

Syntax and speaking

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## Syntax and speaking

**Introduction**

Our syntactic knowledge guides what and how we speak. In turn, what and how we speak reflect the structure of our syntactic knowledge. Thus, studies of syntax and studies of speaking can be mutually informative, at least in principle. In this contribution, I discuss how syntactic theories are an essential part of theories of speaking, and how studies of speaking may (or may not) inform studies of syntax.

Before going into the main discussion, I would like to introduce the basic architecture of the model of sentence production that is widely accepted in the literature, focusing on syntactic aspects.

**Syntactic processes in speaking**

Traditionally, speaking is viewed as involving a transformation of conceptual representations to articulatory-motor or manual-motor representations (Garrett, 1975). Accordingly, models of speaking normally assume that speakers start from pre-linguistic conceptual representations, often referred to as *message representations*. The most extensive discussion, as far as I am aware, is Levelt (1989). According to Levelt, message representation is a multi-component level of representation that includes spatial, kinesthetic, and propositional representations. The most explicitly discussed sub-component is the propositional representation, which encodes information such as semantic categories (e.g., event, person, manner, place, and so on), function-argument structures, semantic types (e.g., e, t, <e, t>, and so on) and thematic information. The questions like how speakers build these representations as they prepare utterances remain largely unanswered, though there is an interesting line of studies that investigates how relational and non-relational components of message representation are prepared in speech planning (e.g., Gleitman, January, Nappa, and Trueswell 2007; Griffin and Bock 2000).

Using (potentially partial) message representations, speakers build some form of grammatical representations. The dominant view in the literature, represented by

models like Bock and Ferreira (2013); Bock and Levelt (1994); Garrett (1975), is that speakers first use thematic representations to build grammatical-functional representations, specifically the f-structure in Lexical Functional Grammar (Bresnan, 1982). This stage of processing is often called the functional level of processing (Bock & Levelt, 1994). In Bock and Levelt model, it is assumed that constituent structures are not yet represented at this stage of processing, but grammatical functional structures (e.g., subject, direct object, indirect object, verb) are represented. Thematic information is used to assign grammatical functions to words (or more precisely, *lemmas*, the mental representations that contain syntactic and semantic information but not phonological information, Kempen and Huijbers 1983; Levelt, Roelofs, and Meyer 1999). How grammatical functions are assigned to lemmas is not entirely clear, but Bock and Levelt (1994) assumed that speakers access verbs' subcategorization information that encodes which thematic role corresponds to which grammatical functions. Speakers may also use other conceptually encoded information, for example animacy information for grammatical function assignment (McDonald, Bock, and Kelly 1993, among others). Some researchers also argue that speakers may develop a strategy to assign grammatical function based on the statistical regularity between thematic roles and grammatical functions (e.g., patients tend to get the object function; Iwasaki 2010). It has also been proposed that verbs' subcategorization information is used only for internal arguments, but not external arguments (Momma, Slevc, & Phillips, 2016, 2018).

Once speakers assign appropriate grammatical functions to appropriate lemmas, they then build constituent structures using the functional structures. The exact nature of constituent structure representation is a matter of debate in the literature. Some argue that this level of representation is relatively impoverished. My view (elaborated below) is that constituent structural representation is rich enough to encode arbitrary and subtle constraints of grammar. Traditionally (at least since Garrett 1975), speakers were assumed to first encode the dominance relation between constituents, independently of the linear order relation (precedence relation), though some argue that dominance and precedence relations are simultaneously represented (e.g., Pickering,

Branigan, and McLean 2002). Finally, speakers linearize the constituents encoded in the dominance representation for phonological encoding. After the phonological encoding, speakers then convert the phonological representations into motor representations, which results in articulation.

### **The nature and quality of syntactic representation in speaking**

In sentence production, speakers construct some sort of syntactic representation of their utterances in real time. Most models of sentence production assume that speakers build hierarchical and abstract representations (Bock & Ferreira, 2013; Bock & Levelt, 1994; F. Ferreira, 2000; F. Ferreira & Engelhardt, 2006; V. Ferreira & Slevc, 2007; Garrett, 1975, 1988; Kempen & Hoenkamp, 1987; Levelt, 1989). But what are the empirical reasons to believe that speakers represent abstract hierarchical structures in real time? This question is central in discussing the relationship between studies of syntax and studies of speaking because syntactic theories are relevant for theories of speaking to the extent that syntactic theories capture the nature of representations that speakers construct in real-time production.

### **Hierarchy**

First, what is the evidence that speakers build hierarchical representations in real-time production? Uncontroversially, sentences can be analyzed as hierarchically organized. Sentences consist of phrases, which consist of smaller phrases, which consist of words, which consist of morphemes, the smallest linguistic units that carry meaning. In line with this observation, all major syntactic theories assume that sentences are hierarchically organized (Chomsky, 1986, 1995; Goldberg, 1995; Kaplan, Bresnan, et al., 1982; Sag & Pollard, 1987). However, in principle, speakers' real-time syntactic representations may not be hierarchically organized. The fact that sentences can be analyzed as hierarchically organized does not necessarily mean that speakers build hierarchical structures for production or comprehension (e.g, Frank, Bod, and Christiansen 2012).

Nevertheless, there are at least two pieces of evidence that speakers' real-time representations are hierarchically organized. First, Fromkin (1971) observed that speakers frequently make speech errors such as the following (taken from Fromkin, Rodman, and Hyams 2011 and Fromkin 1971):

- (1) Seymour sliced the salami with a knife. → Seymour sliced a knife with the salami. [phrasal exchange]
- (2) tend to turn out → turn to tend out [word exchange]
- (3) salute smartly → smart salutely [morpheme exchange]

These exchange errors suggest that speakers manipulate phrasal, lexical, and morphemic representations as units when they plan utterances. Exchange errors occur when two planned units are bound to the different syntactic positions. In other words, sentence planning is based on hierarchically organized linguistic units.

Furthermore, Garrett (1975) observed that word exchange errors like (2) often occur in distance, crossing phrasal and sometimes even clausal boundaries. On the other hand, he observed that phonemic exchange errors (e.g., *darn boor* for an intended, *barn door*) occur locally, involving two phonemes belonging to immediately adjacent words. Garrett argued that for an exchange error to occur, two units involved in the exchange must be represented simultaneously in mind. He called this condition that applies to exchange errors *computational simultaneity*. The fact that word exchange errors are relatively unconstrained by linear proximity suggests that linear proximity is not a strong determinant of whether two words are represented simultaneously. On the other hand, linear proximity is a strong determinant of whether two phonemes are represented simultaneously. From this contrast, Garrett argued that speakers represent sentences hierarchically at the level of syntax but linearly at the level of phonology.

## Abstractness

Second, what is the evidence that speakers construct abstract representations of sentences in real-time production? Syntactic theories typically define structural rules

and constraints over abstract categories of syntax (nouns, verbs, prepositions, noun phrases, verb phrases, prepositional phrases, etc.) rather than over specific individual words. For example, phrase structure rules are rules defined over lexical and phrasal categories rather than individual words (except for lexicalized rules). Selectional constraints (specifically, c-selectional constraints, Grimshaw 1990) are defined over syntactic categories rather than over individual words. Constraints on long-distance extractions are typically defined over phrasal categories (e.g., subjacency constraints, Chomsky 1977; that-trace constraint, Perlmutter 1968). Thus, in most if not all syntactic theories, syntactic representations are not only hierarchically organized, but abstract. But again, in principle, speakers' real-time representations of their own utterances may or may not be abstract.

There are two major lines of evidence that speakers real-time representations of their utterances are abstract, involving abstract categories like nouns and verbs, and that these abstract categories are causally involved in sentence production. The first piece of evidence comes from, again, speech errors. As discussed above, Garrett (Garrett 1975, see also Fromkin 1971; Nootboom 1973) observed that speakers often exchange words that appear far apart in linear distance. Interestingly, when words are exchanged, the two words involved share the same syntactic categories. For example, nouns exchange with nouns but not with verbs, and verbs exchange with verbs but not with nouns. This constraint on word exchange error is known as the syntactic category constraint (Dell, Oppenheim, & Kittredge, 2008). The same is true for substitution errors (Fromkin, 1971; Nootboom, 1973). There is also some experimental evidence suggesting that lexical competition (the presumed source of exchange and substitution errors) is restricted to words in the same categories (Momma, Buffinton, Slevc, & Phillips, 2014). The very existence of the syntactic category constraint suggests that the abstract syntactic category is causally involved in controlling what speakers say, even when they err.

The second line of evidence comes from a phenomenon known as *syntactic priming* (also referred to as *structural priming* or *structural persistence* in the production

literature). Syntactic priming is a well-established phenomenon in which speakers tend to re-use the structure that they recently encountered when more than one structural alternatives is suitable for expressing the same message. For example, Bock (1986) showed that speakers are more likely to describe a picture of an event using passive sentences like (4d) as opposed to active sentences like (4c), after they encountered passive sentences like (4b) compared to (4a):

- (4) a. One of the fans punched the referee. [active prime]
- b. The referee was punched by one of the fans. [passive prime]
- c. Lightning is striking the church. [active target]
- d. The church was being struck by the lightning. [passive target]

Bock (1986) also found that dative alternation such as (5) can be syntactically primed.

- (5) a. A rock start sold some cocaine to an undercover agent. [prepositional dative prime]
- b. A rock start sold an undercover agent some cocaine. [double object prime]
- c. The man is reading a story to the boy. [prepositional dative target]
- d. The man is reading the boy a story. [double object target]

Syntactic priming effect has been replicated numerous times, with diverse languages and diverse structural alternations (Japanese scrambling, Tanaka, Tamaoka, and Sakai 2007; Dutch dative alternation; Hartsuiker and Kolk 1998; Control vs. raising in English: Griffin and Weinstein-Tull 2003; English complementizer choice: V. Ferreira 2003; English Spray-Load alterations; Chang, Bock, and Goldberg 2003; see Pickering and Ferreira 2008 for a review). Importantly, syntactic priming can be observed without any overlap in content or function words between prime and target words (see, e.g., Bock 1989), although repeating content words, especially the head of primed structures, increases the magnitude of syntactic priming (this additional priming is known as lexical boost in the literature (Cleland & Pickering, 2003; Pickering & Branigan, 1998)). The fact that syntactic priming can be obtained without lexical

overlap suggests that the representations of sentences that speakers construct during sentence planning involve abstract syntactic categories.

Thus, both the syntactic category constraints in speech errors and the lexical independence of syntactic priming suggest that speakers' real-time representations of sentences are abstract, in the sense that categories of syntax like nouns, verbs, preposition, noun phrases, verbs phrases, prepositional phrases, and so on, are causally involved in determining what and how we speak.

### **Quality of syntactic representations**

So far, I have discussed the (relatively uncontroversial) view that speakers' syntactic representations are hierarchical and abstract. But that does not necessarily mean that the nature of real-time syntactic representations speakers construct is captured by syntactic theories, which are mostly based on acceptability judgment data. Syntactic representations involved in making acceptability judgments and syntactic representations involved in speaking may mismatch. For example, speakers' representations of sentences may not be as detailed and elaborate as representations involved in acceptability judgment tasks.

Using acceptability judgment, syntacticians have discovered varieties of subtle constraints on sentence structures; e.g., syntactic island constraints (Ross, 1967), that-trace constraints (Perlmutter, 1968) and other various conditions on long-distance extractions (e.g., goal arguments cannot be extracted from double object constructions, Baker and Brame 1972; Kuroda 1968; Merchant et al. 2001). If speakers are sensitive to these subtle constraints, speakers must be able to represent sentence structures that are detailed enough to encode these syntactic constraints. Certainly, even if speakers do obey these constraints, the representations used for making acceptability judgments and the real-time representations used for guiding speaking may not be identical.

However, to the extent that speakers obey the same constraints that govern acceptability judgment patterns, there is little motivation to have a different theory of representations for each task (see Phillips and Lewis 2013 for discussion). Thus,



syntactic theories offer representational foundations for theories of speaking, to the extent that syntactic theories capture the nature of speakers' real-time sentence representation that guides their utterances.

It is worth clarifying at the outset that speakers do produce utterances that are generally judged to be unacceptable, often by mistake. For example, speakers use the wrong tense (e.g., *a university that IS celebratING its 50th anniversary a couple of years ago*; taken from UCLA speech error corpus) use wrong agreement (e.g., *the key to the cabinets ARE rusty*), produce prepositions twice in pied-piped constructions (e.g., *to which we have committed ourselves TO*; taken from UCLA speech error corpus), use wrong pronominal forms (e.g., *the crowd at the Olympic event enjoyed THEMSELVES*, taken from Bock, Nicol, and Cutting 1999), produce wrong case-markers in case-marking languages like Japanese, and so forth. All these grammatical errors can be found in naturally occurring speech (Fromkin, 1971; Iwasaki, 2010), and some of these errors can be reliably elicited in experimental settings. For example, subject-verb agreement and pronominal agreement errors can be reliably elicited (Bock & Miller, 1991; Bock et al., 1999). Case-marking errors can also be experimentally induced (Iwasaki, 2010). However, the critical question is not what speakers end up saying, but what speakers' syntactic representations are as they plan their utterances. Many types of errors introduced above can be explained by assuming an imperfect memory or internal repairs. For example, subject-verb agreement and pronominal errors can be due to a mis-retrieval of subject number features when speakers try to encode verbs' morphological forms (see, for example, Badecker and Lewis 2007 for a cue-based retrieval model of agreement attraction in production. See also Wagers, Lau, and Phillips 2009 for a review of agreement attraction in comprehension). Case marking errors can be due to internal repairs of sentences. For example, when Japanese speakers use the accusative case for the passive subject by mistake, they may be simply starting to say a subject-dropped active sentence (or scrambled OSV sentences) and then repairing it into passive sentences after they uttered the object noun. Certainly, the burden of proof is on the side that argues that what speakers actually said and their

representation of their own sentences during planning can dissociate from each other. However, it is premature to conclude, based on speech error data, that speakers represent ill-formed syntactic structures during sentence planning.

More importantly, speakers' errors are not random in kind. As reviewed above, speakers make morpho-syntactic errors relatively frequently (e.g., tense errors, agreement errors, case marking errors), but they rarely violate basic phrase structure constraints (due to the syntactic category constraint introduced above). They also obey more non-obvious constraints like island constraints, that-trace constraints, and some other non-obvious constraints on extractions rather strictly. First, Pearl and Sprouse (2012) showed that island-violating sentences are vanishingly rare, at least in child-directed speech. Based on the Child Language Data Exchange System (CHILDES) corpus (MacWhinney, 2014), they found precisely zero instances of sentences violating complex NP islands, subject islands, and whether islands and adjunct islands. This lack of island-violating utterances means that speakers do not speak sentences that violate island constraints, at least not frequently enough to appear in the sample Pearl and Sprouse investigated. Certainly, this lack of island violation might reflect simply the lack of opportunities for speakers to speak complex sentences in which island constraints can potentially be violated. However, F. Ferreira and Swets (2005) conducted an experiment in which speakers spoke sentences such as the following.

(6) ? This is the donkey that I don't know where it is from.

This sentence contains resumptive pronouns, pronouns that occur instead of a gap and co-referential to the filler, in an island context (Chomsky, 1986; Heestand, Xiang, & Polinsky, 2011; Polinsky, Clemens, Morgan, & Heestand, 2013; Ross, 1967). In this experiment, speakers were given ample opportunities for violating the island constraint. However, instead of violating syntactic islands, speakers chose to use resumptive pronouns. Resumptive pronouns are normally judged to be relatively unacceptable. However, unacceptable does not necessarily mean ungrammatical, and a recent study suggests that the resumptive pronouns are judged better than island-violating gaps in a forced choice task, suggesting that resumptive pronouns inside islands may actually be

grammatical in English (Ackerman, Frazier, and Yoshida 2017, but see Heestand et al. 2011; Polinsky et al. 2013). If this view on resumptive pronouns is true, speakers rather strictly avoid sentences that are ill-formed due to the violation of island constraints.

Speakers also rather strictly avoid violating the that-trace constraint. For example, Phillips (2013) observed that speakers never violated the that-trace constraint in a naturalistic corpus (0 instances of that-trace violation in 13 cases of subject extractions from embedded clauses). Experimentally, my collaborator and I found that speakers ( $n = 48$ , data collection ongoing) almost never produced *that* in sentences such as (7), even when they were primed to produce *that* half the time (using the method similar to V. Ferreira 2003).

- (7) Who does the chef think (\*that) is splashing the doctor?

Speakers in our experiment produced 22 instances of *that* (violating the that-trace constraint) in 1400 utterances containing wh-extractions from the embedded subject position, such as in (7). 19 of the 22 that-trace violating sentences were produced by two speakers, so when those speakers were removed, there were only 3 instances of that-trace violating sentences out in 1356 relevant utterances. This is particularly striking, considering that the production of *that* was syntactically primed half the time. Thus, the case of that-trace violation in production is vanishingly rare, both in naturalistic and experimental settings. This rather strict avoidance of that-trace violations is not due to the general avoidance of producing *that* in wh-sentences. In the same experiment with the same set of participants, we found that speakers produced *that* 404 times in 1400 sentences containing wh-extraction from the matrix subject position, such as in (8a), and 88 times in 1400 sentences containing wh-extraction from the embedded object position such as in (8b).

- (8) a. Who thinks (that) the monk is splashing the doctor?  
 b. Who does the chef think (that) the monk is splashing?

Thus, speakers produce *that* when producing *that* does not result in a violation of grammatical constraints. Note, however, that speakers were much less likely to produce

*that* in the sentences containing the extraction from the embedded object position than in the sentences containing the extraction from the matrix subject position. This pattern is consistent with the corpus study by Phillips (2013). Phillips found only 2 instances of that production among 161 utterances containing *wh*-extractions from embedded object positions. Thus, speakers seem to be, for currently unknown reasons, much less likely to produce *that* in utterances where the extracted *wh*-element is from the embedded object position, such as in (8b) than when the extracted *wh*-element is from the matrix subject position, such as in (8a). Nevertheless, these results suggest that speakers avoid violating the *that*-trace constraint rather strictly, even when they are encouraged to say *that* via syntactic priming.

Finally, another study that my collaborators and I are currently conducting shows that speakers readily say sentences like (9a) but almost never say sentences like (9b), according to the observation that an extraction of goal objects in double object construction is ungrammatical (Baker & Brame, 1972; Kuroda, 1968; Merchant et al., 2001)

- (9) a. Who is the chef giving the book to? [prepositional dative]  
 b. \*Who is the chef giving the book? [double object dative]

The data collection is still ongoing ( $n = 24$  so far), but we found only 1 instance of sentences like (9b) in 432 trials. In the overwhelming majority of the trials, speakers used the prepositional dative structures such as in (9a). This contrast is unlikely to be due to the artifact of the task or due to general dispreferences of speakers to use double object dative structures in *wh*-sentences. The same speakers in the same experiment, with minimally different picture stimuli, readily produced both types of sentences:

- (10) a. Who is giving the book to the chef? [prepositional dative]  
 b. Who is giving the chef the book? [double object dative]

In sum, speakers readily used both prepositional and double object dative structures in the sentences with matrix subject extraction, but not in the sentences with goal object extractions. Speakers do not produce sentences that violate constraints of

long-distance extractions, including the island constraints, the that-trace constraint, or the constraint on indirect object extraction in double object constructions.

So far, I have argued rather optimistically that the real-time syntactic representations that speakers build during production are isomorphic to representations of sentences described by syntactic theories built on acceptability judgment data. However, I should note that some evidence, mainly from syntactic priming studies, suggests that speakers' syntactic representation is not as detailed as I suggested. For example, Bock, Loebell, and Morey (1990) showed that sentences, such as *The wealthy widow drove her Mercedes to the church*, syntactically prime the prepositional dative production as much as real prepositional datives, presumably because both of them share V-NP-PP sequence. They also showed that locative sentences like *The foreigner were loitering by the broken traffic light* primed passive sentences as much as real passive sentences, presumably because they both contain an auxiliary verb and by-phrase. These results suggest that sentence representation may not be detailed enough to distinguish between arguments and adjuncts or between agentive by-phrase and locative by-phrase. These may suggest that speakers' real-time syntactic representation is not detailed enough to encode these distinctions. However, I should note that the fact that a certain tool (e.g., syntactic priming) is insensitive to a certain hypothesized difference is not evidence that the difference does not exist; i.e., the absence of evidence is not the evidence for the absence (see also the discussion of syntactic priming below).

In this section, I have reviewed the view that speakers represent abstract hierarchical representations that are detailed enough to encode subtle grammatical constraints. To the extent that this view is correct, syntactic theories offer theories of representations that are an essential part of theories of speaking.

### **Limitations and potential utility of production studies in syntax**

So far, I have discussed the view that speakers represent abstract hierarchical representations that are detailed enough to encode subtle grammatical constraints in real-time production. Thus, there is little reason to believe that the nature of

representations used in acceptability judgment tasks and the nature of representations used in constructing sentences during speaking is different. If this view is right, production data should reflect our syntactic knowledge, and thus production data should be relevant in developing theories of syntax, at least in principle. Next I will discuss how production data may (or may not) be useful in syntactic theorizing.

## Limitations

Let me start with the limitations of production studies. Perhaps the most obvious limitation is that it is hard to control what people say. This prevents production researchers from studying varieties of key phenomena in syntactic theories (e.g., *wh*-movements with embeddings, comparatives, sentences involving multiple quantifiers, and sentences involving different types of pronouns and anaphora, among others). Researchers can devise a task that elicits complex sentences, but doing so requires creativity (see, e.g., F. Ferreira and Swets 2005). Also, complex tasks are often subject to criticisms on the basis of external validity (but see Mook 1983). In general, running production experiments on many syntactically interesting phenomena is practically challenging.

Furthermore, speaking is a complex behavior that is influenced by a currently unknown number of factors, one of which is syntactic knowledge. This is more or less true for other behaviors like acceptability judgment, but it is likely that the number of factors that influence production behaviors is vastly greater than the number of factors that influence acceptability judgment or comprehension tasks (Fodor 1983 has made a similar point). As a result, it is not a straightforward task to attribute observed differences in production behaviors to a specific cause, especially in non-experimental settings. For example, it may be tempting to infer that a particular sentence structure is not grammatical if one fails to see any instances of such a sentence structure in a naturalistic corpus. However, there are many potential reasons why speakers may avoid producing it. For instance, as I reported above, sentences with an embedded object extraction and an overt complementizer are rare both in naturalistic and experimental

data. However, this does not mean that the structure is ungrammatical (or less grammatical than some baseline). Indeed, acceptability judgment data suggests that such sentences are likely to be grammatical (Pesetsky, 2017). Speakers can avoid a particular sentence structure for varieties of reasons, and currently, there is no good understanding of what those reasons could be. Thus, making inferences about representation based on production data is risky, likely riskier than making inferences about representations based on acceptability judgment data. Also, a related issue is that production data is fundamentally ill-suited to test a type of prediction that syntactic theories routinely make; i.e., a certain construction should be ungrammatical. Production data cannot offer the definitive evidence that the structure is ungrammatical. Of course, this does not mean that production data should be ignored. The absence of evidence that the structure is grammatical can strengthen the independent evidence that a certain construction is ungrammatical. However, there is an in-principle limitation of production data, and without complementary methods such as acceptability judgment, it is not possible to test predictions of syntactic theories that a certain structure should be ungrammatical.

### **Potential utilities**

Of course, the fact that production studies on syntactically interesting phenomena are difficult does not mean that production studies are irrelevant for the studies of syntactic representations. Indeed, production studies can corroborate or challenge the insights from syntactic theories and, in the best case scenarios, they may even offer tests for competing theories of syntax (with some caveats).

**Providing converging evidence.** Some production studies can offer converging evidence for the basic distinctions and theoretical constructs that most syntactic theories have postulated based on acceptability judgment data. For example, as I discussed above, Fromkin (1971) and Garrett (1975) both showed, by analyzing speech errors, that basic theoretical constructs of syntactic theories, like morphemes, words, phrases, and abstract lexical and phrasal categories do exist as a unit in the

speaker' mind, corroborating the acceptability judgment data combined with various constituency tests. Also, the very existence of syntactic priming (Bock, 1986) suggests that phrasal categories are representational units of language. Melinger and Dobel (2005) suggest that simply presenting a verb in isolation is sufficient to obtain a syntactic priming effect for the structure that is strongly associated with that verb, suggesting that verbs encode some category-level syntactic information about their complements, in accordance with most theories of syntax (c-selection; see also Pickering and Branigan 1998). Griffin and Weinstein-Tull (2003), using sentence-recall tasks Potter and Lombardi (1990), showed that speakers were more likely to recall sentences like *John believed that Mary was nice* than near-synonymous object raising sentences like *John believed Mary to be nice*, after producing another sentence with an object raising construction (e.g., *A teaching assistant reported the exam to be too difficult*) compared to sentences with object control constructions (e.g., *Allen encouraged his roommate to be more studious*). This result corroborates the distinction between object raising and object control structures. Momma et al. (2018) showed that speakers plan verbs in different timing when producing sentences with unaccusative verbs compared to when producing sentences with unergative verbs, suggesting that the unaccusative-unergative distinction is relevant at some level of representation (either at thematic or syntactic level). Also, as discussed above, speakers rather strictly obey constraints like island constraints, that-trace constraints, and constraints that prohibit extracting goal arguments from double object constructions. These results do not necessarily distinguish between competing syntactic theories and analyses, in the sense that these are basic distinctions and theoretical constructs that most if not all syntactic theories postulate, but they do offer the converging evidence that strengthens the foundations of existing syntactic theories.

**Evaluating competing theories.** Production studies may also be able to offer tests for two competing syntactic hypotheses that are hard to evaluate solely on the basis of acceptability judgment data, though with caveats. I introduce three case studies that may potentially be relevant for evaluating competing hypotheses in syntax.



**Analysis of passive.** In syntax literature, how passive sentences should be analyzed is a major topic of research, because it has a major consequence on broader theories of syntax, such as Case theory, theory of movement, theta theory, theories of argument structures, and theories of acquisition. Roughly speaking, there are (at least) two lines of thought. Some propose that passives are transformationally derived from active counterparts (Chomsky, 1957, 1986). Others argue that passives are formed by lexical rules that changes the argument structure of verbs (Bresnan, 1982; Freidin, 1975; Sag & Pollard, 1987).

In production literature, Bock, Loebell, and Morey (1992) argued that passives are not transformationally derived (see also Branigan and Pickering 2017), based on the results from production experiments. In their experiments, speakers read aloud the following types of sentences as prime sentences.

- (11) a. Five people carried the boat.  
       b. The boat was carried by five people.  
       c. The boat carried five people.  
       d. Five people were carried by the boat.

Subsequently, speakers described pictures that can be described by active sentences with the inanimate subject, like the following:

- (12) The alarm clock awakened the boy.

They measured the proportion of active sentences likes (12) in speakers' response to the pictures. They found that speakers were more likely to produce active sentences like (12) after the active sentence primes like (11a) and (11c) than after the passive prime like (11b) and (11d). This is a standard syntactic priming effect (Bock, 1986). More critically, they found that speakers were more likely to produce active sentences with inanimate subjects like (12) after the primes with inanimate subjects like (11b) and (11c) than primes with animate subjects like (11a) and (11d). In other words, Bock and colleagues found that speakers tend to preserve the mapping between animacy and the surface subject position, regardless of the voice of the prime sentences. I call this

animacy-function priming effect. Bock and colleagues (see also Pickering & V. Ferreira, 2006; Branigan & Pickering, 2007) suggested that, under the transformational account, speakers should show no (or weaker) animacy-function priming effect when the primes are passive sentences. This is because the animate argument (five people) is the underlying object in (11d). Speakers should tend to preserve the mapping between the animacy and object positions, so they should tend to use animate argument (five people) as an underlying object if the transformational account is correct. This animacy-function priming effect for the deep object position should cancel out with the animacy-function effect for the surface subject position. Contrary to this prediction, their results show that speakers produce more active sentences with inanimate subjects like (12) after primes like (11b) than (11d). Thus, speakers showed the tendency to preserve the mapping between the animacy and surface subject position, but not the mapping between animacy and the deep object position. Based on this pattern, Bock and colleagues argued that the transformational account of passives cannot explain their production data.

The validity of this argument depends on at least three assumptions, none of which can be false for the argument to hold. First, it was assumed that passive transformation has a corresponding processing operation that transforms active sentences to passive sentences (in line with the *Derivational Theory of Complexity*, see Berwick and Weinberg 1986; Fodor, Bever, and Garrett 1974; Phillips 1996). Second, it was assumed that an animacy-function priming effect could be obtained for non-subject positions (so that the effect cancels out the competing animacy-function priming effect for the surface subject position). Third, animacy-function priming effect should be equally sensitive to both levels of representations (underlying and surface representations).

If all these assumptions are correct, their data may speak against the transformational account of passive sentences. But each assumption can be challenged. This is not to argue that the results from (Bock et al., 1992) are irrelevant to syntactic theorizing or should be ignored. Instead, the point is that the assumptions about the relationship between the representational claims and the behavioral effects need to be

spelled out and tested independently. It is also important to emphasize that there are varieties of acceptability judgment data supporting the transformational account of passives. For example, a sentence like *Fredrick is considered to be nice* is considered an acceptable passive sentence (taken from Carnie 2011 p. 335; modified slightly).

However, *Frederick* does not receive a theta role from *is considered* but receives a theta role from the predicate of the embedded clause, *is nice*. This data challenges the view that active-passive distinction is encoded lexically because the theta role of the subject of *is considered* depends on the predicate of the embedded clause *is nice*. To capture the dependency between the matrix subject and the embedded verb, some mechanism that connects the two elements, like movement that leaves a co-referential empty category, is necessary. Changing verbs' argument structure is not sufficient. This argument based on acceptability judgment data (that sentences like *Fredrick is considered to be nice* is perfectly acceptable) should not be valued less just because it conflicts with a particular interpretation of some production data.

**Syntactic unaccusativity.** Intransitive verbs can be classified into two sub-classes: unergative verbs, whose sole argument is agent (e.g., *run*), and unaccusative verbs, whose sole argument is patient (or theme, e.g., *fall*). This basic distinction is not in dispute; there are various signs of unaccusativity across different languages (including in the production data; Momma et al. 2018). The question is whether unaccusative-unergative distinctions are realized not only at the level of semantics, but also at the level of syntax.

Kim (2006) showed that speakers were more likely to use passive sentences to describe a picture after the prime sentences with unaccusative verbs compared with active transitive verbs. This result suggests that passives and unaccusatives are representationally similar, and syntactic accounts of unaccusative verbs suggest. As Kim admitted, alternative interpretation is possible if one assumes that a repetition of thematic role-grammatical function correspondence or thematic role-linear position correspondence can also induce syntactic priming effect. However, if syntactic priming is insensitive to thematic structures, as suggested by Bock and Loebell (1990; but see

Chang et al. 2003), Kim's results may suggest that unaccusative and passive sentences share the same (or similar) syntactic structures above and beyond the difference in thematic structures, provided that the syntactic priming effect is not sensitive to the mapping between thematic roles and linear order.

In comparison to Kim (2006), Flett (2006) showed that Spanish speakers tended to re-use post-verbal or pre-verbal subject structures in unaccusative sentences, to the same degree after unergative and unaccusative primes. But this result does not show that unaccusative sentences and unergative sentences are indistinguishable syntactically. It shows that syntactic priming is sensitive to surface word order similarity (Tanaka et al., 2007), and is relatively insensitive to the thematic structure or non-surface syntactic structure. Thus, with an important caveat that the syntactic priming may not be purely syntactic, the result from Kim (2006) might suggest that unaccusatives are syntactically like passives.

**Representation of Ellipsis.** In syntax literature, there is a debate about the representational nature of ellipsis sites. Some argue that the ellipsis site contains syntactic structures in addition to semantic structures (e.g., Chung, Ladusaw, and McCloskey 1995; Merchant et al. 2001). Others argue that only semantic structures are contained in the ellipsis site (e.g., Culicover, Jackendoff, Jackendoff, et al. 2005; Ginzburg and Sag 2000). Xiang, Grove, and Merchant (2014) tested these possibilities using syntactic priming. In their study, they have speakers read the following sentence fragment:

- (13) a. First Ralph sang a song to Sheila, and then [Prepositional dative prime]  
 b. First Ralph sang Sheila a song, and then [Double object prime]

These fragment of prime sentences were continued with one of the following:

- (14) a. Marcus sang one to her / Marcus sang her one [Non-ellipsis]  
 b. Marcus did. [Ellipsis]  
 c. Marcus groaned [Neutral control]

In (14a), the continuation again contained PD or DO structure overtly, and the VP structure matched with the VP structures of the preceding sentences. In (14b) the VP was elided, so there was no overt PD or DO structure. In (14c), the verb was an unrelated verb that did not bear ellipsis dependency relation to the preceding clause. Xiang et al. found that speakers were more likely to use the structure that they encountered in the initial clause in the non-ellipsis condition and the ellipsis condition, but not in the neutral control condition. Again, with the important caveat that the syntactic priming may be sensitive to thematic structures, Xiang and colleagues data may suggest that the ellipsis site contains syntactic representations that cause priming.

**Caveats.** Through the discussion of specific production studies, I argued that the production data can be relevant to syntactic theorizing but that the interpretations of these studies depend on the hypotheses about how representational claims connect to behavioral predictions. Such hypotheses can be called *linking hypotheses*, and they can vary independently from representational hypotheses. This point has long been noted in the comprehension literature (see, e.g., Berwick and Weinberg 1986; Fodor et al. 1974; Marantz 2005; Miller and McKean 1964; Phillips 1996; Phillips and Lewis 2013; Townsend and Bever 2001). For example, the derivational theory of complexity is a linking hypothesis that claims that more complex structures (e.g., in terms of a number of nodes in syntactic representations or in terms of number of transformation necessary to derive a sentence among other potential complexity measures) takes more time to compute and thus more time to comprehend. When the derivational theory of complexity (that assumes that the number of transformation is a complexity measure) and transformational theory of passive sentences are combined, it is possible to predict that passive sentences should take more time to understand than active sentences (due to an additional transformation operation). Let's say that this prediction is incompatible with some behavioral data. That would mean either representational hypothesis is wrong or the linking hypothesis is wrong (e.g., Berwick and Weinberg 1986). Thus, even when behavioral data goes against certain representational hypotheses, it is not always straightforward to make a strong inference about

representations. This is especially so when the behavior of interest involves complex processes that are affected by multiple factors, like in sentence production. It is necessary to spell out and test the assumed linking hypotheses before the behavioral data (including both production data and acceptability judgment data) can be used to support or disconfirm representational claims. This difficulty of connecting behavioral data and representational claims may be frustrating to psycholinguists (including myself) because it often prevents them (and me) from making a strong claim about representations based on psycholinguistic data. But that does not mean that the problem can be ignored.

### **Other issues**

**Syntactic priming as a privileged source of data?** Above, I have introduced varieties of syntactic priming studies and their potential utility and limitations in investigating the nature of syntactic representations. In short, syntactic priming can be used as a tool for investigating potential representational similarities between different sentences. In this sense, syntactic priming studies can provide an additional source of data for syntactic theories, provided that the precise cause of syntactic priming can reasonably be identified. I suspect that this claim is rather uncontroversial. However, some researchers have made the stronger claim that that syntactic priming should be a privileged source of data for syntactic theories (Branigan Pickering, 2017). In short, Branigan and Pickering argued that syntactic priming should be more privileged than acceptability judgment, because it is implicit, because it is not (or less) affected by parsing factors, and because it can directly examine representations (rather than just whether a sentence is grammatical or not). They argued that acceptability judgment tasks, in comparison, require explicit decision-making tasks, that it involves the source ambiguity problem (explained below), and that it can only assess whether a sentence belongs to a set of grammatical sentences without being combined with constituency tests, which they argued are independently problematic. This claim is particularly relevant to the central theme of this handbook, so let me

unpack their argument.

First, Branigan and Pickering claimed that syntactic priming is an implicit effect, but acceptability judgment tasks involve explicit decision-making processes. Syntactic priming effect can indeed be obtained without speakers' awareness (for the clearest demonstration, see V. S. Ferreira, Bock, Wilson, and Cohen 2008) and it is indeed the case that acceptability judgment tasks require explicit decision making. However, it is not clear how and why implicit methods are better than explicit methods in investigating syntactic representations. Branigan and Pickering noted that the potential decision-making bias might contaminate acceptability judgment results. However, it remains unclear which specific decision-making bias affect the result of which specific acceptability judgment, in a way that is problematic for data interpretation.

Second, they argued that acceptability judgment tasks invoke what they call the source ambiguity problem, that is, acceptability degradation/improvement can be attributed to some factors other than grammaticality of sentences. They implied that the syntactic priming does not suffer from the same problem. However, syntactic priming effect, or any other effects on complex behaviors for that matter, suffer from the same problem. When studying a complex system like human language, it is rarely the case that an experimental effect can be attributed unambiguously to a single cause. As I reviewed above, it is far from clear what causes syntactic priming effect. It may be due to the repeated thematic role-linear order correspondence (Bock et al., 1990; Chang et al., 2003), repeated linear order of words and constituents (Hartsuiker & Kolk, 1998), or repeated phrase structure sequence (Bock et al., 1990).

Finally, they argued that the acceptability judgment task only allows researchers to test whether a sentence is a set of grammatical sentences in a language. That is, they argued that acceptability judgment tasks are methods that determine weak generative capacity. In comparison, they claim that syntactic priming can assess the representations directly, so it is a method that can determine strong generative capacity. This claim is simply false. As pointed out by Gaston, Huang, and Phillips (2017)), acceptability judgment tasks are routinely used in assessing representational

similarity (ellipsis, coordination), hierarchical relation (binding), and structural locality (wh-movement, relativization, topicalization, scrambling, among others).

In sum, syntactic priming can provide an additional source of data for syntactic theories, but it is not clear why syntactic priming should be viewed as a privileged source of data for syntactic theories. A reasonable view, in my opinion, is that which methodology is more suitable depends on what specific question a researcher is trying to answer. Syntactic priming is a good tool for detecting some similarity between two structures (e.g., see the discussion on Kim 2006 above). But it is not a particularly good tool for detecting differences between two structures, because the fact that two sentences prime each other do not mean that they are identical (see the discussion on Bock & Loebell 1990 above). In addition, the failure to obtain priming effect does not necessarily suggest that two structures are not similar.

**Closing circularity.** Acceptability of sentences can be influenced by varieties of factors, including grammaticality, pragmatic naturalness, complexity, and frequency of constructions, among other factors. A critical task for researchers using acceptability judgment is to identify the source(s) of acceptability degradation/improvement. When researchers hypothesize that acceptability judgment difference is not due to grammatical status, they need to offer an alternative explanation for the acceptability difference. One potential source of acceptability difference is that difference in the frequency of constructions (Greenbaum 1977, 1980; see Schütze 2016 for a discussion). However, the problem is that any frequency explanations of acceptability difference is circular and thus carry little explanatory force. To close this circularity, there needs to be an independent explanation of why certain structures are less frequent than others. Such an explanation necessarily involve theories of speaking. Thus, studies of production can be useful in making a non-circular argument in syntax.

## Conclusion

Theories of speaking seek to capture how speakers use syntactic knowledge during speaking. Thus, understanding the nature of syntactic knowledge is a central part of



understanding speaking. In turn, speaking reflects the structure of their syntactic knowledge. Thus, production data can be used to test behavioral predictions of syntactic theories, when combined with articulated linking hypotheses that connect representations and behaviors. With some caveats and limitations discussed above, studies of speaking and studies of syntax can be mutually informative to each other.

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