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CONCEPTUAL PRIMING IN SENTENCE PRODUCTION: EFFECTS OF CONCRETE PICTURES ON METAPHORICAL LANGUAGE

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A major challenge in language production research is understanding how messages are linguistically encoded, especially for abstract concepts. Using picture priming in a sentence production task, I demonstrate that activating a cognitive domain can trigger the use of domain-related (metaphorical) language for abstract concepts in sentences otherwise unrelated to the primes. The results show that specific concrete domains, activated by picture perception, frame the use of language for the abstract concepts. Control analyses argue against lexical or syntactic priming explanations for the effect. The findings indicate distinct and measurable effects of cross-domain priming due to domain activation, suggesting that conceptual metaphors are a cognitively real component of the language production mechanism. The results further suggest that concepts that are not part of the intended message but are accessible in a speaker's current cognitive state can influence sentence formulation.

1. INTRODUCTION. How do we transform thought into words? Recent research on language production has identified a small set of key mechanisms. Previous studies have demonstrated a robust effect of syntactic priming: speakers formulate utterances that are similar in structure to sentences that have been previously read, heard, or used by the producer (e.g., Bock 1986, Bock, Loebell, and Morey 1992, Chang, Dell, Bock, and Griffin 2000, Griffin and Bock 2000, Pickering and Branigan 1998). Other research has established the importance of lexical priming (e.g., Bock 1991) as yet another factor in production. Yet there has been far less research addressing how we capture meanings, what influences the process of message encoding, or how these meanings are transformed into linguistic forms. In order to explore these questions, I examine a form of conceptual priming.

In particular, I investigate one potential source of influence on the expression of abstract concepts: whether the activation of concrete schemas affects the formal instantiation of abstract concepts in sentence production. Looking at abstract language illuminates certain central processes in message construction. For one, abstract concepts can often be expressed in a rich variety of ways. Since abstract concepts often do not carry prototypical semantic properties of specific linguistic categories (they tend not to be concrete objects or visible properties, for example), they are open to expression through a range of syntactic structures and lexical items. To convey the intended message, language users often express abstract concepts through a particular conceptual framework (e.g., containment, possession), which then entails specific syntactic and lexical forms. Choice of a domain is crucially determined by semantic saliency. The most highlighted aspect of the abstract concept selects the most appropriate concrete domain among the set of candidate domains that are associated with the abstract domain (Lakoff and Turner 1989, Levelt et al. 1999). This phenomenon is consistent with other processes in the language production system, in which semantic saliency (Ferreira 1996) and semantic densities of words (Smith 2000) have been shown to determine the use of specific lexical items and syntactic structures. Lakoff and Turner (1989) argue that after domain selection, the abstract domain gains linguistic properties via a cross-domain mapping that projects syntactic and lexical features and general knowledge of the selected concrete domain onto the abstract concept. I propose that in this way, an intended message about an abstract concept is affected by the choice of a particular concrete domain.

I tested this proposed relationship between abstract language and concrete domains in message formulation by designing a production experiment. Drawing from well-established areas of metaphor com-

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prehension and picture priming, I manipulated the activation of concrete schemas through picture primes. I then examined whether these activated schemas influenced the type of language used to convey abstract concepts in sentence production. Since the conceptual framing of an abstract domain in terms of a particular concrete domain depends on semantic saliency, I hypothesized that activating a specific domain through picture perception would influence the choice of language about abstract concepts.

This study made critical use of previous research by Lakoff and colleagues on conceptual metaphor. Lakoff (1993) argues that conceptual metaphor is routinely employed when I talk about abstract notions. For example, an “idea” can be exchanged, stolen, or shown just like a physical object. Thus, the abstract notion of an “idea” is described metaphorically in terms of properties of a physical object. Lakoff (1987) argues that abstract concepts are not only described in terms of concrete concepts like physical objects, but that these abstract target domains are also conceived of in terms of concrete source domains (see also Johnson 1987, Lakoff 1987, 1993, Lakoff and Johnson 1980, 1999, Lakoff and Turner 1989). For example, the abstract concept of LOVE can be described and conceived of in terms of the concrete source domain FIRE (e.g., I don’t want to get burned again.), UNITY (e.g., We were made for each other.), FLUID IN A CONTAINER (e.g., She was filled with love.) and so on. Lakoff (1987) further argues, based on linguistic patterns and other nonexperimental evidence, that the conventional metaphorical expressions that fill our everyday speech are produced automatically, effortlessly, and without conscious awareness. He claims that there is a network of conceptual metaphors within the cognitive system—a system of cross-domain mappings that project experientially grounded knowledge about concrete source domains onto conceptual representations of abstract target domains (Lakoff and Johnson 1980). In this way, the conceptual system grounds abstract concepts in terms of more perceptually, motorically, or physically concrete concepts.

In addition, there is substantial corroboratory evidence that concrete source domains are activated during reasoning about abstract target domains. Boroditsky (2000) found that subjects primed with an object-moving spatial image (depicting objects moving in one direction along a line) were more likely to reason about time as a moving object, while perceiving an ego-moving scenario (where a person is moving relative to objects) made subjects reason about time as a stationary object that the experiencer moves past. Her study supports Lakoff’s claim by showing that space and time share the same relational structure, such that time can be reasoned about via a spatial schema. Activation of a concrete domain (space) influences how people frame an abstract domain (time). Sentence comprehension studies have additionally shown that processing utterances about abstract concepts activates representations of concrete source domains (Kaschak et al. 2004, Nayak and Gibbs 1990, Richardson et al. 2003). Some work even shows that activation of the source domain of a conceptual metaphor is strong enough to influence the comprehension of a message about abstract domains (Boroditsky 2001, Gibbs 1992, 1994). My goal here is to extend this line of research on sentence comprehension to see whether priming specific source domains leads to the use of metaphorical language drawn from those source domains in sentence production.

2. EXPERIMENT. I conducted a production experiment in which subjects saw concrete picture primes followed by linguistic prompts, and then quasi-spontaneously produced sentences using the linguistic prompts. In each trial of the experiment, subjects saw two consecutive pictures, both depicting either containment (e.g., an apple in a box), possession (e.g., a boy holding an apple), or neither relation (e.g., a boy using a computer; hereafter: “neutral” relations). The pictures were followed by a linguistic prompt: a person’s name and an abstract word (e.g., *Sally, trouble*). All of the abstract words could be metaphorically described and understood in terms of multiple concrete source domains, critically including containment and possession, but were otherwise unrelated to the picture primes. Based on each linguistic prompt, subjects produced a simple sentence. Using strictly linguistic criteria, I classified these resulting sentences as using containment metaphors, possession metaphors, or neither. I hypothesized that if metaphorical language produced about abstract concepts depends on the active use of a conceptual metaphor, then activating a concrete source domain (i.e., containment or possession) with the picture primes should increase the number of associated metaphorical responses. That is, perceiving containment pictures (e.g., an apple in a box) should increase activation of one’s conceptual representation for containment, which should increase the number of responses expressing containment (e.g., *Sally got into trouble*) compared to

responses in the neutral condition. Likewise, activation of the possession domain by perceiving possession pictures (e.g., a boy holding an apple) should increase the use of possession responses (e.g., *Sally had trouble with her family*).

2.1 MATERIALS

2.1.1 PICTURE MATERIALS: The picture stimuli were color drawings adapted from commercially available clip art or stimuli used by Griffin and Bock (2000). The experiment employed 180 pictures. Of these, 60 critical pictures depicted three types of scenes (20 each): (1) containment (e.g., a bird in a cage, an apple in a box, or a bear in a bathtub), (2) possession (e.g., a hand holding a roll of film, a squirrel holding a nut, or a runner holding a flag), or (3) a neutral scene (e.g., flower in front of a house, a girl playing the piano, or a cat watching a moon). An additional 60 pictures that were neutral with respect to containment or possession depicted scenes likely to induce active or passive descriptions for a control study described below. Finally, 60 other neutral pictures served as fillers. A norming study verified that each of the 60 critical pictures clearly conveyed containment, possession, or neither relation. This norming used 10 subjects who did not participate in the main experiment. Each picture was presented for 1200 ms. The subject then typed a description of the picture. Pictures were selected if eight or more subjects gave a response that matched the intended category, using the coding procedure described below for the main experiment.

2.1.2 WORD MATERIALS: Each pair of pictures in the main experiment was followed by a linguistic prompt of a person's name and an abstract word. A corpus analysis using the British National Corpus verified that the abstract words were used in containment-related metaphorical expressions (e.g., "be in trouble") or possession-related ones (e.g., "have trouble") with similar frequency. For each word, I collected 500 sentences from written language components of the corpus and 500 sentences from spoken language components, from various genres such as novels, journals, lectures, and speeches. Overall, the proportion of possession to containment utterances for the abstract words in the experimental items was 1.11:1.

2.2 PROCEDURE. Participants were tested individually. They completed a set of 3 practice trials, followed by 90 experimental trials. Each participant was presented with 30 critical trials randomly ordered with 30 control and 30 filler trials. On each trial, a pair of two different pictures was consecutively presented on a computer screen. For critical trials, the two pictures always depicted the same type of concept (i.e. two containment, two possession, or two neutral pictures). The first picture remained on the screen for 1200 ms, followed by a 500 ms ISI, then the second picture appeared for 1200 ms, followed by another 500 ms. Finally, the two-word linguistic prompt was presented for 1500 ms. After the linguistic prompt disappeared, participants typed a simple sentence using the two words. Each response sentence was recorded by the experimental software. Participants received no online feedback. The experiment was designed as a Latin square, so that each of the 30 linguistic prompts appeared in only one condition for each participant, counterbalanced across participants, and each participant received an equal number of prompts in each condition.

2.3 PARTICIPANTS. Thirty native speakers of American English who were students at the University of Hawai'i participated in exchange for credit in introductory linguistic courses. All participants reported normal hearing and vision.

2.4 DATA CODING. A total of 900 critical responses were collected from the 30 subjects in the main experiment. Following the well-documented metaphorical framework proposed by Lakoff and Johnson (1980), the responses were assigned to one of the three categories: possession metaphor, containment metaphor, or other. A sentence was categorized as using a possession metaphor when the abstract word was described in terms most commonly applied to possession of a tangible object. Aspects of this concrete source domain include possession, acquisition or loss of objects, or giving or taking away objects. Possessed objects can be looked for, found, or missed. They can be given (e.g., *give him more trouble*), stolen (e.g., *steal her love*), or brought (e.g., *bring some questions*) and so on. On the other hand, a sentence was categorized as using a containment metaphor when the abstract word was described in terms

most commonly applied to containers and containment relations. Containers can be entered (e.g., *get in trouble*), exited (e.g., *get out of trouble*), or can contain entities (e.g., *be in love*). Further, somebody or something can be in or out of a container, or bounded region, and the container can have a variety of different sizes, depths, or capacities. Finally, when the abstract word was described in a way that employed neither a containment nor a possession metaphor, as in *Sally seems to invite more trouble*, the response was categorized as “other.” To encourage natural sentence production, participants were not given syntactic categories for the abstract words. Therefore, as shown in responses such as *Sally is a trouble maker*, or *Kathy is troubled with a headache*, abstract words such as *trouble* were sometimes used as nouns, and sometimes as verbs.

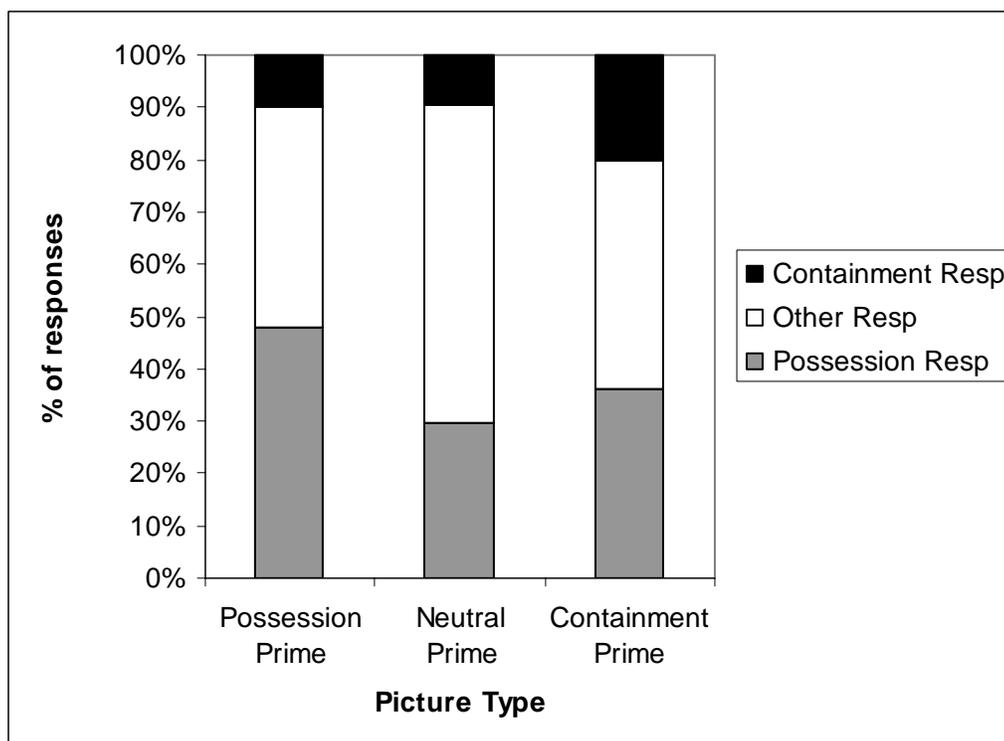
2.5 RESULTS. The results for critical items demonstrated that picture perception significantly increased the production of associated metaphorical sentences (see Fig. 1). Perceiving possession pictures (vs. neutral pictures) increased the production of possession responses by more than half (possession mean: 48.0%, vs. neutral mean: 29.7%), while Containment pictures (vs. neutral pictures) more than doubled the production of containment responses (containment mean: 20.3% vs. neutral mean: 9.7%). Repeated-Measures ANOVAs with number of possession responses as the dependent measure and three levels of prime type (Possession, Containment, Neutral) showed significant effects in both subject and item analyses ($F(2, 58)=14.89, p<.001^2$ and $F(2, 58) = 8.26, p<.005$ as did analyses with number of containment responses as the dependent measure ($F(2, 58)=13.73, p<.001$ and $F(2, 58)=7.45, p<.005$). Paired *t*-tests showed that both possession and containment responses were significantly increased by the associated picture type compared to neutral pictures (in possession responses $t=4.70, p<.001$ by subject and $t=4.47, p<.001$ by item while in containment responses $t=4.75, p<.001$ by subject and $t=2.98, p<.01$ by item).

3. CONTROL ANALYSIS. Although the results indicate a strong effect of the picture prime on the use of metaphorical language in the produced sentences, the observed priming effect could have resulted from two processes other than the concrete source domain activating metaphorical language. (1) Lexical priming: the image could have activated specific words that were subsequently used in sentence production, such as *in* for containment or *have* for possession. (2) Syntactic priming: the image could have activated specific syntactic structures associated with containment versus possession depictions, and these syntactic structures could have been more frequently produced in subsequent sentences. Both of these alternative explanations rest on linguistic encoding of the picture primes. That is, for them to go through, a subject who perceives a picture must implicitly describe it as, say, *an apple in a box*. That phrase structure or those lexical items can then influence the target sentence. To examine whether domain activation, syntactic priming or lexical priming were likely causes of the observed effects, I conducted a control study and a post hoc analysis. The control materials, which were included in the main experiment, tested for linguistic encoding and syntactic priming. The post hoc analysis filtered the results of the main experiment with the results of the picture description pretest to exclude cases that could plausibly be seen as lexical priming.

3.1 CONTROL STUDY (SYNTACTIC PRIMING): Previous research has shown reliable effects of active versus passive primes on the syntactic form of subsequent sentences, using picture primes that were described aloud. For example, Chang et al. (2000) showed that speakers who described aloud a prime picture with an active or passive sentence tended to use an active or passive picture description in target picture description. The control study investigated whether syntactic priming extends to the task, in which subjects were not asked to describe the pictures primes, but might nevertheless have formed implicit linguistic descriptions. The control materials consisted of pictures that tended to elicit active or passive descriptions. I reasoned that if participants created implicit linguistic descriptions of the containment versus possession

² Where necessary, analyses were corrected for non-sphericity using the Greenhouse-Geisser method. Original degrees of freedom but corrected *p* values are shown.

FIGURE 1. RESPONSE TYPES AFTER PICTURE PERCEPTION



picture primes, they would also create implicit descriptions of the control primes. The descriptions of the control primes would then cause syntactic priming, resulting in more active sentences following active picture primes than neutral ones, and more passive sentences following passive pictures than neutral pictures. Further, any such syntactic priming was expected to be greater for the control items than the critical ones.³ If, however, there was no effect of the control pictures on subjects' productions of active versus passive sentences, it is unlikely that the results for the main experiment could have been due to syntactic (or lexical) priming.

The control study contained 30 trials. Each trial consisted of a sequence of two picture primes followed by a linguistic prompt: a person's name and a verb, balanced for order. Of 60 control pictures, 20 pictures were biased toward passive descriptions (e.g., *a boy was hit by the ball*), 20 were biased toward active descriptions (e.g., *a man kicks a computer*) and 20 were neutral. These stimuli partially overlapped with those in Griffin and Bock (2000), were normed in the same pretest as the pictures for the main experiment, and used the same criteria for inclusion.

All responses in the control study were assigned to one of three categories: active, passive, or other. This was a three-by-two design, since there were three picture types (active, passive, neutral) and two word orders (name + verb, verb + name). None of the effects approached significance, in subject analyses or items analyses, whether using proportion of active responses or proportion of passive responses as dependent measures (all F 's < 2.11). This suggests that neither picture type nor word order influenced the subjects' responses. The control results argue against syntactic priming as a plausible explanation for the results in the main experiment. The lack of evidence of syntactic priming in the control study suggests

³ Syntactic priming effects seem to be larger in infrequent structures (e.g., passive constructions) than frequent ones (Griffin and Weinstein-Tull 2003). If there are syntactic structures associated with possession or containment sentences, we expect them to be highly frequent ones (e.g., subject-verb-direct object for possession sentences, and simple sentences with PPs for containment sentences). As a result, we would expect any syntactic priming effects to be stronger with the control stimuli than the critical stimuli.

that perceiving pictures did not cause the subjects to encode the picture information into syntactically specific linguistic descriptions.

3.2 POST HOC ANALYSIS (LEXICAL PRIMING): Another possible source of the observed effect is lexical priming. If, contra the results of the syntactic priming analysis, subjects implicitly encoded the picture stimuli using linguistic descriptions, they might have reused the words in those descriptions in subsequently produced sentences. To assess this possibility, I collected all words produced in the picture description norming task that could plausibly cause lexical priming to containment or possession. These were ‘in, inside, full (of), filled (with)’ for containment pictures and ‘have, hold, with, carry, pick, grab, drag’ for possession pictures. Experimental responses from the main experiment were then categorized according to whether they (1) contained a potential lexical prime or (2) fell into the targeted domain but did not employ a plausible lexical prime.

Containment responses involving potential lexical priming words showed a significant increase in the containment picture condition compared to the neutral picture condition. Critically, however, other containment responses also increased significantly ($F(1(2, 58))=5.62, p < .05, F(2(2, 58))=5.2, p < .05$). Likewise, possession productions involving potential lexical primes increased significantly in the possession condition compared to the neutral condition, but so did other domain-related responses ($F(1(2, 58))=4.89, p < .05, F(2(2, 58))=4.2, p < .05$).

In short, the significant effect of picture type remained even after the exclusion of sentences including words that could potentially have been lexically primed. Linguistic priming might explain the increases in the lexically related responses, but it cannot explain the significant increases in the other domain-related responses.⁴ Coupled with the lack of evidence for any linguistic encoding of the picture primes, this leads us to conclude that the picture primes activated the concrete domains of possession and containment. This concrete source domain activation was responsible for the increased use of containment- and possession-related metaphorical expressions following containment and possession pictures.

4. DISCUSSION. This study investigated whether or not pre-activating a certain source domain would influence the production of metaphorical sentences about abstract concepts. The results confirmed that source domain activation affected metaphorical sentence formulation. For both containment pictures and possession picture primes, the number of metaphorical domain-related sentences increased compared to the neutral condition even after excluding potentially lexically primed sentences. Activating a particular concrete domain made speakers more likely to formulate language about abstract concepts in terms of that concrete domain, empirically supporting the claim that conceptual metaphor is an active component of linguistic cognition (Lakoff and Johnson 1980). This argument has received previous experimental support from studies of language comprehension (Boroditsky 2000). The results expand on this picture and show that in language production, perceptual experiences leading to domain activation drive the choice of a particular conceptual frame for linguistic expression, which in turn influences the specific language that is produced. The results seen above suggest that a conceptual framing (or cross-domain mapping) is a significant contributing factor in encoding an abstract message linguistically. Previous language production studies argue that lexical and thematic role information can be activated independently from phrase structure information in the course of sentence production (e.g., Ferreira 2003; Griffin and Weinstein-Tull 2003). The current results indicate that the activation of conceptual domains is another component of sentence production that does not appear to (directly) depend on lexical or syntactic activation, and that can be experimentally manipulated to probe the production process.

In earlier work on the production system, the message level was described as a place where a nonlinguistic abstract code is represented in some form. The message was thought to capture the speaker’s intended ideas and meanings and provide the raw material for the next process, grammatical encoding

⁴ It is possible that the pretest underestimated the set of potential priming words. Yet note that domain priming predicts an increase in the amount of domain-associated words in the produced sentences, so excluding responses with domain-associated words underestimates the amount of domain activation.

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(Bock 1995). In other words, the message was defined as an intentional representation that influences the process of sentence production. However, Wardlow Lane et al. (2006) have recently shown that grammatical encoding processes include not only conceptual features that make up the intended message, but also features that are not intended to be expressed and yet are accessible to the speaker. Likewise, this study shows that particular concepts that are not required components of the message can become activated (or become accessible) and influence the process of constructing speech. Thus, both intentionally and unintentionally activated conceptual components shape the production of sentences, including concepts such as the concrete domains tested here that do not seem to be activated through linguistic behavior. Messages are determined not just by speakers' intentions, but also by their current cognitive states. In the case of abstract language, an activated concrete domain has measurable effects on the ultimate form of the message that is produced. This effect thus provides further evidence for the importance in the production and comprehension of language of the embodied experiences and the rich environment in which a linguistic act takes place.

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