

The psychological and neural reality of syntactic movement

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Topics

- agrammatic aphasia
 - verb movement
 - object scrambling
-
- Derived Order Problem Hypothesis (DOP-H)
 - data from Italian and Turkish
 - fMRI data of non-brain-damaged speakers

Agrammatic aphasia

- nonfluent speech production
- mainly content words
 - nouns and verbs
- free and bound grammatical morphemes are omitted or substituted
- comprehension relatively well-preserved

Agrammatic aphasia



(...) no, plans, no, no.
Sinterklaas shop business,
my purse always empty;
future, no past (...) no,
absolutely (...) in the pot
tasty things, snacks, tasty
(...) no, no (...) eating tasty
things, presents Christmas
(...) yes, draw numbers, all
get presents, ten guilders,
ten guilders each

Agrammatic aphasia

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Sinterklaas shop business,
my purse always empty;
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all presents **getting**, ten
guilders, ten guilders each

- reduced number of lexical verbs
- non-finite verbs
- final position

Dutch as SOV-language

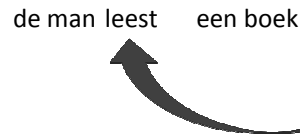
de man die een boek leest
the man who a book reads

de man kan een boek kopen
the man can a book read

Dutch rule Verb Second



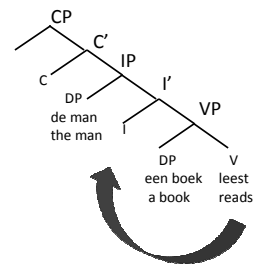
Dutch rule Verb Second



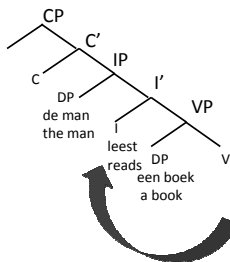
Left periphery

- in Dutch the finite verb these sentences is moved to C (den Besten) or to I (Zwart)

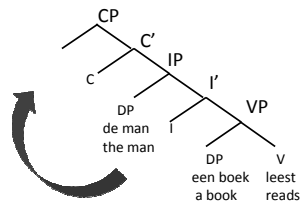
Verb Second to I (Zwart)



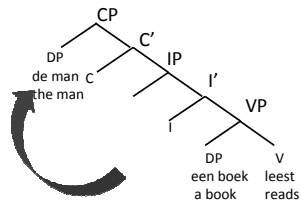
Verb Second to I (Zwart)



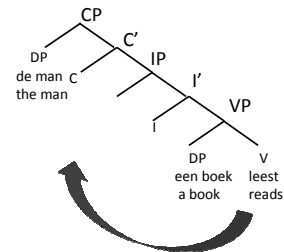
Verb Second to C (Den Besten)



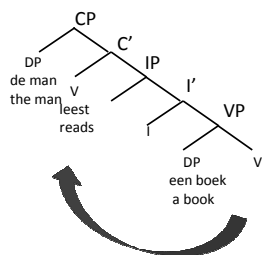
Verb Second to C (Den Besten)



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Verb Second to C (Den Besten)



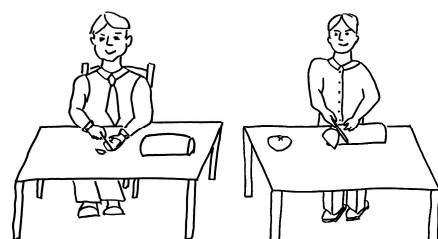
Question

- are finite verbs difficult to produce because they have been 'moved' out of their base position?
 - then finite verbs in Verb Second position < then finite verb in clause final position
- or because they are finite?
 - then finite verbs in Verb Second position = finite verbs in clause final position

Experiment 1

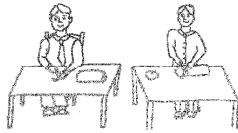
- production of finite verbs in clause final and Verb Second position
- 9 agrammatical speakers
- sentence completion

Materials



Matrix clause in Dutch:

+ verb movement

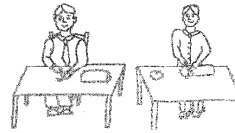


This is the boy that the tomato cuts and this is the boy that the bread cuts. So, this boy cuts the tomato and this boy ...

Subject: 'cuts the bread'

Embedded clause in Dutch:

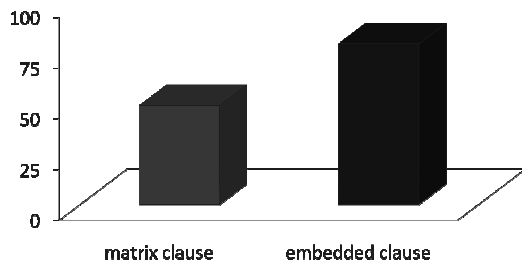
- verb movement



This boy cuts the tomato and this boy cuts the bread. So, this is the boy that the tomato cuts and this is the boy that ...

Subject: 'the bread cuts'

Results



Conclusion

- object + verbs are easier to produce when the verb is in clause final position (OV)
- verbs in Verbs Second are hard to produce

→

- finite verbs in matrix clause are not difficult because they are finite
- but because they are in derived position – in the left periphery

Next question

- is this due to weak representations of the left periphery?
- or is derived word order difficult as such?

Object scrambling in Dutch

de man die nu het boek leest
the man who now the book reads

de man die nu het boek leest



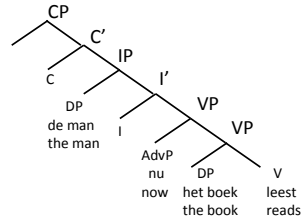
Object scrambling in Dutch

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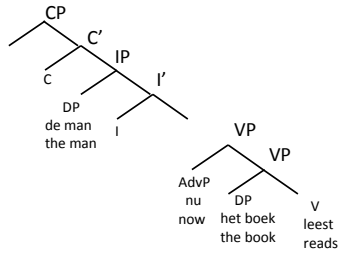
de man die het boek nu leest



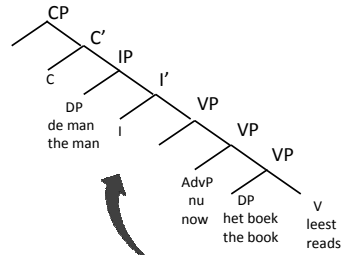
Object Scrambling Dutch



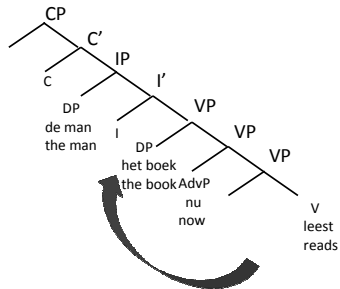
Object Scrambling Dutch



Object Scrambling Dutch



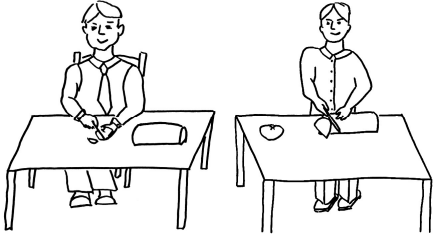
Object Scrambling Dutch



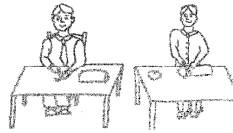
Experiment

- sentence completion paradigm
- 10 agrammatic speakers

Experiment



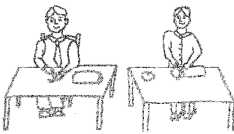
Condition 1: base order



This boy cuts the tomato and this boy cuts the bread. So this is the boy who now the tomato cuts and this is the boy who

Subject: '*now the bread cuts*'

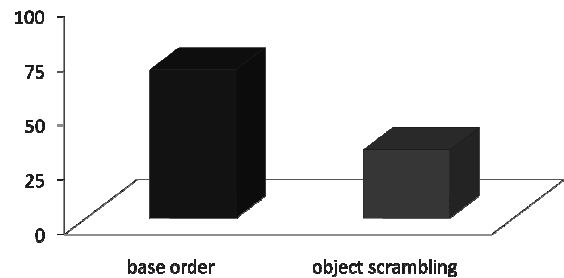
Condition 2: object scrambling



This boy cuts the tomato and this boy cuts the bread. So this is the boy that the tomato now cuts and this is the boy that

Subject: '*the bread now cuts*'

Results



Conclusion

- problems are not restricted to left periphery

A theory

- all languages have a base word order
 - SOV for German and Dutch
 - SVO for English
- all other word order are derived
 - Verb Second in Dutch
 - yes-no questions in English
 -

Derived Order Problem Hypothesis (DOP-H)

- constructions in derived order are hard to produce (and comprehend) for individuals with agrammatic aphasia
- tested for several languages
 - object scrambling in Turkish (Yarbay Duman)
 - yes-no questions in English (Bastiaanse & Thompson)
 - object clitics in Italian (Rossi)

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Object scrambling in Turkish

- Turkish base order is SOV
- overt case marking
- free word order

Object scrambling in Turkish

adam duvarı boyadı
the man_{nom} the wall_{acc} painted


adam duvarı boyadı



Object scrambling in Turkish

adam duvarı boyadı
the man_{nom} the wall_{acc} painted

duvarı adam boyadı



Experiment

- 8 agrammatic Turkish speakers
- prompting sentence structure

Base order



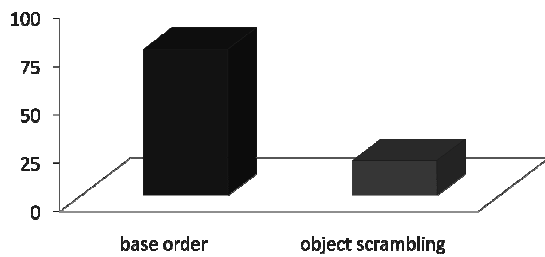
Here you can say: the man the door paints and here you can say"

Derived order

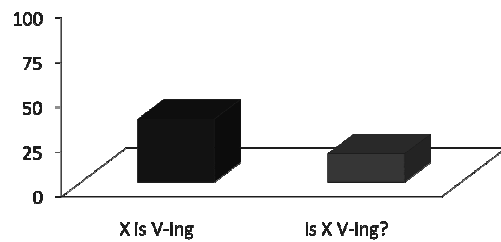


Here you can say: the door the man paints and here you can say"

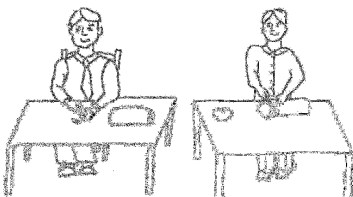
Results



English yes-no questions

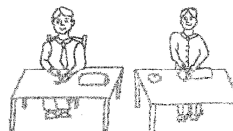


Back to first experiment



Matrix clause in Dutch:

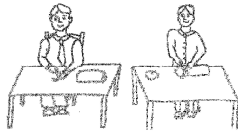
+ verb movement



This is the boy that the tomato cuts and this is the boy that the bread cuts. So, this boy cuts the tomato and this boy ...

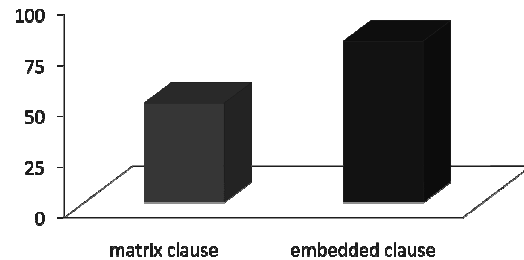
Subject: 'cuts the bread'

Embedded clause in Dutch: - verb movement



This boy cuts the tomato
and this boy cuts the
bread. So, this is the boy
that the tomato cuts and
this is the boy that ...
Subject: *'the bread cuts'*

Results



Question

- how is this represented in the brain?

Expectations for verb movement

- there must be one or more areas in the brain that mediate 'verb movement'
- this is presumably (close to) Broca's area



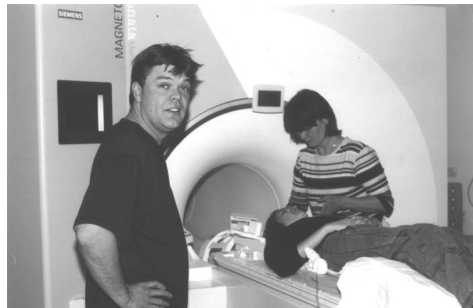
fMRI experiment

- with Dirk den Ouden
- 20 healthy subjects
- same idea as the 'tomato and bread cutting' test
- silent production

fMRI

- what do you see?
 - the changes in magnetic fields, due to oxygen uptake
- what is the idea?
 - when an area is active, it uses more oxygen than an area that is not active
- what do you do?
 - compare the differences in magnetic fields in two conditions
- what do you think?
 - that the more active areas are the locations where the process under study takes place

fMRI-scanner



Design

- block design
- 3 blocks
 - rest
 - matrix clauses
 - embedded clauses
- presentation
 - subject sees a picture with an introductory sentence
 - subject has to complete the sentence

Condition 1

- elicitation of matrix clauses:
 - ik lach want
 - I laugh because₁

Condition 1

- elicitation of main clauses:
 - ik lach want
 - I laugh because₁
- *want* is a connective, requiring matrix clause word order (SVO)

Condition 1

- elicitation of matrix clauses:
 - ik lach want 'de jongen snijdt het brood'
 - I laugh because₁ the boy cuts the bread

Condition 2

- elicitation of embedded clauses:
ik lach omdat
I laugh because₂

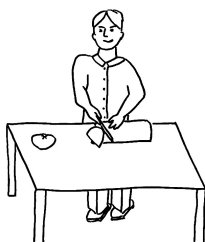
Condition 2

- elicitation of embedded clauses:
ik lach omdat
I laugh because₂
- *omdat* is a complementizer, requiring
embedded clause word order (SOV)

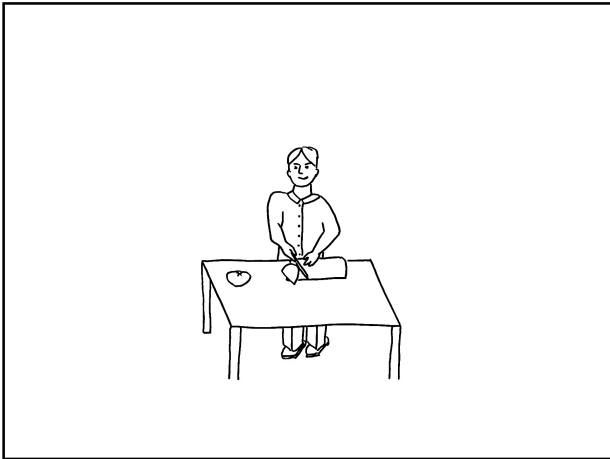
Condition 2

- elicitation of embedded clauses:
ik lach omdat de jongen het brood snijdt
I laugh because₂ the boy the bread cuts

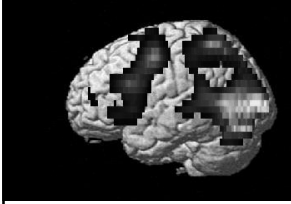
ik lach want



ik lach omdat



fMRI-pictures:
what do you see?



the degree of
oxygen usage

fMRI scans

what do you see?

- the degree of oxygen usage

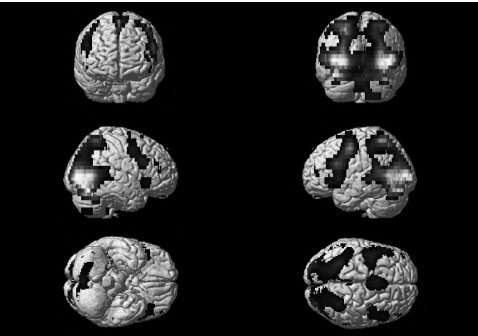
what do you do?

- subtract activation in the two conditions to determine which areas are activated in one condition but not in the other

(1) Activation during
sentence production

- which areas are activated when people complete a sentence silently?
- subtract activation during the rest condition from activation during the two experimental conditions to find out if you are measuring something real
- (matrix + embedded sentences) - rest

Sentence production
activation - rest



(2) Matrix clause – embedded clause

- which areas are active when the finite verb is in second position (the +verb movement condition) but not when the finite verb is in basic position (the –verb movement condition)?

want subject V_{fin} object

-

omdat subject object V_{fin}



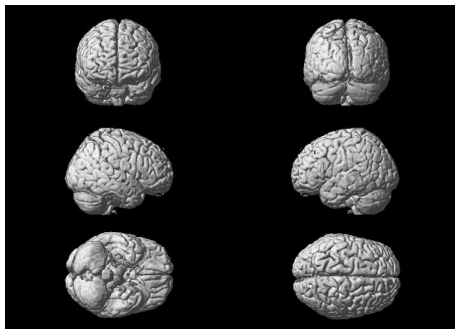
(3) Embedded clauses – matrix clauses

- which areas are active when the finite verb is in basic position (the –verb movement condition) that are not active when the finite verb is in second position (the +verb movement condition)?

omdat subject object V_{fin} want

-

subject V_{fin} object



Conclusions

- significantly more activation when a sentence with the finite verb in second position is produced than when a sentence with a finite verb in basic position is produced
- in other words: for verb movement extra brain activation is required

Conclusions

- this activation is not only found in the dorsal part of Broca's area
- but also in other frontal and temporal areas and in the basal ganglia

So,

- we do know that 'verb movement' requires more activation in some brain areas,
- but we do not know whether these areas are specific for
 - verb movement
 - syntactic movement
 - speech production of complex materials
 - processing complex grammatical materials
 - generating complex materials in general

But

- we do know that linguistically defined operations have a mental representation
 - at least those in the left periphery
- by studying agrammatic behavior and by using neuro-imaging techniques the mental validity of linguistic notions can be tested

Tak for din opmærksomhed

