SUFFIX COMBINABILITY AND THE ORGANIZATION OF THE MENTAL LEXICON

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Acknowledgements

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- Experiment 2 was carried out in the psycholinguistic laboratory of the Adam Mickiewicz University in Poznań.
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 templatically, e.g., the CARP template in Bantu (Hyman 2003):
    - **Causative-Applicative-Reciprocal-Passive**
Affixes without bases 2

  - 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)*

<table>
<thead>
<tr>
<th>ificare</th>
<th>iano</th>
<th>tura</th>
<th>(z)a</th>
<th>(z)ione</th>
<th>mento</th>
<th>etto</th>
<th>ario</th>
<th>(t)ore</th>
<th>ico</th>
<th>ata</th>
<th>(V)ale</th>
<th>bile</th>
<th>evole</th>
<th>iere</th>
<th>ezza</th>
<th>aggio</th>
<th>oso</th>
<th>ese</th>
<th>one</th>
<th>ista</th>
<th>izzare</th>
<th>eggiare</th>
<th>trice</th>
<th>(t)orio</th>
<th>ita</th>
<th>iera</th>
<th>iero</th>
<th>ino</th>
<th>ume</th>
<th>(1)eria</th>
<th>(2)eria</th>
<th>aggine</th>
<th>ismo</th>
</tr>
</thead>
</table>
The combinability of the English suffix *-ist*

<table>
<thead>
<tr>
<th>SUFF1</th>
<th>Lexical category of SUFF1</th>
<th>Followed by SUFF2</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>-ist</em></td>
<td>N</td>
<td><em>-dom, -ic, -y, -ize</em></td>
</tr>
</tbody>
</table>

Data from Aronoff & Fuhrhop (2002), based on OED, CD 1994
English -ist: Our cognitive approach

<table>
<thead>
<tr>
<th>SUFF1</th>
<th>Lexical category of SUFF1</th>
<th>SUFF2</th>
</tr>
</thead>
<tbody>
<tr>
<td>-ist</td>
<td>N</td>
<td>N: -dom (2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ADJ: -ic (631), -y (5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V: -ize (3)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>SUFF1</th>
<th>Syntactic category of SUFF1</th>
<th>SUFF2</th>
</tr>
</thead>
</table>
| -ist  | N              | N: -dom (2)  
ADJ: -ic (631), -y (5)  
V: -ize (3) |
-ist: Predictable combinations

<table>
<thead>
<tr>
<th>SUFF1</th>
<th>Syntactic category of SUFF1</th>
<th>SUFF2</th>
</tr>
</thead>
<tbody>
<tr>
<td>-ist</td>
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<td>N: -dom (2)</td>
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<td></td>
<td></td>
<td>V: -ize (3)</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>SUFF1</th>
<th>SUFF1 lexical category &amp; semantics</th>
<th>SUFF2</th>
<th>Examples</th>
</tr>
</thead>
</table>
| -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

- Time
- +
- arnia
- 500 ms
- 7,000 ms
- 250 ms
Experiment 2: Accuracy

Existing combinations:
\[ M_{\text{ACC}} = 81\%, \ SD=0.09 \]

Non-existing combinations:
\[ M_{\text{ACC}} = 74\%, \ SD=0.12 \]

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 psycholinguistics, 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:
\[ M_{\text{ACC}} = 76\%, \ SD = .10 \]

**Predictable** combinations:
\[ M_{\text{ACC}} = 85\%, \ SD = .10 \]

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:

\[ M_{\text{ACC}} = 69\%, \ SD=.15 \]

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

\[ M_{\text{ACC}} = 79\%, \ SD=.15 \]

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:
\[ M_{\text{RT}}=1370.29, \ SD=432.41 \]

**Predictable** combinations:
\[ M_{\text{RT}}=1295.98; \ SD=425.48 \]

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

### Combinability of SUFF1 for objects

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</thead>
</table>
| 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-adl-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) | sklep-ien-ny  
mieszkan-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)**

<p>| | | | | | |</p>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-ina</td>
<td>N</td>
<td>ADJ: -owy</td>
<td>wykładz-in-owy</td>
<td>flooring-</td>
</tr>
<tr>
<td>2</td>
<td>-nik</td>
<td>N</td>
<td>ADJ: -owy</td>
<td>grzej-nik-owy</td>
<td>heater-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N: -ka (object)</td>
<td>zapal-nicz-ka</td>
<td>lighter</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N: -arz (person)</td>
<td>dzien-nik-arz</td>
<td>journalist</td>
</tr>
<tr>
<td>3</td>
<td>-idło, -ydło</td>
<td>N</td>
<td>ADJ: -owy</td>
<td>wah-adł-owy</td>
<td>pendular</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N: -arz (person)</td>
<td>abec-adl-arz</td>
<td>stupid teacher</td>
</tr>
<tr>
<td>4</td>
<td>-nia</td>
<td>N</td>
<td>ADJ: -owy</td>
<td>przekład-ni-owy</td>
<td>gear-</td>
</tr>
<tr>
<td>5</td>
<td>-wie</td>
<td>N</td>
<td>ADJ:- -owy</td>
<td>mieszk-ani-owy</td>
<td>housing-</td>
</tr>
<tr>
<td>6</td>
<td>-ak</td>
<td>N</td>
<td>ADJ: -owy</td>
<td>leż-ak-owy</td>
<td>deckchair-</td>
</tr>
</tbody>
</table>
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 [ROOT + THEME]_{STEM} (cf. morpheme, 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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