Gapping – On-line reactivation of verb information?
Evidence from an action/gapped verb compatibility study

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Verb Gapping

Verb gapping
e.g., John opens a water bottle and Jim [] a juice bottle.

Processing verb-gapping sentences
→ gap detection and retrieval of missing verb information

On-line reactivation of verb information?
present approach: employing a methodological paradigm from the embodied-simulations framework
Outline

Previous studies on reactivation of gapped verb information

Embodied-simulations framework

Present study (pilot experiment)
Previous studies

Evidence for on-line reactivation of gapped verb information from previous studies: Hofmann (2006); Kaan et al. (2004)
Hofmann (2006)

Word-by-word presentation (self-paced) of sentences, including verb gapping sentences, e.g.

Marktfrauen verkaufen frisches Gemüse an kritische Kunden
Market women sell fresh vegetables to critical customers

und Diebe wertvollen Schmuck an reiche Sammler.
and thieves valuable jewellery to wealthy collectors.

Test of reactivation of gapped verb information: probe recognition task → interruption of sentence presentation by recognition test: presentation of probe word with the task to decide whether it was mentioned in the sentence
Hofmann (2006): Design

Market women sell fresh vegetables to critical customers [TP1] and thieves valuable jewellery [TP2] to wealthy collectors.

Two test points: either after last word of first conjunct [TP1] or after object noun in second conjunct [TP2]

Two probe words: either object noun of first conjunct (e.g., vegetables) or verb (e.g., sell)

Three sentence types:
  gapping: … and thieves [ ] valuable jewellery …
  full form_1v: … and thieves sell valuable jewellery …
  full form_2v: … and thieves steal valuable jewellery …
Market women sell fresh vegetables to critical customers [TP1] and thieves [ ] / sell / steal valuable jewellery [TP2] ...

Probe: either vegetables or sell

Results for the probe recognition latencies

gapping: interaction of test point and probe word
TP1: no difference in latencies for nouns and verbs
TP2: shorter latencies for verbs than for nouns

full form_1v: interaction of test point and probe word
TP1: no difference in latencies for nouns and verbs
TP2: shorter latencies for verbs than for nouns

full form_2v: no interaction of test point and probe word
TP1 and TP2: no difference in latencies for nouns and verbs
Market women sell fresh vegetables to critical customers [TP1] and thieves [ ] / sell / steal valuable jewellery [TP2] ...
Probe: either vegetables or sell

Similar pattern of results for gapping and full form_1v
Different pattern of results for full form_2v

Yet: results for gapping and full form_1v were not the same:
gapping → Latencies for verb: longer at TP2 than at TP1
full form_1v → Latencies for verb: shorter at TP2 than at TP1

→ Results of Hofmann (2006): indirect evidence for on-line reactivation of gapped verb information

Kaan et al. (2004)
Word-by-word presentation (fixed rate) of sentences, including verb gapping sentences, e.g.

Jane ordered a coffee with cream and Bill a sandwich with cheese.

Test of reactivation of gapped verb information: Testing whether and when comprehenders notice an implausibility of the object noun in the second conjunct, i.e., implausible combination of gapped verb and object noun phrase

→ plausibility manipulation paradigm
Kaan et al. (2004): Method

Two versions of each gapping sentence

**plausible**: Jane *ordered* a coffee with cream and Bill a sandwich with cheese.

**implausible**: Jane *drank* a coffee with cream and Bill a sandwich with cheese.

Recording of event related potentials (ERP; brain response to stimuli, measured using EEG)
Jane ordered / drank a coffee with cream and Bill a sandwich with cheese.

Result → comparison of plausible and implausible condition ERPs to object noun in second conjunct (e.g., sandwich) of implausible condition showed an N400 (which reflects semantic integration difficulty).

Early effect of implausibility indicates reconstruction of gapped verb information shortly after the gap.

Result of Kaan et al. (2004): evidence for on-line reactivation of gapped verb information (for implausible noun-verb combinations and with fixed presentation rate).
Present study

Present study: different approach
→ employing a paradigm from the embodied-simulations framework
Embodied-simulations view

Language comprehension involves mental simulations that are grounded in perception and action

_The girl fetched a lemon and started to slice it. Suddenly, she cut her finger. Some of the juice got in the cut._

Comprehenders may understand the text about the girl and the lemon by mentally simulating the described events
Common systems: modal representations

Embodied-simulations view → common-systems
Representations of described situations are built in the same modality-specific mental subsystems as representations constructed during actual experience

→ modal representations
composed of representations of features in different modalities and representations of motor programs
Simulations of experience

Simulation view: linguistic input gives rise to a re-enactment of the modality-specific memory traces from past experiences with entities being denoted by the given words.

mental simulation of experiences

Kurt Vonnegut (1969): “to turn print into exciting situations in their skulls”

e.g., comprehending the sentence about the girl who cut her finger by mentally simulating the perception of the described situation.

Note: simulations are not full-fledged even representations in perception are highly selective and incomplete simulations of described situations might even be sketchier: linguistic input hardly ever specifies every detail of the described situations.
Empirical evidence: neuroscientific

Empirical support for the simulation view from neuroscientific studies

Overlap of pattern of brain activation when processing a linguistic expression and when actually perceiving the object or performing the activity denoted by the linguistic expression

Examples

González et al. (2006): Reading odor-related words (e.g., *cinnamon*) evokes activation in the olfactory cortex

Hauk et al. (2004): Reading action verbs (e.g., *kick*) activates areas in motor cortex that overlap with the areas that are activated when actually doing the actions
Empirical evidence: behavioral

Empirical support for the simulation view from behavioral studies

Action-sentence-compatibility effect (cf. Glenberg & Kaschak, 2002) when comprehending sentences implying a particular motor action and performing a corresponding motor action

Typical finding: match advantage/mismatch disadvantage → Shorter RTs with match between direction of described action and to be performed action than with mismatch

Example: Manual rotation (e.g., Taylor, Lev Ari, & Zwaan, 2008; Taylor & Zwaan, 2008; Zwaan & Taylor, 2006)

Sentence: John closed/opened the water bottle
Action: knob turning in clockwise/counter clockwise direction
Embodied-simulations view: interim

Embodied-simulations view: still in its infancy stage

One of the shortcomings: little attention to genuine linguistic phenomena

Yet: the embodied-simulations view has drawn attention to many new questions leading to novel findings, particularly wrt the relationship between language and perception/action and leading to the development of novel methodological paradigms

e.g. segment-by-segment manual rotation
e.g., Zwaan & Taylor (2006, Expt. 4)

Participants read sentences that were presented segment-by-segment

Experimental sentences implied either a clockwise or a counter clockwise manual rotation; Example:

To save | water | after | watering | the | garden | he | turned off | the | faucet.
He | realized | that | the | music | was | too loud | so | he | turned down | the | volume.

Participants advanced through the sentences by turning a knob either in clockwise or counter clockwise direction
Segment-by-segment manual rotation II

To save water after watering the garden he turned off the faucet.

He realized that the music was too loud so he turned down the volume.

Knob turning clockwise or counter clockwise direction of described action x direction of knob turning: match vs mismatch

Result for the verb segment: Shorter RTs in match condition compared with mismatch condition

No effect for preceding/subsequent segments

→ immediate and short-lived effect
Gapping: Present study

Present study: Adopting the segment-by-segment manual-rotation paradigm to investigate processing of verb-gapping sentences

Example:
*John opens a water bottle and Jim [ ] a juice bottle.*
Simulating and gapping

| John | opens a water bottle | and Jim | a juice bottle |

→ Compatibility effect not only for overt verb but also for gapped verb?

Insights wrt

(1) gapping: re-activation of verb information at the gap?
(2) simulation: bound to the processing of overt words?
Experiment: Method

Short narrative texts (three sentences)

Experimental texts in two versions
second sentence = gapping sentence: clockwise vs counter clockwise manual rotation (closing vs. opening sth)

Example:
(setting: children’s birthday party)
Tina schließt / öffnet eine Limonadenflasche auf der Terrasse
Tina closes / opens a lemonade bottle on the terrace
und Tom eine Saftflasche im Kinderzimmer.
and Tom a juice bottle in the children’s room.
Experiment: Method (cont.)

Segment-by-segment presentation (1-3 words), self-paced
Critical gapping sentence: six segments (see example)
Tina 1| closes / opens a lemonade bottle 2| on the terrace 3| and Tom 4| a juice bottle 5| in the children’s room 6|

Participants advanced from segment to segment by turning a knob either in clockwise or counter clockwise direction

expected: match/mismatch effect for overt-verb segment
(e.g., closes/opens a lemonade bottle)

match/mismatch effect for gapped-verb segment
(e.g., a juice bottle)
Result: nice part

Mean reading times (in ms) for the sentence segments (one to six) in the match and mismatch conditions

Tina closes/opens a lemonade bottle on the terrace and Tom a juice bottle in the children’s room
Result: not so nice part

Mean reading times (in ms) for the sentence segments (one to six) in the match and mismatch conditions

- one
- two
- three
- four
- five
- six

Tina closes/opens a lemonade bottle on the terrace and Tom a juice bottle in the children’s room

Stuttgart November 10th 2011
Match < Mismatch / Match > Mismatch

Present experiment: mismatch advantage/match disadvantage (match > mismatch)

=> different from typical finding of previous studies: match advantage/mismatch disadvantage (match < mismatch)

Note: some other studies on the interaction between comprehension and action also yielded a mismatch advantage/match disadvantage effect (Boulenger et al., 2006; Buccino et al., 2005; see also Borreggine & Kaschak, 2006)

Research on which factors determine the type of effect (match < mismatch / match > mismatch) is still in its beginning

However: previous studies that found a mismatch advantage/match disadvantage effect employed different paradigms

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Same paradigm – different effect?

Several experiments by Zwaan and Taylor (employing segment-by-segment manual rotation paradigm): **match advantage/mismatch disadvantage** (match < mismatch)

Present experiment (employing the *same paradigm*): **mismatch advantage/match disadvantage** (match > mismatch)

**Same paradigm – why different type of effect?**

Opposite result pattern may be due to differences *wrt knob turning procedure*:

*Zwaan and Taylor*: knob turning of approx. 5°, releasing the knob to its centre position after having read all the segments of a sentence

*Our experiment*: knob turning of approx. 50°, letting the knob turn back to its centre position after each turning
Different procedure – same effect?

Suppose: Zwaan and Taylor’s compatibility effect is due to an effect of action on language comprehension (rather than of comprehension on action), i.e. effect of preceding knob turning on processing of current segment.

Our experiment: releasing the knob to centre position after each turning, with hand still on knob \(\rightarrow\) back turning of knob.

\(\rightarrow\) direction of knob turning immediately preceding current segment \(\rightarrow\) opposite to direction according to knob condition: \(\text{match/mismatch (knob condition)} = \text{mismatch/match (back turning)}\)

\(\rightarrow\) RT\(\text{match (back turning)} < \text{RTmismatch (back turning)}\)

\(\rightarrow\) same type of effect as in Zwaan and Taylor’s studies???
Or different effects?

Suppose: compatibility effect in Zwaan and Taylor’s studies and in present experiment is due to an effect of language comprehension on action, i.e. effect of processing of current segment on subsequent knob turning

And suppose: temporal parameters are crucial, i.e., temporal overlap between mental simulation and initiating manual rotation

Possibly:
different knob turning procedures $\rightarrow$ differences wrt temporal overlap

Zwaan & Taylor:
action planning while simulating $\rightarrow$ match: facilitation

Present study:
action planning after simulating $\rightarrow$ match: interference

[Theory of Event Coding (Hommel et al., 2001): activated (facilitation) vs. bound (inhibition) feature codes]
Compatibility effect (described action/performed action) for both overt-verb and gapped-verb segment but not for any of the other sentence segments.

Effect for gapped-verb segment suggests that gapped verb information was re-activated online that the simulation view may prove of value wrt genuine linguistic phenomena such as verb gapping.

Replication needed not least wrt the type of effect issue (match > mismatch vs. match < mismatch).
That’s it

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