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How message similarity shapes the timecourse of sentence formulation

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ABSTRACT

Transforming a preverbal message into an utterance (e.g., *The swimmer is pushing the paparazzo*) requires conceptual and linguistic encoding. Two experiments tested whether the timecourse of sentence formulation is shaped jointly or independently by message-level and sentence-level processes. Eye-tracked speakers described pictures of simple events with verb-medial (SVO/OVS) and verb-initial (VSO/aux-OVS) sentences in Dutch. To assess effects of message-level and sentence-level variables on formulation, the experiments manipulated the ease of *relational* encoding at both levels: target events were preceded by conceptually similar or dissimilar prime events (*event primes*) that increased speakers' familiarity with the action shown in the target event (e.g., *pushing*), and the prime events were accompanied by recorded active or passive descriptions (*structural primes*) that facilitated generation of suitable linguistic structures on target trials. The results showed effects of both types of primes on the form of target descriptions and on formulation. Speakers repeated the primed structures more often when target events were conceptually similar to the prime events. Importantly, conceptual similarity constrained the effects of structural primes on the timecourse of formulation: speakers showed more consistent deployment of attention to the two characters during linguistic encoding in structurally primed than unprimed active sentences, but conceptual familiarity reduced the priming effects in eye movements. Thus familiarity with message-level information can change how speakers express their messages and, during formulation, can provide conceptual guidance that supersedes effects of sentence-level variables. Effects of the event primes were stronger in VSO sentences, where early verb placement explicitly required early encoding of relational information, suggesting that linear word order can also constrain message-level influences on formulation.

Introduction

Speaking involves a complex series of conceptual and linguistic encoding processes (Levelt, 1989). Many of the debates in psycholinguistics have centered on questions regarding information flow across different levels of the production system, in particular regarding the degree to which individual encoding processes unfold independently or in interaction with other processes (see Clifton, Meyer, Wurm, & Treiman, 2012, for a review of production and comprehension models). For example, theories of lexical access include models that emphasize strictly serial processing of conceptual, lexical and phonological information (e.g., Levelt, Roelofs & Meyer, 1999; Roelofs, 1997) and

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models that allow interactions between these levels (e.g., Dell, 1986; Dell & O'Seaghdha, 1992; see Rapp & Goldrick, 2000, for a review). Theories of structural processing also include models that presuppose a strict separation of structural processes from lexical access (Chang, Dell, & Bock, 2006; Chang & Fitz, 2014) and models that allow for interactions between structures and the lexicon (Hartsuiker et al., 2008; Pickering & Branigan, 1998). Similar questions are found in research on the relationship between syntactic structures and prosodic phrasing (Nakamura, Arai, & Mazuka, 2012; Tooley, Konopka, & Watson, 2014; Wagner & Watson, 2010).

By comparison to lexical, structural and phonological processing, less is known about the processes that put the whole production sequence into motion, i.e., the formulation of the preverbal message (a conceptual representation that captures the speaker's communicative intent) and the mapping of this information onto language (see Konopka & Brown-Schmidt, 2014, for a review). In general, it is clear that processing at higher levels in the system must constrain processing at lower levels: *what* speakers want to communicate influences *how* they communicate it. Thus, for example, conversational history or concerns about audience design can determine the amount of conceptual detail that speakers encode as well as the form of referential expressions (e.g., Arnold, 2010; Brown-Schmidt & Konopka, 2014). What is unclear is whether and how messages can shape the way speakers formulate, or *assemble*, sentences expressing their messages online.

This paper aims to identify dependencies between message-level and sentence-level processes during the formulation of simple event descriptions (active sentences like *The swimmer is pushing the paparazzo into the pool*). While most production theories agree that message and sentence formulation involve a number of processes that unfold incrementally (Levelt, 1989; Wheeldon, 2013), the coordination of these processes is a matter of debate. The approach we take here to identify between-level dependencies is to track the effects of experience-dependent changes in message-level and sentence-level processes on the timecourse of formulation. In two experiments, we manipulate speakers' familiarity with the *content* of the target messages and with the linguistic structures they can use to express these messages. We then compare effects of message familiarity on formulation against effects of familiarity with the linguistic structures used to express the target messages (Konopka, 2012; Konopka & Meyer, 2014). Thus we test whether message-level and sentence-level encoding processes influence the timecourse of formulation jointly or independently, and we discuss the implications of these outcomes for understanding the dynamics of processes at the interface of thinking and speaking.

Incrementality and control of formulation

When preparing to speak, we normally encode sequences of message-level (conceptual) and sentence-level (linguistic) increments. Speakers may, for example, encode a small increment of conceptual information and pass this increment on to linguistic encoding processes before the entire message is complete. At the sentence level, a message increment may then also be encoded linguistically in a sequence of smaller increments. This type of incremental planning leaves room for considerable flexibility in formulation and thus provides a natural test-bed for addressing questions about information flow between levels of the production system.

Studies examining the online formulation of messages and sentences confirm that increment size at both levels can be highly variable. For example, when describing simple objects (e.g., *small star*), speakers can encode the part of the message that expresses size (*small*) separately from the part of the message that identifies the referent (*star*; Brown-Schmidt & Konopka, 2008, 2014), suggesting that increments can be lexically sized. Similarly, speakers may encode the content of a simple event (*The dog chasing the mailman*) one character at a time, particularly when one character is more salient or accessible than the other (Gleitman, January, Nappa, & Trueswell, 2007; Kuchinsky & Bock, 2010). On the other hand, there is also evidence that message formulation can begin with generation of a larger conceptual representation – i.e., a representation that includes information about *relationships* between elements of the message (objects or characters) before linguistic encoding begins (Bock, Irwin, & Davidson, 2004; Griffin & Bock, 2000; Konopka & Meyer, 2014; Lee, Brown-Schmidt, & Watson, 2013).

Comparing across studies, these results provide suggestive evidence that properties of the message may play a key role in controlling formulation. Although the content and structure of messages are difficult to define (see Chang et al., 2006; Konopka & Brown-Schmidt, 2014), the most striking differences in message properties across studies arguably concern the conceptual cohesiveness of the stimuli used to elicit speech. Notably, speakers appear to encode individual message elements *one by one* when messages have little internal conceptual structure (e.g., noun phrases describing non-interacting objects; Brown-Schmidt & Konopka, 2008, 2014; Griffin, 2001; Konopka, 2012; Meyer, Sleiderink, & Levelt, 1998) or, in the case of events, when the conceptual structure is hard to apprehend (e.g., events where relationships between characters are hard to encode; Kuchinsky & Bock, 2010). In contrast, speakers appear to prepare *larger* message increments when a to-be-described event is relatively unambiguous and can be quickly encoded as a conceptually coherent proposition (Konopka & Meyer, 2014; Kuchinsky & Bock, 2010). It is therefore possible that differences between messages on this dimension may inherently support different formulation strategies.

The proposal that formulation can vary with the ease of conceptual encoding is consistent with studies showing *experimentally-dependent* changes in increment size *within* the same message and sentence types. For example, speakers tend to generate smaller message-level and sentence-level increments under conditions of high cognitive load or time pressure (Ferreira & Swets, 2002; Wagner, Jescheniak, & Schriefers, 2010). Increment size also depends on the ease of completing linguistic encoding operations from the outset of formulation: speakers are