Ambiguity resolution in brain-damaged and non-brain-damaged individuals

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December 10, 2014

Outline of talk

- The visual world paradigm

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- Lexical processing and ambiguity resolution in non-brain-damaged population

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- Lexical processing and ambiguity resolution in aphasia

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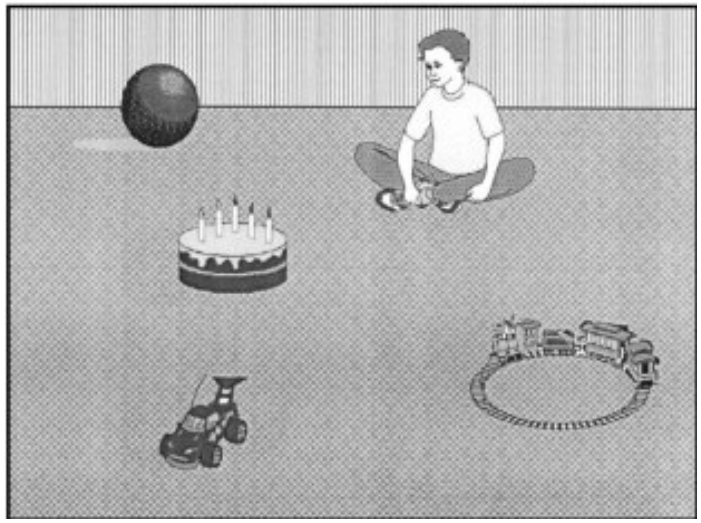
- Lexical processing and ambiguity resolution in non-brain-damaged population
- Lexical processing and ambiguity resolution in aphasia
- The present study

The visual world paradigm



- introduced by Cooper (1974)
- developed by Tanenhaus et al. (1995)
- made famous by Altmann and Kamide (1999)

"The boy will eat the cake" or "The boy will move the cake".

Advantages of the visual world paradigm

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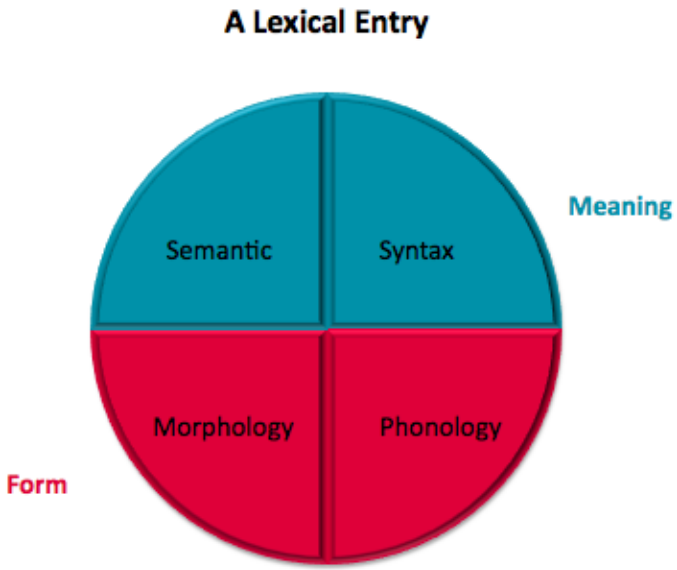
- reflects online language processing
- provides more “natural” experimental environment
- provides fine-grained information with good temporal resolution (from one measurement every 16.6 milliseconds up to two measurements every millisecond)
- instrument of choice when working with non-reading populations: children, adults with language disorders

Lexical processing

Lexical entry model by Levelt (1989)



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- lexical integration

Lexical access (Duffy et al., 1988)

During lexical access, a range of lexical units (here: meanings) is activated, where the amount of activation of each unit depends on its frequency and on context, if any. The most active unit is accessed first.
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- however, access to multiple meanings is not simultaneous
- the meaning with higher frequency and/or stronger contextual support is accessed first
- if both (of several) meanings have comparable amount of activation (i.e., they receive equal contextual support or have similar frequencies of occurrence), lexical access is delayed due to conflict resolution

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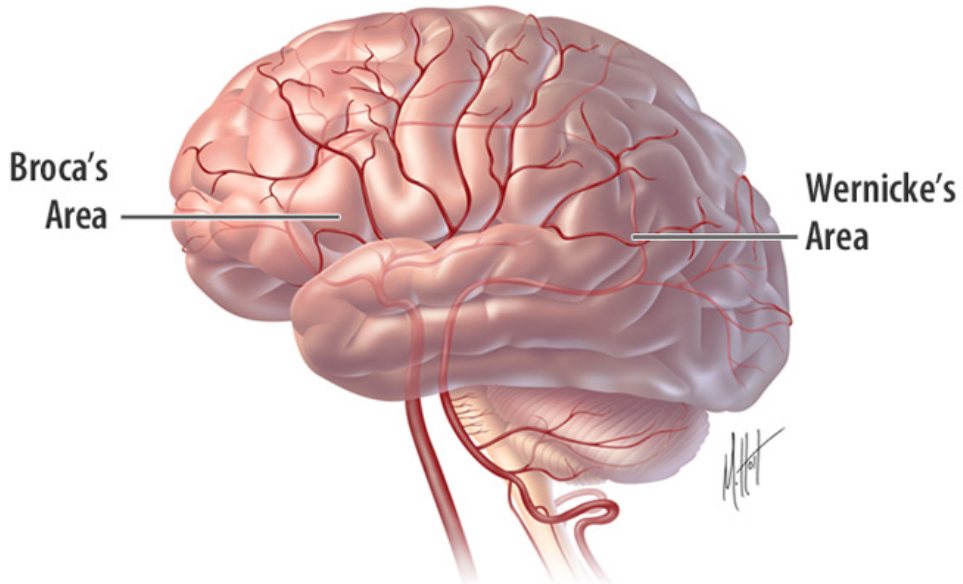
- if integration is not successful (i.e. the most frequent meaning was selected but does not fit into the context), reanalysis is needed
- during reanalysis, the access-selection-integration stages are believed to be repeated, since reanalysis usually takes additional time

What is aphasia?



Aphasia is an acquired language disorder due to brain damage (in most cases, stroke or head injury).
Two main types of aphasia are distinguished: **non-fluent** (damage to Broca's area) and **fluent** (damage to the Wernicke's area).

Non-fluent Broca's aphasia

Non-fluent Broca's aphasia is characterised by agrammatism and a lack of speech fluency. Two different impairments of lexical processing in non-fluent Broca's aphasia were suggested:

- slowdown in lexical access
- impaired lexical selection/integration (more experimental support)

Brain regions typically damaged in non-fluent Broca's aphasia are responsible for selection between competing alternatives and integration of contextually appropriate meanings.

$\Longrightarrow$ Individuals with Broca's aphasia activate all meanings of an ambiguous word but experience a delay in selection.

Fluent Wernicke's aphasia

Fluent Wernicke's aphasia is characterised by phoneme and word-level deficits but relatively spared syntax.
Lexical processing:

- normal lexical access pattern (even faster than normal in some studies)
- impaired lexical selection/integration
- problems arise due to abnormally high activation levels and/or damaged inhibition

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- online mechanisms of lexical processing (access, selection and integration; reanalysis)
- in native speakers of Russian with and without aphasia
- using the benefits of the visual world paradigm.

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Participants of the study:

- 36 individuals in control group (23 female; mean age 50 years, with no recorded history of neurological or psychiatric disorders)

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Participants of the study:

- 36 individuals in control group (23 female; mean age 50 years, with no recorded history of neurological or psychiatric disorders)
- 15 individuals with non-fluent Broca's aphasia (5 female; mean age 52 years)
- eight individuals with fluent Wernicke's aphasia (4 female; mean age 56 years)

The present study. Means

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- We employed balanced ambiguous words (i.e., with meanings of equal frequencies) in a sentential context.
- We manipulated the contexts whereby in half of cases the context initially favored (biased) one meaning, but after first presentation of the ambiguous word a reanalysis was required.
- We manipulated the distance between the first presentation of an ambiguous word and ambiguity resolution to further distinguish the performance of aphasic groups (expected difficulties in the Wernicke's fluent aphasia).

The present study. Materials

- 20 short audio stories

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- 20 corresponding visual panels

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- 20 filler stories, not containing experimental manipulations

The present study. Experimental stories

It took the technician an hour to get ready for the repair works. Eventually he found a screw.

(1) **Short distance**

Togda on pochinil **kran** s **tekuschej vodoj**.
Then he fixed **crane/tap** with **leaking water**

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(2) **Long distance**

Togda on pochinil **kran** s uzhe nadoevshej sosedyam,
Then he fixed **crane/tap** with already annoying neighbors,
postojanno i gromko **tekuschej vodoj**.
permanently and loudly **leaking water**

Then he fixed the crane/tap that was leaking permanently and loudly, and annoyed the neighbors.

The present study. Comprehension questions

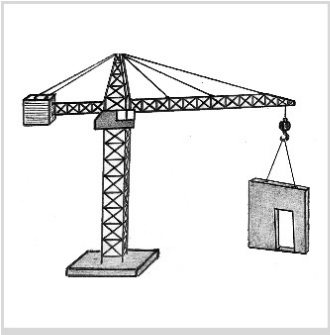
(3) Comprehension question

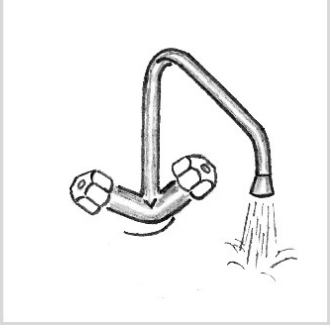
Gde	kran	otremontirovannyj	tehnikom?
Where	crane/tap	fixed	by-technician?

Where is the crane/tap the technician fixed?

Participants answered comprehension questions by looking at the corresponding picture for five seconds after the trial.

The present study. Visual panels





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- Contextual bias: up until ambiguity resolution the context biased either the meaning towards which ambiguity would be resolved (target meaning, *tap*) or the competitor meaning (*crane*).

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- Contextual bias: up until ambiguity resolution the context biased either the meaning towards which ambiguity would be resolved (target meaning, *tap*) or the competitor meaning (*crane*).
- Length of ambiguous material between the ambiguous word and ambiguity resolution: short (immediate ambiguity resolution) or long (4–6 words until ambiguity resolution).

The present study. Analysis

Eye-movements in two regions were analysed:

- first presentation of an ambiguous word in ambiguous context (*Then he fixed the **crane/tap***)

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- disambiguating phrase (***with leaking water***)

The present study. Results. Accuracy

- Control group (96% correct) $>$ non-fluent group (79%) $>$ fluent group (60%)

All subsequently described results belong only to the experimental items, to which correct responses were acquired.

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- Control group (96% correct) $>$ non-fluent group (79%) $>$ fluent group (60%)
- In short/long ambiguous material conditions: control and non-fluent groups – no difference, fluent group – in the long conditions performance was worse (54% vs. 67%) and not different from chance.

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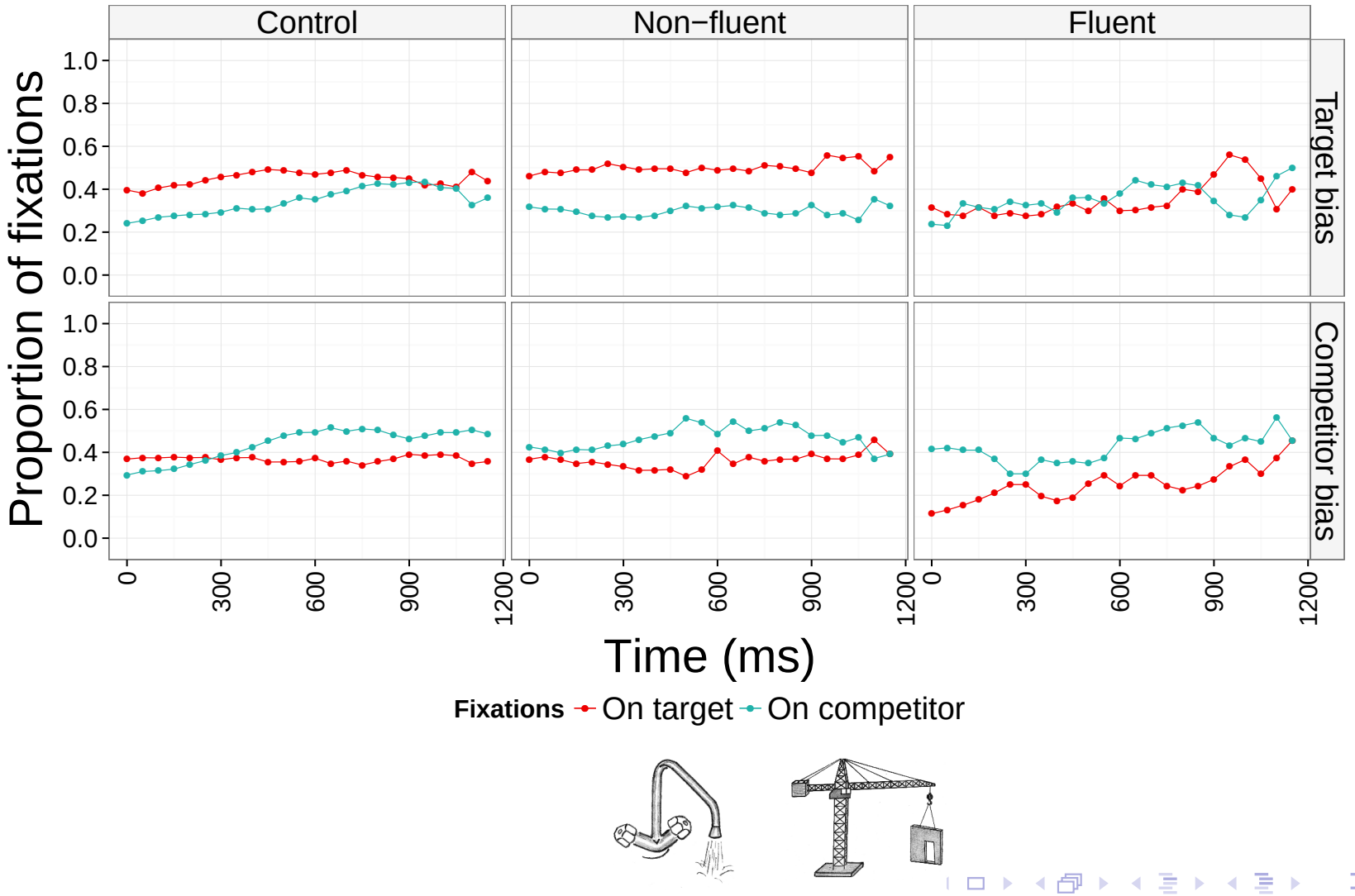

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- participants with non-fluent Broca's aphasia do not increase looks to the competitor as fast as the others
- target/competitor bias affected all groups of participants $\Longrightarrow$ equal sensitivity to contextual bias in all groups

Results. Ambiguity resolution

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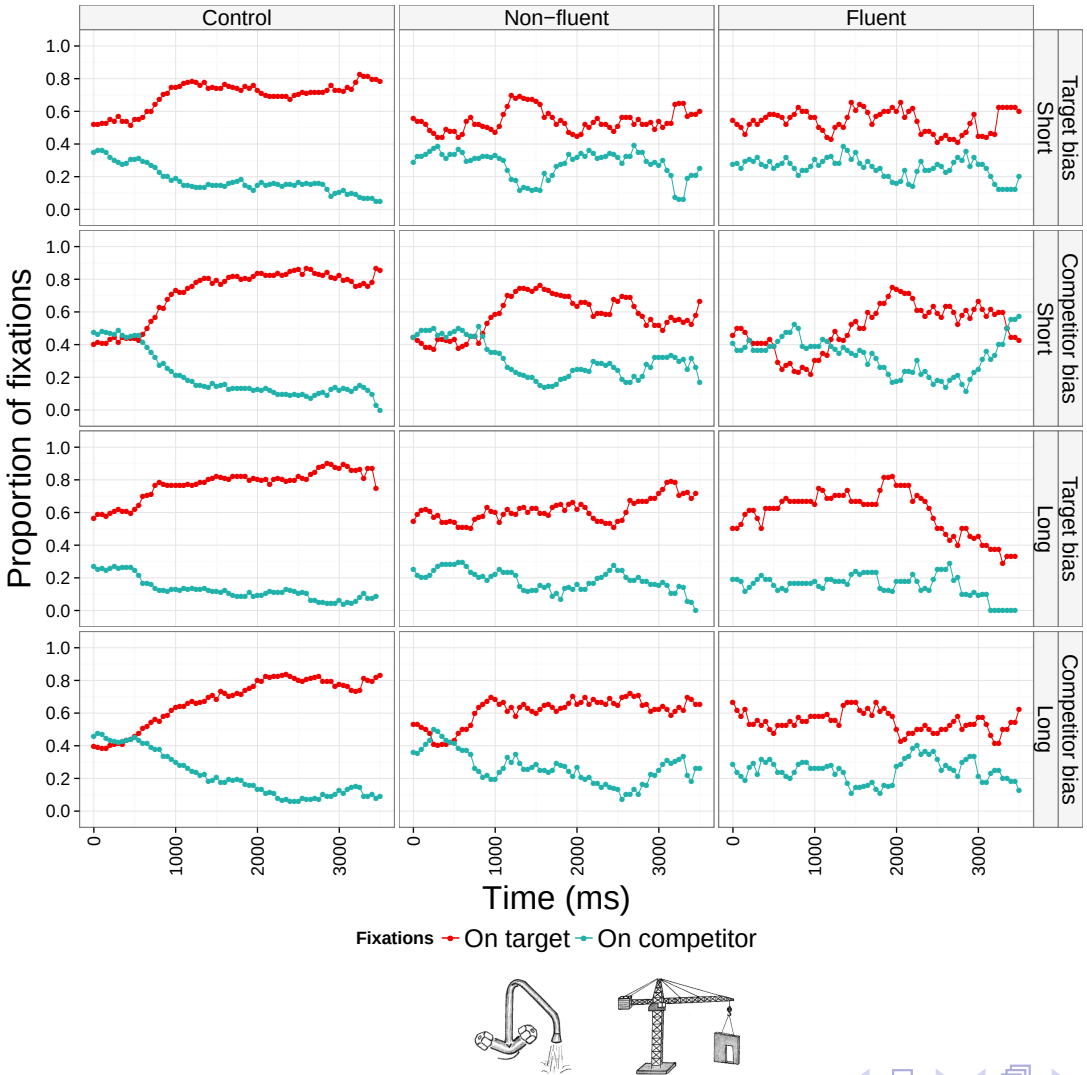

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- in the control group under target bias condition, probability of fixating the target was higher and probability of fixating the competitor was lower given long distance in comparison to short distance
- in the control group under target bias condition, target fixations increased and competitor fixations decreased more slowly over time than in competitor bias condition

Results. Control group

Control group is:

- sensitive to contextual bias
- sensitive to the length of intervening ambiguous material – target advantage grew stronger in the long condition (in accordance with previous findings: the longer the distance to disambiguation, the more committed participants get to their current interpretation)

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- preserved sensitivity to contextual bias and no delays in lexical selection
- difficulties with simultaneous activation of multiple referents (based on slower activation of competitor)
- impaired reanalysis (based on accuracies and a tendency to lower activation of target in the reanalysis region)

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