C on the hierarchy cannot be attached to words containing C (i.e., *CAD should be an impossible combination whereas CDE should be a well-formed combination).

CBO: Italian derivational suffixes

(Talamo 2015)

	ificare	(i)ano	tura	(z)a	(z)ione	mento	etto	ario	(t)ore	ico	ata	(V)ale	bile	evole	iere	ezza	aggio	oso	ese	one	ista	izzare	eggiare	trice	(t)orio	ità	iera	iero	ino	ume	(1)eria	(2)eria	aggine	ismo
ificare	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
(i)ano	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	0	0	1	0	1	0	1	1
tura	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1	0	0	0	0	1	1	1	1	0	0	0	1	1	1	0	0	0	1	1
(z)a	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1
(z)ione	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
mento	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1
etto	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	1	1	0	1	1	1	0	0	0	0	1	0	1	1	0	1	0	1
ario	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	1	1	1	0	0	0	1	0	0	0	0	0	0	0	1
(t)ore	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	1
ico	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	1
ata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
(V)ale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	1	1	0	0	1	0	0	0	0	1	0	0	1
bile	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	1
evole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	1
iere	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	1	0	0	1	0	0	0	0	1
ezza	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
aggio	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1
oso	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	1	1	1	0	1	1
ese	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	1	0	0	1	1	1	0	0	1
one	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	1	0	1	0	0	0	1	0	1	0	0	0	0	0
ista	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	1	0	1	0	0
izzare	0	0	1	0	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
eggiare	0	0	1	0	0	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
trice	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
(t)orio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
ità	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0
iera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
iero	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
ino	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	1	0	0
ume	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)eria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(2)eria	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
aggine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ismo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The combinability of the English suffix *-ist*

SUFF1	Lexical category of SUFF1	Followed by SUFF2
-ist	N	*-dom, -ic, -y, -ize*

Data from Aronoff & Fuhrhop (2002), based on OED, CD 1994

English -ist: Our cognitive approach

SUFF1	Lexical category of SUFF1	SUFF2
-ist	N	N: *-dom* (2) ADJ: *-ic* (631), *-y* (5) V: *-ize* (3)

Table from Manova (2011)
Data from Aronoff & Fuhrhop (2002), based on OED, CD 1994

Nouns, adjectives and verbs are seen as cognitive categories, cf. Langacker (1987).

-ist: Fixed combinations

SUFF1	Syntactic category of SUFF1	SUFF2
-ist	N	N: *-dom* (2) ADJ: *-ic* (631), *-y* (5) V: *-ize* (3)

Table from Manova (2011)
Data from Aronoff & Fuhrhop (2002)

-ist: Predictable combinations

SUFF1	Syntactic category of SUFF1	SUFF2
-ist	N	N: *-dom* (2) ADJ: ***-ic* (631)**, *-y* (5) V: *-ize* (3)

Table from Manova (2011)
Data from Aronoff & Fuhrhop (2002)

Predictable combinations: the role of semantics

N [+abstract] vs N [–abstract] (Italian, based on *La Repubblica* corpus)

SUFF1	SUFF1 lexical category & semantics	SUFF2	Examples
-izzare	V caus	N: *-mento* (4), *-zione* (>1000), *-tore* (>150) ADJ: *-bile* (>100), *-torio* (10)	*volgarizzamento* 'popularization' *americanizzazione* 'americanization' *potabilizzatore* 'water purifier' *utilizzabile* 'usable' *privatizzatorio* 'privatizatory '

Data from Manova & Talamo (2015)

Hypotheses

- **H1**: If SUFF1 tends to combine with only one SUFF2 of a major lexical category (N, ADJ, V), SUFF1-SUFF2 combinations are unique pieces of structure and speakers should know them by heart.

- **H2**: If speakers know suffix combinations by heart, existing combinations should be recognised with higher accuracy and faster than non-existing ones.

- **H3:** Fixed and predictable suffix combinations should be processed differently.

Two psycholinguistic experiments

- visual recognition of existing and non-existing suffix combinations
- similar to the lexical decision task but involve only suffix combinations and no words

Derivational morphology in psycholinguistic research

- Overviews in Diependale et al.(2012), Baayen (2015) and Lieben (2015)
  - lexical decision task, reading comprehension, i.e. visual recognition
  - to understand morphological segmentation usually **bases (words** or **stems,** e.g. DARK for DARKNESS and CORN for CORNER**)** are used as **primes for word recognition**
- Recently, growing interest in the priming effect of affixes
  - Crepaldi et al. (2015): prime nonwords facilitate lexical decisions to target words ending with the same suffix
  - Lázaro et al. (2015)**:** a suffix as a prime facilitates the recognition of words ending with that suffix
  - **Both studies conclude that the priming effect of suffixes is not orthographic but morphological, i.e. the effect was not found for simplex words as targets.**

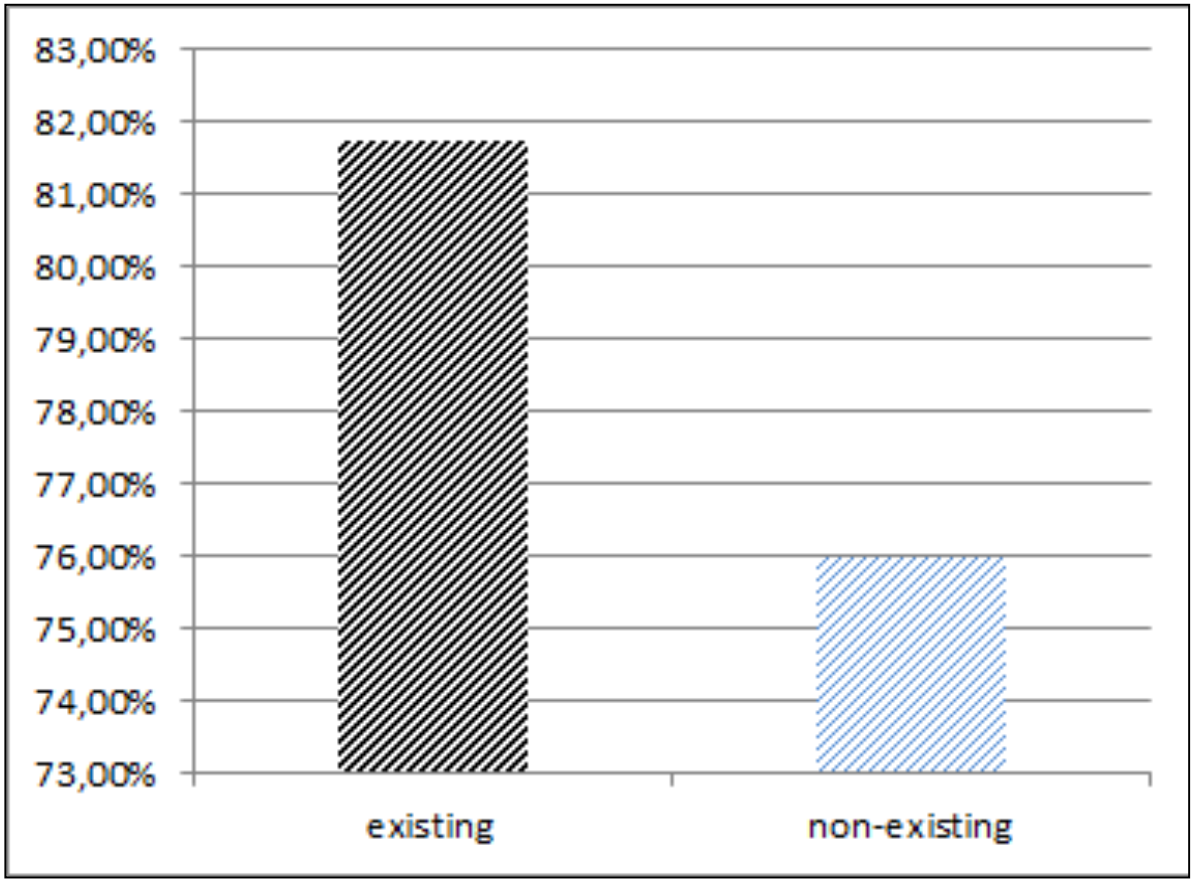
Experiment 1

- **Participants**: 64 native speakers of Polish
  - age: M=23.2, SD=1.76
  - no history of developmental dyslexia or reading disabilities
  - non-linguists
- **Materials**: 60 items
  - 30 existing suffix combinations from Polish, e.g.:
    - *-ar-nia* as in *kawi-**ar-nia*** '*café*'
  - 30 non-existing suffix combinations created by changing the order of the suffixes of the legal ones or by manipulating phonemes, e.g.:
    - from the existing ***-ar-nia*** → ***-ni-ar*** *or* ***-ur-nia***.
  - 2 lists
    - each with the suffixes of the other in reverse order
    - each participant saw all combinations

Experiment 1: Procedure

- **Task**: decide as quickly and as accurately as possible if a combination exists or not
- **Training**: a few examples of derivations of existing and non-existing words with two suffixes in Polish to ensure that the participant understands the task
- **List of items**: participants received a list of existing and non-existing suffix combinations and have to complete the task
- **Maximum time for decision**: 10 minutes

Experiment 1: Accuracy of recognition of existing and non-existing combinations



Acc for existing:
M=81.72%, SD=0.29

Acc. for non-existing:
M=75.99%, SD=0.22

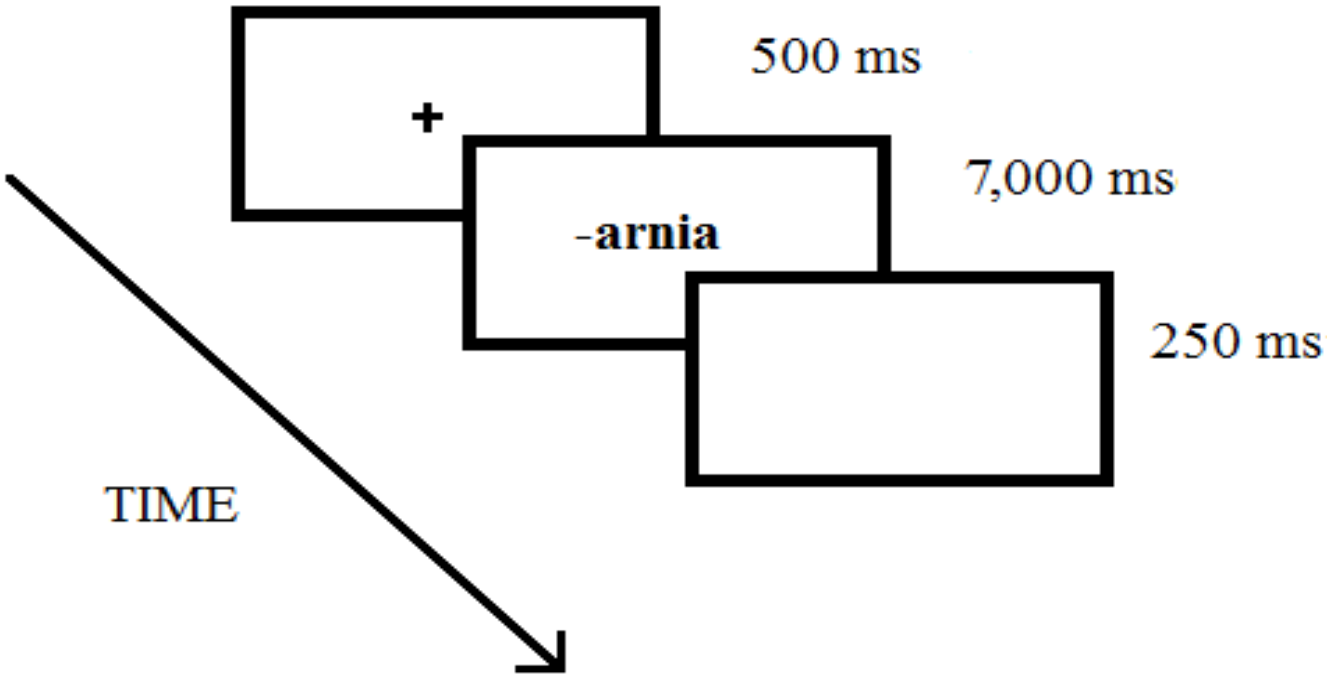
The result is statistically significant:

t(63)=2.34, p=0.02

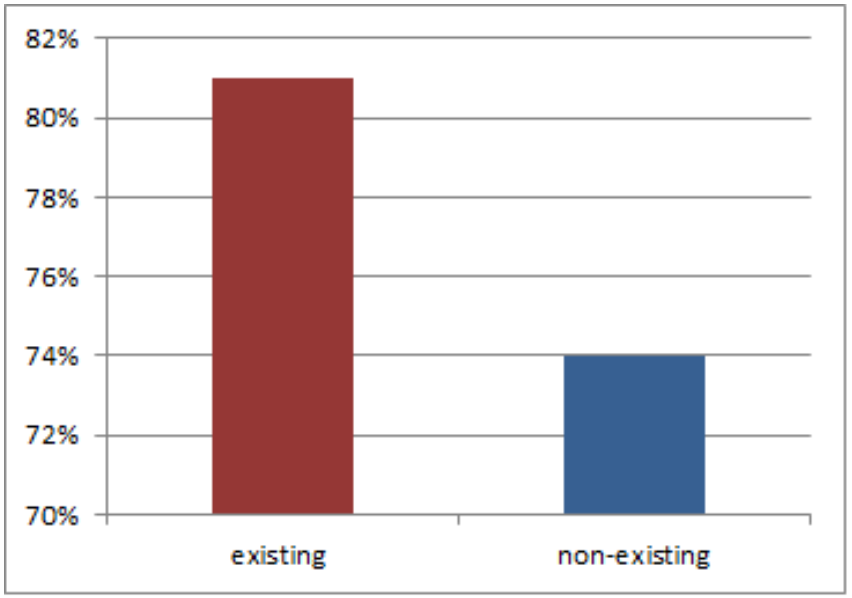
Experiment 2

- **Participants**: 53 native speakers of Polish
  - age: M=21.43, SD=1.83
  - no history of developmental dyslexia or reading disabilities
  - non-linguists
- **Task**: Press the right arrow button if a string of letters is an existing combination or the left CTRL button if it is not. In case of a doubt, behave as if a stimulus does not exist.
- **Materials**: 88 items, randomized with the E-prime 2.0 software
  - 44 existing and 44 non-existing suffix combinations
  - non-existing combinations produced as in Experiment 1
  - 2 lists
    - each with the suffixes of the other in reverse order
    - each participant saw all combinations

Experiment 2: Procedure



Experiment 2: Accuracy



Existing combinations:

M_{ACC}= 81%, SD=.09

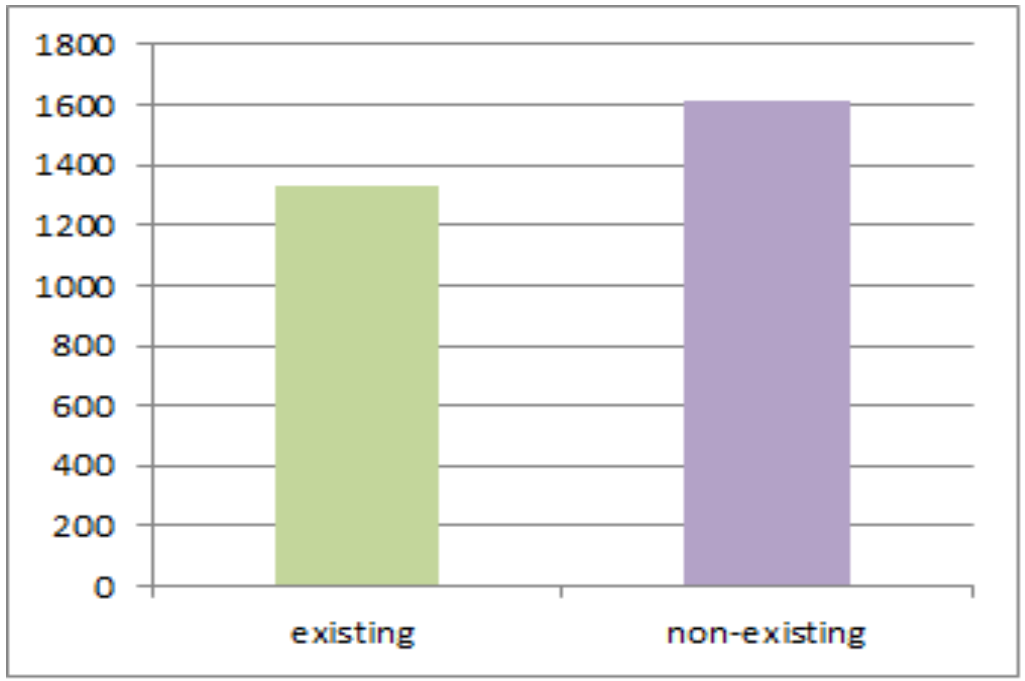
Non-existing combinations:

M_{ACC}= 74%, SD=.12

The result is statistically significant:

t(52)=3.03, p=0.004

Experiment 2: RTs



Existing combinations:

1333 ms

M_{RT}=1333.14, SD=420.57

Non-existing combinations:

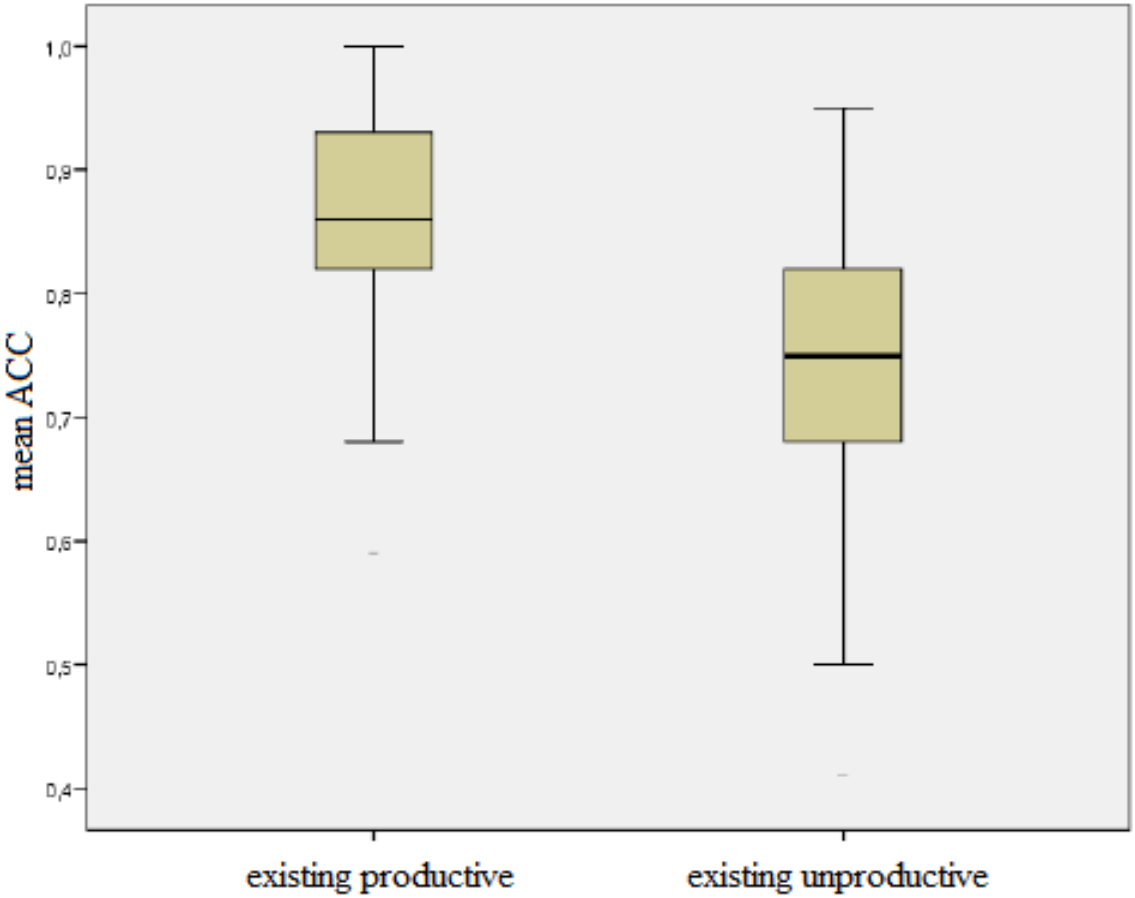
1610 ms

M_{RT}=1610.38, SD=556.02

The difference is statistically significant:

$t(51)=-7.53$, $p<0.001$

Experiment 2: Mean accuracy of the productive combinations



Productive combinations:

M_{ACC}= 86%, SD=.09

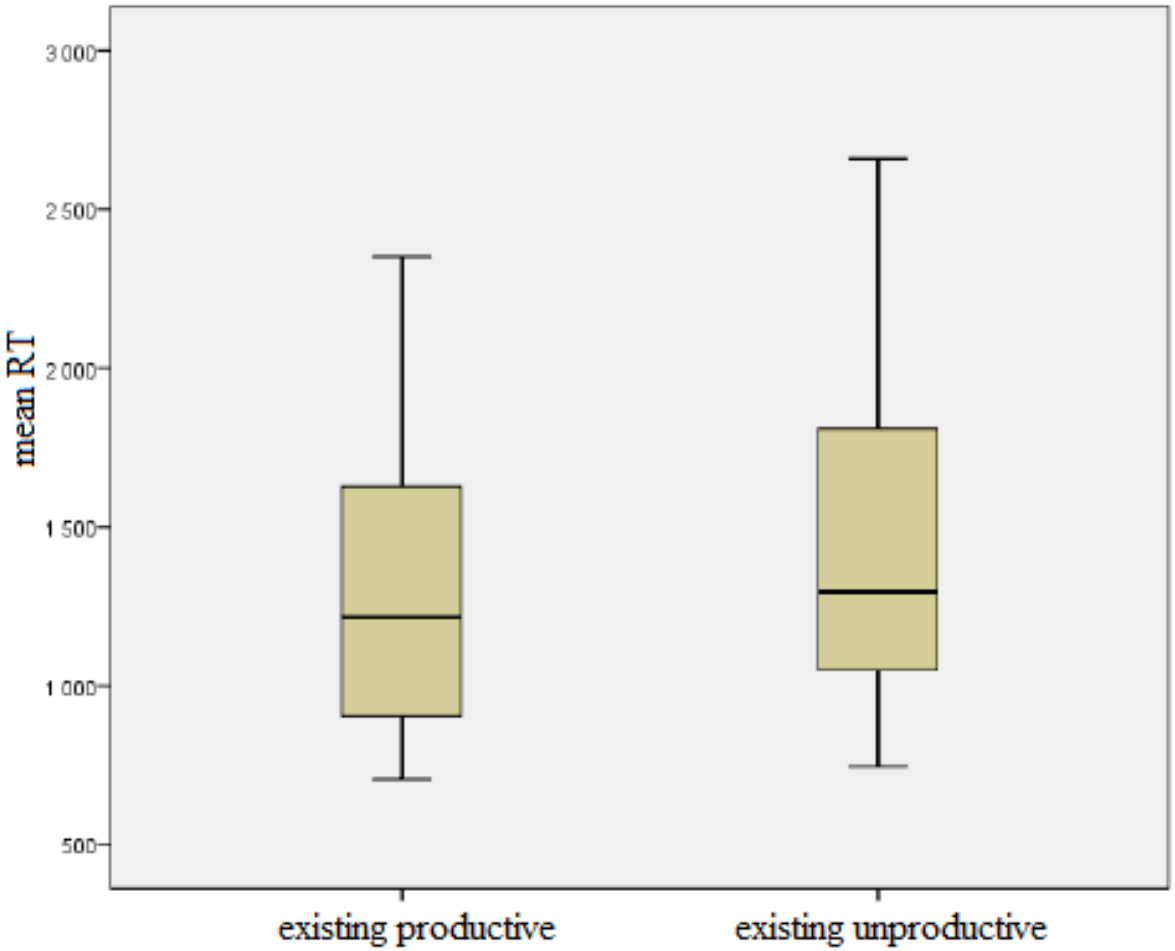
Unproductive combinations:

M_{ACC}= 75%, SD=.11

The difference is statistically significant:

***t*(51)=7.81, *p*<0.001**

Experiment 2: Mean RTs of the productive combinations



Productive combinations:

M_{RT}=1288.44, SD=429.14

Unproductive combinations:

M_{RT}=1421.01, SD=488.41

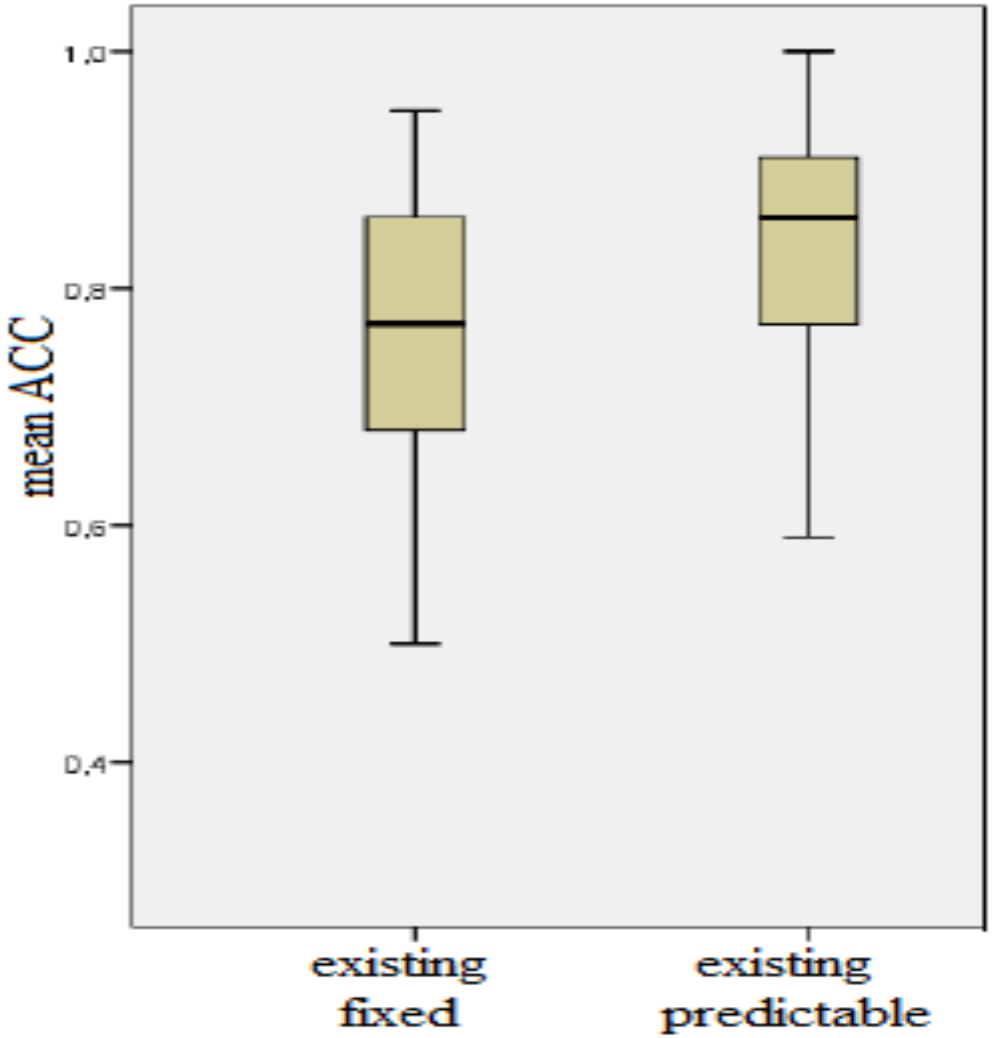
The difference is statistically significant:

***t*(51)=-4.08, *p*<0.001**

Summing up & Discussion

- The results of the two experiments converge:
  - The accuracy of recognition of the existing combinations is significantly higher than the accuracy of recognition of the non-existing combinations.
  - The reaction times to the existing combinations are significantly shorter than to the non-existing ones.
  - Thus, recognition of suffix combinations seems to resemble recognition of words and non-words in psycholingustics, cf. word superiority effect.
  - The productive combinations are recognized more accurately and faster than the unproductive combinations.

Fixed and predictable combinations: Accuracy



A two-way ANOVA:

***F*(2,101)=16.744; *p*<0.001**

Fixed combinations:

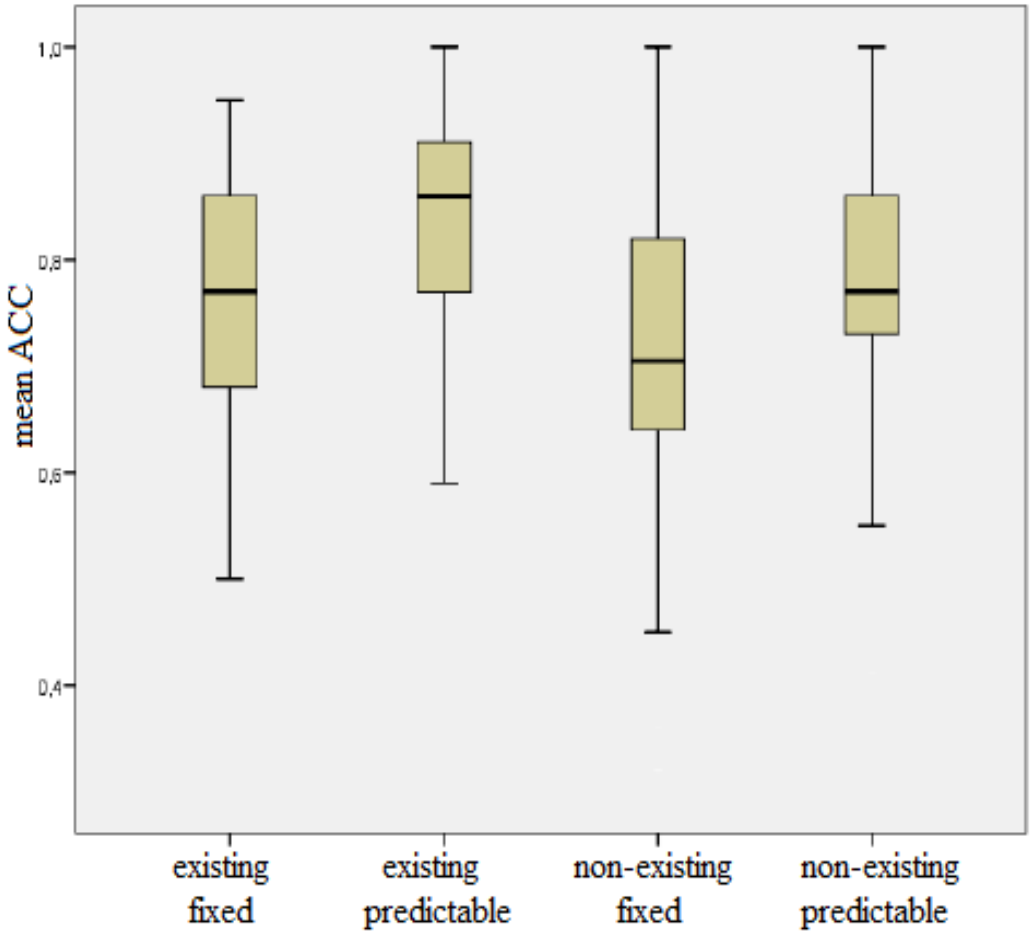
M_{ACC}= 76%, SD=.10

Predictable combinations:

M_{ACC}= 85%, SD=.10

The difference is statistically significant: ***p*<.001**

Fixed and predictable combinations vs. non-existing combinations derived from legal fixed and predictable combinations: Accuracy



A two-way ANOVA:

***F*(2,101)=16.744; *p*<0.001**

Non-existing (combinations derived from legal) **fixed** combinations:

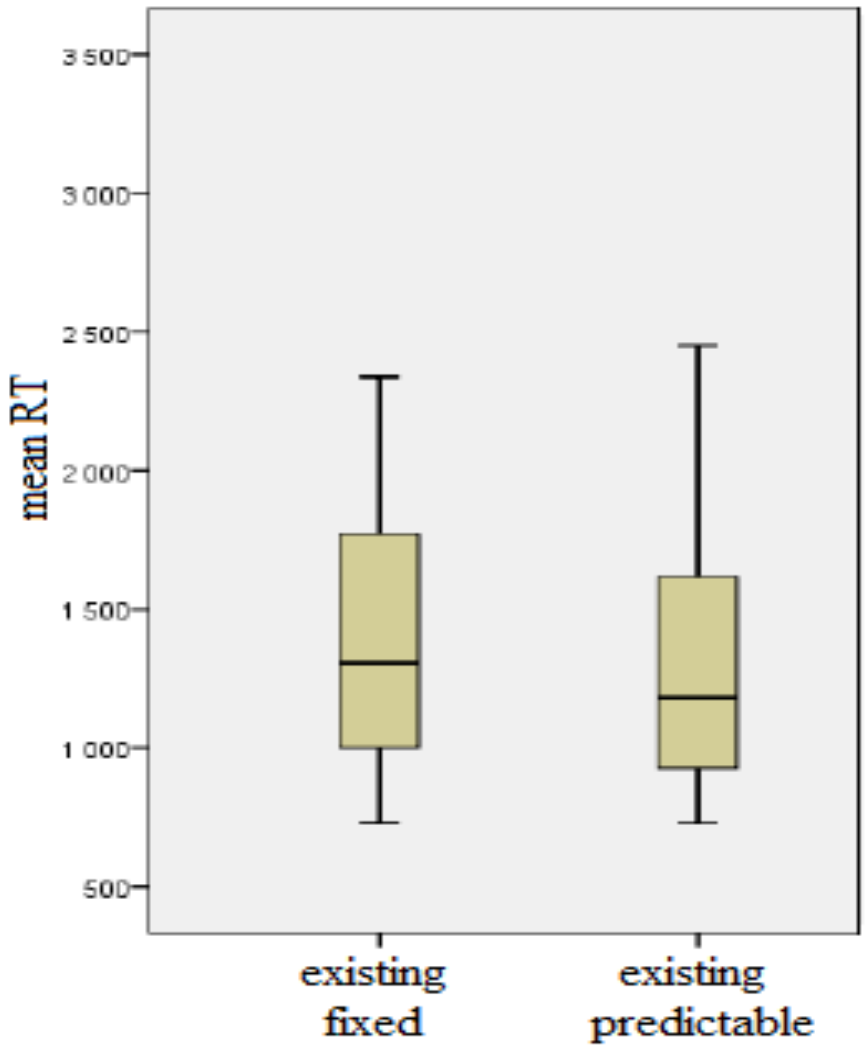
M_{ACC}= 69%, SD=.15

Non-exiting (combinations derived from legal) **predictable** combinations:

M_{ACC}= 79%, SD=.15

The difference is statistically significant: ***p*<.001**

Fixed and predictable combinations: RTs



A two-way ANOVA:

***F*(2,92)=38.148; *p*<0.001**

Fixed combinations:

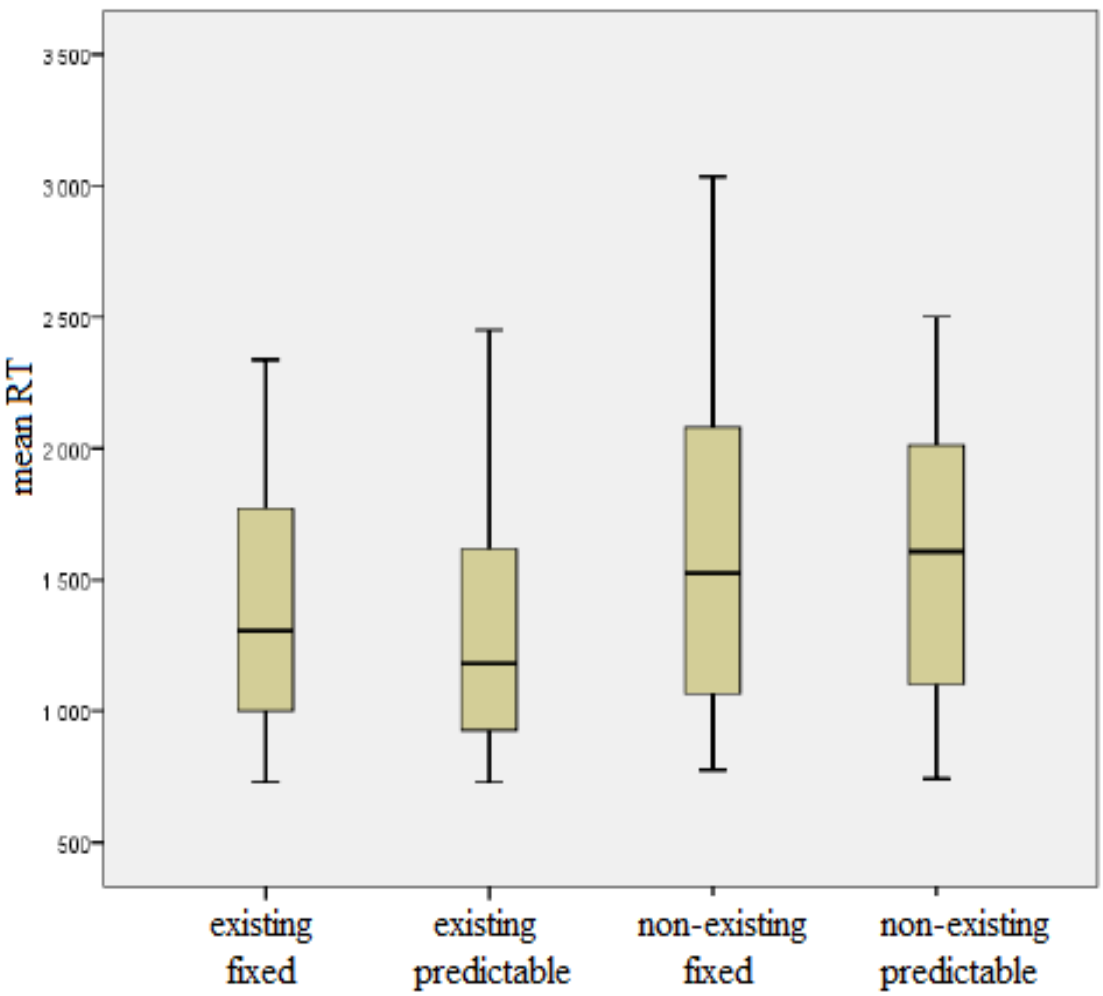
M_{RT}=1370.29, SD=432.41

Predictable combinations:

M_{RT}=1295.98; SD=425.48

The difference is statistically significant: ***p*<.001**

Fixed and predictable combinations vs. non-existing combinations derived from legal fixed and predictable combinations: RTs



A two-way ANOVA:

***F*(2,92)=38.148, *p*<0.001**

Non-existing (combinations derived from legal) **fixed** combinations:

M_{RT}=1652.98, SD=631.87

Non-existing (combinations derived from legal) **predictable** combinations:

M_{RT}=1567.79, SD=497.09

The difference is **not** statistically significant: ***p*>.05**

Fixed vs. predictable combinations: Summing up

- Predictable combinations are recognized more accurately and induce shorter RTs than fixed combinations
- Fixed and predictable (i.e., all existing) combinations seem rote-learned

Fixed and predictable combinations are semantically motivated 1

Combinability of SUFF1 for objects

1	-ina	N	ADJ: -owy N: -arnia (1) (place), -arz (1) (person) N: -ówka (1) (object)	wykładz-in-owy okle-ini-arnia okle-ini-arz okle-in-ówka	flooring- veneer workshop veneer producing worker veneer cutter
2	-nik	N	ADJ: -owy N: -ka (object) N: -arz (person)	grzej-nik-owy zapal-nicz-ka dzien-nik-arz	heater- lighter journalist
3	-idło, -ydło, -adło	N	ADJ: -any (3), -isty (1), -owy (default), -asty (1) N: -arz (person), -arnia (1) (place), -nica (1) (object)	krop-idl-any zwierci-adl-isty wah-adł-owy my-dl-asty abec-adl-arz my-dl-arnia my-del-nica	aspergillum- mirror- pendular soapy stupid teacher soap shop soap dish
4	-nia	N	ADJ: -owy	przekład-ni-owy	gear-
5	-Vnie	N	ADJ:-ny (4) , -owy (default)	sklepi-en-ny mieszk-ani-owy	vault- housing-
6	-ak	N	ADJ: -owy	leż-ak-owy	deckchair-

Fixed and predictable combinations are semantically motivated 2

Combinability of SUFF1 for objects (productive combinations)

1	-ina	N	**ADJ: -owy**	wykładz-in-owy	flooring-
2	-nik	N	**ADJ: -owy** N: -ka (object) N: -arz (person)	grzej-nik-owy zapal-nicz-ka dzien-nik-arz	heater- lighter journalist
3	-idło, -ydło	N	**ADJ: -owy** N: -arz (person)	wah-adł-owy abec-adl-arz	pendular stupid teacher
4	-nia	N	**ADJ: -owy**	przekład-ni-owy	gear-
5	-Vnie	N	**ADJ:- -owy**	mieszk-ani-owy	housing-
6	-ak	N	**ADJ: -owy**	leż-ak-owy	deckchair-

Summing up

- Our research shows that suffix combinations are:
  - fixed and predictable
  - rote-learned
  - semantically motivated (a limited number of semantic categories derives all suffix combinations in a language)
  - often derive up to 10 types
  - exist without bases

Ramifications for grammatical theory

- Derivation of words does not take place affix by affix starting from the root.
- The mental lexicon does not store only morphemes, words, constructions, schemas, rules and idiosyncrasies (depending on the theory), but also combinations of affixes.
- Suffixes have semantics but when parts of larger structures such as suffix combinations (or words, cf. Baayen 2015: 105) they may be accessed without reference to their semantics (cf. Realizational morphology and Construction morphology that treat affixes as having no semantics).
- Morphological structures such as affix combinations are between morpheme and word and constitute a level of their own parallel to that of phrases in syntax.

Conclusions

- Pieces of form such as [affix + affix] exist as autonomous structures in the mental lexicon.
- Any combination of (two) morphemes, regardless where

  $[\text{ROOT} + \text{THEME}]_{\text{STEM}}$ (cf. morphome, Aronoff 1994) or

  [AFFIX + AFFIX], which, for some reason, has become autonomous in a language, is a morphological phrase (cf. syntactic phrases).
- Morphological phrases are morphological constructions and have to be integrated in constructionist frameworks.
- Morphological phrases prove the existence of purely morphological structure different from the structures in phonology and syntax.

Thank you!

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