Compounds and Aphasia: Recent Developments in Theoretical and Experimental Neurolinguistics

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Overview

- Introduction: Characteristics of compounds

- Compound storage in the mental lexicon: models

- Morphological knowledge impairment

- Processing of derived words

- Discussion with future remarks

Introduction: Compounds

- Combining two lexical items in order to describe a new item or a notion

- Better insight into the architecture of the mind and neurological patterns drove the need for more extensive research in the last two decades

- The most productive morphological processes of complex word formation: compound and derivational processes

Introduction: Characteristics of Compounds

- Latest developments overviewed include different compound structures in various languages

- Depending on the structure type languages exploit:

    (i) stem - stem and stem - word structures (Greek)

    (ii) word - based compound (English)

    (iii) fixed structure (German & Dutch)

    (v) flexible head constituent position and rich structural composition, includes also prepositional (Italian)

Introduction: Characteristics of Compounds

- Following diversity in structure, three major categories are combined to form compounds:

    - Nouns (N)

    - Verbs (V)

    - Adjectives (Adj) in coordinate, subordinate, and attributive relation

- The composition may differ across languages in respect to whether compounding requires a marker, hyphenation or function words (e.g. prepositions) between compound constituents

Introduction: Characteristics of Compounds

- Constituents behaves as the head constituent - endocentric compounds (e.g., light in moonlight), or modifier constituent - exocentric compounds (e.g., moon in moonlight) [Marelli et al. 2014]

- Logical and grammatical head: Relation between the head and the meaning of a compound

- Grammatical head gives grammatical category of the compound and is the locus of inflection (determines the syntax)

- The logical head is determined by the logical relation between the two terms of the compound

- When the grammatical head corresponds to the logical head - **endocentricity**

- When the grammatical head does not correspond to the logical head - **exocentricity**

Introduction: Characteristics of Compounds

- Various types of knowledge are involved in the creation of a compound

- Examining various types of knowledge by compound inducing experiments, investigation leads to preliminary postulations:

  1. the way how compounds are stored in the mental lexicon

  2. how they are processed in production and comprehension

Introduction: Characteristics of Compounds

- Evidence is looked for in the error patterns in patients with developed language impairments, including aphasic conditions and neurodegenerative diseases

- Error patterns of people with language impairments compared to typical population gives insight into the representation of complex words in the mental lexicon and concerns how they are processed

Qs:

- How are compounds stored in the mental lexicon?

- How is morphological knowledge impaired?

- How are derived words processed?

Qs:

- **How are compounds stored in the mental lexicon?**
- How is morphological knowledge impaired?
- How are derived words processed?

How are compounds stored in the mental lexicon?

- Three dominant models:

  - full listing

  - decomposition/ full parsing

  - dual route

- Full listing account: complex words are stored as whole words and accessed as such

- Promotes storage economy, but no difference between simple and complex words

Recent Developments: compound effect

- The strongest evidence for difference of compound to simple word storage is the compound effect (Semenza & Mondini 2010)

- Structural and rule knowledge evident in error patterns and independent of phonological form

- Mondini et al. (2003) tested aphasic comparing to typical population on naming simple nouns and verbs followed by compound nouns in the picture naming tasks

- The experiment confirmed earlier prediction in differentiating simple lexical items from compounds, showing close to perfect results in naming simple words, and grouping error patterns in compound production, on the other side

- Errors types such as substitution and omission of compound constituents support compositional approach in word retrieval, that will be given more attention in the later sections

Recent Developments
Lorenz et al. (2014) & Marelli et al. (2014)

- Dual route account: activating both, holistic and decompositional methods, depending on semantic transparency and lexical frequency of the head constituent

- Recognition and production experiments of different modalities: visual and auditory:

  - naming to definition tasks

  - lexical decision tasks

  - picture naming tasks

  - priming tasks

Recent Developments:
Lorenz et al. (2014) & Marelli et al. (2014)

- Headedness effect - the main predictor to determine mental representation of compounds (which possibly affect nominal compound naming)

- Followed by various factors affecting processing:

  - semantic transparency

  - frequency effect of morphological elements

Recent Developments:
Lorenz et al. (2014) & Marelli et al. (2014)

- In addition to omissions and substitutions, errors such as misordering, paraphasias, neologisms and circumlocutions gave strong evidence for the mental representation of compounds that supports two stage lexical access (Levelt et al. 1999):

  (i) semantic – conceptual level, followed by lemma level, where grammatical properties of morphologically complex word are accessed

  (ii) and phonological level

Recent Developments:
Lorenz et al. (2014) & Marelli et al. (2014)

- Constituent errors: omission, substitution, phonological distortion

- Tasks: Compound picture naming task & naming to definition task

- Neologisms and circumlocutions of one of constituents → the origin of errors leads to existence of semantic level

- Failure to retrieve the exact phonological form → existence of phonological level of representation

- In sum, lexical processor identifies at some point the morphological structure of compounds

- In support to this claim, subjects didn't produce substitution errors when targets were single words (Lorenz et al. 2014, Marelli et al. 2014, Mondini et al. 2003)

Recent Developments:
Headedness effect (Marelli et al. 2014)

- Supports the dual route approach:

    head – final compounds undergo compositional operation and are hierarchically positioned structures

    head – initial compounds are accessed similarly to lexicalized categories

- head – final compounds are more frequent than head – initial ones, therefore the default structure (Williams 1981), they used the Italian language where both types observed to assess lexical processing in aphasic population

- Picture naming tasks: derived and compound nouns as complex targets

- Prediction supported with the following results: patients showed greater impairment in retrieving the modifier than the head constituent when naming head – final compounds (more complex structure and caused constituent retrieval more difficult even for less impaired patients)

Recent Developments:
Headedness effect (Marelli et al. 2014)

- Omission of the first constituent more frequent with head – initial compounds

- Substitution of the first constituent more frequent with head – final compounds

- Anomia errors: greater effect on the retrieval of modifiers than of head constituents → the headedness effect confirmed as being the most salient and meaningful element of compounds

- Modifiers harder to access, posing greater impact on cognitive resources among the population with naming impairments

Recent Developments:
Headedness effect (Marelli et al. 2014)

- Right headedness rule supported:

    In head – final compounds the head is easier to access than the modifier

    In head – initial compounds both constituents were similarly easy to access

- Majority of omissions of first constituents in head – initial compounds

- Prediction that for head – final compounds retrieval subjects were less accurate, as they undergo compositional process, also confirmed

Recent Developments:
Headedness effect (Marelli et al. 2014)

- It was confirmed that the head is represented in central processing levels (the most salient element of compounds), expected as head – final and being lexicalized as head – initial (single lexical entry)

- The research posited firm grounds in cross – linguistic research on headedness effect in compound retrieval & further research on compounding from different aspects

Recent Developments:
Semantic transparency (Lorenz et al. 2014)

- Unlike grammatical class, defined at lemma level, semantic transparency and opacity categories are taken to be represented and processed differently, as indicated by the transparency effect with constituent errors

- More constituent errors in transparent compounds than opaque ones could suggest that compositional access of transparent compounds would include activation of all neighbouring concepts (parallel activation of semantically related concepts at conceptual level), while opaque access include full form access

- On the other side, more semantic errors were present with less semantic transparency

Recent Developments:
Semantic transparency (Lorenz et al. 2014)

- Such results fit nicely within the account given by Libben (1998): connection between full form and constituent elements at semantic level only in the case of transparent compounds, but not the opaque compounds

- Within the groups of NV and NN compounds, it was expected for agrammatic aphasic conditions to display difficulties with verbs more than with nouns – confirmed

- However, no positional effect was observed

Qs:

- How are compounds stored in the mental lexicon?

- **How is morphological knowledge impaired?**

- How are derived words processed?

How is morphological knowledge impaired?

- Focus from compound production not only in aphasic conditions caused by brain lesions, but also in neurodegenerative diseases, namely Alcheimer's disease (Semenza et al. 2007)
- Error patterns in compound naming different in AD than aphasic
- Distinction attributed to the lack of morphological knowledge in AD population
- Compound substitutions with simple words - no "compound effect"
- Alzheimer's Type: memory limitations and failure in semantics prevail over deficits on syntax

How is morphological knowledge impaired?
Kordouli et al. (2018)

- Investigating compound processing in cases of agrammatism in stroke induced and primary progressive aphasia (PPA): Kordouli et al. 2018

- Presence of grammatical, morphological, and semantic knowledge in stroke-induced agrammatism and agrammatism induced by PPA (Greek)

How is morphological knowledge impaired?
Kordouli et al. (2018)

- PPA - impaired linguistic knowledge (caused by neurological deterioration) to be distinguished between:

    (i) agrammatic

    (ii) semantic

    (iii) logopenic

How is morphological knowledge impaired?
Kordouli et al. (2018)

- Agrammatism (PPA-G) is characterized by impaired morphological knowledge, hence non fluent speech and syntactic impairment in production and comprehension

- Semantic (PPA-S) form is characterized by fluent speech but lacks in semantic knowledge and object naming (anomia)

- Logopenic (PPA-L) exhibits phonological knowledge impairment, such as word retrieval and as such includes circumlocutions and phonemic paraphasias

How is morphological knowledge impaired?
Kordouli et al. (2018)

- Morphological impairments related to inflection and derivation in aphasic agrammatism (stroke induced and PPA) reflected mainly in verbal inflection in production

- Ability to detect morphological violations in comprehension of derived N, V, and Adj forms is severely impacted in PPA, but relatively preserved in stroke induced agrammatism

- Total decomposition and dual route approach are supported by the errors concerning compound constituents, and not only whole compounds, in word retrieval

How is morphological knowledge impaired?
Kordouli et al. (2018)

- Constituent errors such as omission, substitution, and misordering support the presence of structural knowledge & strongly speak in favor of compositional approach

- Neologisms and circumlocution can relate also to whole compounds and correspond to semantic deficits

- Compound types investigated in the experiments included grammatical categories (N, V & Adj), headedness factor, constituent semantic relation, and structural schemes (grammatical, morphological, and semantic knowledge)

- Picture naming tasks and naming by definition tasks were used to reveal error patterns and subsequently results from the naming by definition task were compared between two populations

How is morphological knowledge impaired?
Kordouli et al. (2018)

- Naming by definition task: drastically different results in the type of target word in case of the stroke induced agrammatic individual & control subject group

- Stroke induced individuals: prediction confirmed → compound difficulties in speech, supported by the errors concerning one of the constituents (substitution, omission and inappropriate morphological structure: changing the compound marker, preferring less inflectional morphological structure)

How is morphological knowledge impaired?
Kordouli et al. (2018)

- Predictions about verbal compound difficulties was confirmed in the case of more progressed PPA patients, but not with the stroke induced agrammatic patient and PPA individual in early stage (no grammatical category effect), which indicates that verbal impairment appears in later stage

- Additionally, difficulties considering semantic relation between constituents, which was not predicted

- Compound type difficulties were not demonstrated in case of the PPA individual in early stage

- Performance of more progressed PPA individuals additionally impaired, but headedness effect with exocentric compounds was present even with the more progressed PPA patients

Interim Summary

- Difficulties correspond well with Levelt's model of word retrieval
- Morphological deficit suggests mild impairment at lemma level, followed by phonological deficit with prosodic cues of missing elements, that may correspond to phonological form of compounds
- Decompositional and dual route approaches in processing compounds, depending on the nature and progression of conditions
- Early stage agrammatic individual indicated phonological impairment but as the disease progress neurological deterioration causes more morphological impairments on lemma level related to grammatical categories, specifically with verbal stimuli, and on conceptual – semantic level related to semantic relation between constituents and head to compound relation

Qs:

- How are compounds stored in the mental lexicon?

- How is morphological knowledge impaired?

- **How are derived words processed?**

Derived words

- Suffixes and prefixes with different functions:

  -suffixes being productive in forming different grammatical categories

  -prefixes contributing to meaning

- These affixes processed differently

Derived words

Ciaccio et al. (2020)

- Derivation by prefixation and suffixation in word formation

- Population with acquired language impairment accompanied by morphological disorders

- Purpose: to better understand if there are differences in processing prefixed and suffixed words

Derived words

Ciaccio et al. (2020)

- Guided by previous psycholinguistic researches in morphological priming effect by the prefix facilitated the target (Marslen-Wilson)

- Q 1: Is it easier to process derived word by suffixation, where the suffix follows the head? Taking into consideration that both elements undergo decomposition, which imposes greater load in engaging cognitive resources when processing prefix followed by the stem as the head

- Q 2: Are the errors the same or are there differences in how prefixed and suffixed words are impaired?

Derived words
(Ciaccio et al. 2020)

- The task: reading aloud simple, prefixed and suffixed words (German)

- 3 individuals with agrammatic aphasia compared to control subjects

- Aphasic individuals were pre assessed on different tasks: reading aloud, repetition, visual and auditory lexical decision and error analysed with mostly substitutions and omissions

- Stimuli of different properties: more or less transparent, different imageability, frequency of both affixes and stems, length, and number of neighbours

Derived words
(Ciaccio et al. 2020)

- Affix errors considered both prefix and suffix errors, where the stem was preserved and affix not produced correctly (omitted, substituted or neologism produced)

- Stem errors indicated that affix was preserved but not the stem

- More affix errors with prefixed words than with affix words

- Stem length effect present: affix errors increased with the stem length increase

- More frequent prefixed errors were found in omissions than in substitutions or neologisms

- Decrease in error rates with increasing imageability

- The presence of these effects suggests that errors increase with increasing lemma frequency & decrease with increasing word – form frequency and imageability

Discussion

- While the results for one participant speaks against morphological impairment, other two participants were results consistent with the study predictions that due to processing costs for prefixed as compared to suffixed words and stem being word – final
- Retrieval of prefixed word could be more costly in terms of computational resources, and is present in morphological impairments

Discussion

- Omissions most frequent prefix errors observed
- Different functions of each element in derived forms: prefixed do not express grammatical properties of derived forms (they are more semantically involved) and are not heads, which is the case with suffixes
- Some questions for future studies include how to treat the prefixation with headedness effect present, or the specific stage in the production differences between prefixed and suffixed words are applicable

Conclusion

- Compound mental representation and processing: total decomposition and dual route approaches in word retrieval are supported by the errors concerning compound constituents and not only whole compounds
- Omission, substitution, and misordering constituents support the presence of structural knowledge
- These patterns strongly speak in favour of compositional approach
- Derivation by prefixation and suffixation in word formation: decompositional mechanism in case of prefixed words and holistic approach in case of suffixed forms have already been enclosed and described
- Studies considering derived words are yet to be explored in lexical retrieval

Thank you!

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