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Verb gapping: An action-gap compatibility study

Berry Claus *

Department of German Studies and Linguistics, Humboldt-Universität zu Berlin, Unter den Linden 6, 10099 Berlin, Germany

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ABSTRACT

This study addresses the processing of verb-gapping sentences, e.g., *John closes a juice bottle and Jim* [ ] *a lemonade bottle.* The goal was to explore if there would be an interaction between language comprehension and motor action not only for overt action verbs but also for gapped verbs. Participants read gapping sentences that either described clockwise or counter-clockwise manual rotations (e.g., *closes* vs. *opens a juice bottle*). Adopting a paradigm developed by Zwaan and Taylor (2006), sentence presentation was frame-by-frame. Participants proceeded from frame to frame by turning a knob either clockwise or counter clockwise. Analyses of the frame reading-times yielded a significant effect of compatibility between the linguistically conveyed action and the knob turning for the overt-verb (e.g., *closes/opens a juice bottle*) as well as for the gapped-verb frame (e.g., *a lemonade bottle*) – with longer reading times in the match condition than in the mismatch condition – but not for any of the other frames (e.g., *and Jim*). The results are promising in providing novel evidence for the real-time reactivation of gapped verbs and in suggesting that action simulation is not bound to the processing of overt verbs.

1. Introduction

Can language be "a surrogate for experience" (Taylor & Tversky, 1992, p. 495)? According to some theories of language comprehension (e.g., Barsalou, 1999; Glenberg, 1997, 2007; Zwaan, 2004), the answer to this question should be absolutely positive. These theories assume that language comprehension involves embodied mental simulations that are grounded in perception and action. They share the assumption that representations derived from linguistic input recruit the same modality-specific mental subsystems as representations derived from direct experience. In what follows, I will use the term *embodied-simulation view* to embrace different theoretical approaches that all assume a common representational system for linguistic cognition, non-linguistic cognition, and perception and action.

The embodied-simulation view is empirically supported by numerous impressive findings (for overviews see e.g., Barsalou, 2008; Meteyard, Cuadrado, Bahrami, & Vigliocco, 2012). Neuroscientific studies have revealed a considerable overlap between the pattern of brain activation that occurs when a particular linguistic expression is processed and the pattern of activation that is involved in directly perceiving the object or doing the activity, which the linguistic expression denotes (e.g., González et al., 2006; Pulvermüller & Hauk, 2006; Tettamanti et al., 2005). Findings from behavioral studies point to an equivalence between representations derived from linguistic input and representations being used in perception and action by indicating that effects that have been demonstrated in studies on perception and action also show up in language comprehension tasks (e.g., Chen & Bargh, 1999; Claus & Kelter, 2009; Glenberg, Sato, & Cattaneo, 2008; Pecher, Zeelenberg, & Barsalou, 2003). Furthermore, there are several behavioral studies that revealed interaction effects between language comprehension and concurrent perceptual processes (e.g., Bergen, Lindsay, Matlock, & Narayanan, 2007; Kaschak et al., 2005; Meteyard, Bahrami, & Vigliocco, 2007; Zwaan, Madden, Yaxley, & Aveyard, 2004). One important line of evidence – which also is of immediate relevance to the study to be presented in the present paper – stems from studies addressing the interaction between language comprehension and action and indicating that processing linguistic input can affect motor actions. In particular, many studies revealed an *action–sentence compatibility effect* (Glenberg & Kaschak, 2002), i.e., response times for sentences describing an action in a particular direction were found to be affected by whether the direction of the hand movement required for responding was compatible or incompatible to the direction implied by the sentence (e.g., Bergen & Wheeler, 2005; de Vega, Moreno, & Castillo, 2013; Glenberg & Kaschak, 2002; Zwaan & Taylor, 2006; see also Bub & Masson, 2010).

By now, the embodied-simulation view has gained considerable importance in research on language comprehension. It has drawn attention to many new questions leading to novel findings, particularly as to the relationship between language processing and perceptual and motor processes. Yet, the embodied-simulation view is still in its infancy

* Humboldt-Universität zu Berlin, Institut für deutsche Sprache und Linguistik, Unter den Linden 6, 10099 Berlin, Germany. Tel.: +49 30 2093 9673.
E-mail address: berry.claus@hu-berlin.de.

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stage. There are several fundamental issues that have largely been neglected so far, in particular genuine linguistic phenomena such as scope, anaphora, and elliptical constructions.

The goal of the present study was to explore whether the embodied-simulation view can contribute to research on the processing of a particular type of elliptical constructions, namely *verb gapping* (Ross, 1970). Verb gapping is the omission of the finite verb (and possibly additional verbal material) in the second conjunct of a conjoined sentence. An example is given in (1), where the finite verb *ordered* is elided in the second conjunct.

1. Spencer ordered a cup of coffee and Katherine a cup of tea.

Processing a verb-gapping sentence such as (1) requires detecting the gap and retrieving the omitted verb information, with the missing information being given in the first conjunct. In theoretical linguistics, gapping is a well-studied type of ellipsis (e.g., Jackendoff, 1971; Johnson, 2009; Kuno, 1976; Repp, 2009; Ross, 1970; Sag & Hankamer, 1984; Steedman, 1990). The situation is different, however, for research in psycholinguistics and psychology of language. Studies addressing the processing of elliptical constructions have focused on a particular ellipsis type, i.e., verb-phrase ellipsis (e.g., *Katherine ordered a cup of tea and Humphrey did, too*). Within this work, different accounts have been proposed as to how the elided element is reconstructed during processing (e.g., Frazier & Clifton, 2001: copying mechanism account; Frazier & Clifton, 2005: shared-structure account; Martin & McElree, 2008, 2010: cue-dependent direct access account). Though the issue as to the reconstruction mechanism is not yet settled, findings from studies on verb-phrase ellipsis and on sluicing, i.e. elision of an entire clause except for a *wh*-word (e.g., *Humphrey ordered something but Spencer doesn't know what ~~Humphrey ordered~~*) converge in suggesting that the elided element is reconstructed in real time — immediately when or shortly after encountering the ellipsis (e.g., Callahan, Walenski, & Love, 2012; Poirier, Wolfinger, Spellman, & Shapiro, 2010; Shapiro & Hestvik, 1995; Shapiro, Hestvik, Lesan, & Garcis, 2003: Yoshida, Dickey, & Sturt, 2013).

Verb gapping has received only little attention in empirical studies on the processing of ellipsis. Streb, Henninghausen, and Rösler (2004) contrasted different anaphoric constructions, including verb gapping as an example of surface anaphora (Hankamer & Sag, 1976) and pronouns as an example of deep anaphora. Carlson (2001), Carlson, Dickey, and Kennedy (2005) and Hoeks, Redeker, and Hendriks (2009) addressed the interpretation of sentences such as (2) that are ambiguous between a gapping reading (*Katherine met Spencer yesterday and Humphrey ~~met Spencer~~ today*) and a "conjunction-reduction" reading (left peripheral deletion: *Katherine met Spencer yesterday and ~~Katherine met~~ Humphrey today*).

2. Katherine met Spencer yesterday and Humphrey today.

There are only a few studies on verb gapping that are directly concerned with the reconstruction of the missing verb information and explored the time course of the reactivation of the gapped verb (Hofmann, 2006; Kaan, Overfelt, Tromp, & Wijnen, 2013; Kaan, Wijnen, & Swaab, 2004). Hofmann (2006) employed a probe-recognition task to investigate whether gapped verb information is reactivated in real time. Participants read gapping sentences such as (3) and corresponding non-elliptical full forms, word-by-word, self-paced. There were two different test points for the probe recognition task; the probe word was either presented after the last word of the first conjunct [TP1] or after the direct object in the second conjunct [TP2]. The probe word was either the direct object noun of the first conjunct (e.g., vegetables) or the finite verb (e.g., sell).

3. Market women sell fresh vegetables to critical customers [TP1] and thieves valuable jewelry [TP2] to wealthy collectors.
[(From Hofmann, 2006; translated from German)]

For both, the gapping sentences and the corresponding full forms, an interaction between test point and probe word was found. At the first test point, TP1, the probe recognition latencies for the noun and verb probes did not differ. However, at the second test point, TP2, probe recognition latencies for verb probes were shorter than those for noun probes. This specific result pattern and the fact that it was the same for the gapping versions and the full-form versions of the sentences could be considered as evidence that gapped verb information was reactivated online. Yet, there were also differences in the results for the gapping versions and full forms. With gapping sentences, probe recognition latencies for verb probes at TP2 were longer than at TP1, whereas with full forms probe recognition latencies for verb probes were shorter at TP2 than at TP1. Moreover, the finding of shorter latencies with gapping sentences for verb probes compared with noun probes at TP2 may not reflect the reactivation of the gapped verb information. This finding could also be accounted for when assuming that the missing verb was not yet reconstructed when encountering the probe word. According to this interpretation, the effect on the probe words arose after the presentation of the probe word rather than resulting from reactivation of the verb information prior to encountering the probe word (see McKoon & Ratcliff, 1986; see also Nicol, Swinney, Love, & Hald, 2006). Thus, the study by Hofmann (2006) does provide preliminary albeit not unequivocal support for a real-time reactivation of gapped verb information.

Kaan et al. (2004) conducted an ERP-study and employed a plausibility manipulation paradigm to explore the time course of processing gapped verbs. More specifically, they investigated whether and when comprehenders notice an implausibility of the object noun in the second conjunct, by juxtaposing two versions of gapping sentences as in (4), differing in the gapped verb and its selectional restrictions on the argument, such that the object noun was either implausible (4a) or plausible (4b).

4a. Jane drank a coffee with cream and Bill a sandwich with cheese.
4b. Jane ordered a coffee with cream and Bill a sandwich with cheese.
[(From Kaan et al., 2004)]

Event related potentials to the object noun in the second conjunct (e.g., sandwich) in the two conditions revealed an N400 in the implausible condition relative to the plausible condition, followed by a P600. This early effect of implausibility suggests that the gapped verb information was reconstructed in real time, i.e., at the gap or shortly after it. However, the finding is based on specific test conditions: reading of implausible sentences and a fixed presentation rate. Furthermore, the plausibility effects observed by Kaan et al. (2004) could not be replicated in a follow-up study (Kaan et al., 2013).

To sum up, findings from a behavioral study and an ERP study are consistent with a real-time reactivation of gapped verb information. However, the evidence is scarce and not clear-cut. One of the goals of the present study was to contribute to this issue by employing a different methodological approach. Rather than using a probe-recognition or plausibility-manipulation paradigm, the present study adopted a paradigm, which has been developed within the embodied-simulation framework, i.e., the reading-by-rotating paradigm introduced by Zwaan and Taylor (2006, Experiment 4; see also Taylor, Lev Ari, & Zwaan, 2008; Taylor & Zwaan, 2008; Zwaan, Taylor, & de Boer, 2010).

In the reading-by-rotating paradigm, participants are presented with sentences implying either a clockwise manual rotation (see (5a)) or a counter-clockwise manual rotation (see (5b)). The sentences are presented frame-by-frame (the vertical lines in the example sentences indicate the frame boundaries). Participants advance from one frame to the next by turning a knob either in clockwise or in counter-clockwise direction.

5a. His pencil | was dull | so | before | the | SAT | he | sharpened | his | pencil.
5b. He | realized | that | the | music | was | too loud | so | he | turned down | the | volume.
[(From Zwaan & Taylor, 2006)]