Are There Really Syntactic Complexity Effects in Sentence Production? A Reply to Scontras et al. (2015)

Maryellen C. MacDonald,[a] Jessica L. Montag,[b] Silvia P. Gennari[c]

[a]*Department of Psychology, University of Wisconsin-Madison*
[b]*Department of Psychological and Brain Sciences, Indiana University*
[c]*Department of Psychology, The University of York*

As researchers keenly interested in the language production-memory-comprehension dynamic, we welcome investigations of production difficulty by Scontras, Badecker, Shank, Lim, and Fedorenko (2015, henceforth SBSLF). However, their experiments provide little new information, and we question their broader memory-production approach.

1. What is SBSLF's evidence for syntactic complexity effects in production?

SBSLF contrasted sentences such as (1a–b), which differ in the grammatical role of *reporter*, either the subject (1a) or object (1b) of *attacked*; subscripts show these syntactic dependencies.

1a Subject-extraction: The reporter$_i$ [who$_i$ __$_i$ attacked the senator].
  b Object-extraction: The reporter$_i$ [who$_i$ the senator attacked __$_i$].

SBSLF argue that "structures with non-local dependencies like the object-extraction in (1b) may be more costly to produce because one of the dependencies initiated by the pronoun 'who' needs to be maintained in memory while the intervening material ('the senator' in [1b]) is being uttered" (p. 562). This quote, plus the article title—"Syntactic complexity effects in sentence production"—invites the inference that SBSLF's findings (longer initiation latencies and durations for object-extractions than subject-extractions) are syntactic complexity effects. However, SBSLF instead note some concerns with their studies and conclude that it "remains an open question" why their results obtained (p. 13). We think that SBSLF's choice of comparison conditions, methods, and materials compromise interpretation of their results.

Correspondence should be sent to Maryellen MacDonald, 532 Psychology Bldg, University of Wisconsin-Madison, 1202 West Johnson St., Madison, WI 53706. E-mail: mcmacdonald@wisc.edu

1.1. Uninformative comparison

We have studied production of subject-extractions like (1a) (Gennari, Mirković, & MacDonald, 2012), but the critical comparison between subject- and object-extractions in our studies has not been between (1a–b) types but between (1b) and a passive subject-extraction with short dependency distance, (1c) (Gennari & MacDonald, 2009; Gennari et al., 2012; Montag & MacDonald, 2014):

1c   Subject-extraction (passive): The reporter$_i$ [who$_i$ __$_i$ was attacked by the senator].

The (1b–c) comparison is preferable for two reasons. First, (1b–c) are closely matched for meaning—we investigate which alternative people use to convey a given message, for example, when describing a picture. SBSLF's (1a–b) contrast instead confounds dependency distance and meaning. Second, their (1a–b) comparison also confounds dependency distance with availability of alternative ways to convey the same message. Gennari et al. found that speakers used the (1a) structure 100% of the time to describe relevant pictures; other possibilities (e.g., "The reporter who the senator was attacked by") were never used. By contrast, speakers fluctuate between (1b) and (1c) structures to convey that message. SBSLF's (1a–b) comparison thus contrasts production of a highly favored structure (1a) to one (1b) that has a competing alternative. That comparison is undesirable because the existence of good alternative forms is itself associated with production difficulty (Stallings, MacDonald, & O'Seaghdha, 1998). Given these confounds of meaning and availability of competitors in the (1a–b) contrast, SBSLF's results do not have a clear interpretation.

1.2. Methods

SBSLF identified several methodological problems that undermined their initiation and latency measures: Participants were instructed not to say the highly favored (1c) type sentences and say the (1b) type instead, so that the object-extractions were uttered in conditions in which speakers had to avoid the prepotent response, whereas the subject-extraction trials (1a) had no extra instructions. They also noted that Experiment 1's visual displays were easier to follow in the subject-extraction than in the object-extraction conditions. SBSLF did not mention several additional concerns: In Experiment 1, initiation latencies included the time taken to read the question prompt in each trial (questions differ across conditions); and in Experiment 2, object-extraction trials with past tense verbs required longer utterances than the subject-extraction trials, and the visual display again favored faster initiation and completion of the subject-extraction trials. In the subject-extraction, a single look at the verb region on the screen allowed the verb to be uttered (e.g., *will thank*), but the verb components were discontinuous in object-extractions (e.g., *will the grader thank*), requiring looks back and forth from the verb and noun regions to complete the phrase. Thus, dependency distance in these studies is confounded with length, scene complexity, prompt comprehension, and instructions to avoid a favored sentence structure.

1.3. Materials

SBSLF's materials cannot provide a test of their hypothesis that dependency distance contributes to production difficulty. Fig. 1 illustrates two strong lexical effects on production difficulty. First, as shown in cells A-B in the figure, if we replace the embedded noun phrase *the senator* with a pronoun like *you*, the effect of dependency difference reverses—the object-extractions are strongly preferred in speech to both adults (Roland, Dick, & Elman, 2007) and children (Montag & MacDonald, 2015). Cells C–D show that the animacy of what is being discussed is also crucial: When speakers are describing something inanimate like *policy* (cell C), the long-dependency object-extractions and the short-dependency subject-extractions are equally favored and have equal initiation latencies (Montag & MacDonald, 2014). Humphreys and Gennari (2014), holding dependency distance constant, found that both initiation latency and production errors varied with the animacy of the head of the clause (*reporter* vs. *policy*). The one lexical combination in Fig. 1 with classic dependency distance effects is cell D, for reasons we explain elsewhere (Gennari et al., 2012; MacDonald, 2013). SBSLF's materials are all of this D type —animate head nouns (*reporter*) and embedded nouns (*senator*). Because presence/ absence of the dependency distance effect hinges on lexical properties, materials limited to the lexical configuration that yields predicted results cannot be used to support

	Inanimate Head (policy)	Animate Head (reporter)	
Pronoun in Embedded Clause (you)	**Longer Dependency Preferred** **Longer**: The policy [that you attacked] **Shorter**: The policy [that was attacked by you] **(A)**	**Longer Dependency Preferred** **Longer**: The reporter [who you attacked] **Shorter**: The reporter [who was attacked by you] **(B)**	**White cells (A, B, C)** • are not consistent with dependency distance predictions • contain the most common relative clause types in English
Full noun phrase in Embedded Clause (the senator)	**No Dependency Preference** **Longer**: The policy [that the senator attacked] **Shorter**: The policy [that was attacked by the senator] **(C)**	**Shorter Dependency Preferred** **Longer**: The reporter [who the senator attacked] **Shorter**: The reporter [who was attacked by the senator] **(D)**	**Shaded cell (D)** • is consistent with dependency distance predictions • contains noun types typically used in psycholinguistic research

Fig. 1. Patterns of production preferences and difficulty for object- and passive subject-extractions (1b and 1c types, respectively) as a function of head noun animacy and whether a pronoun or full noun phrase is the agent in the embedded clause. SBSLF's materials are only from Cell D.

SBSLF's hypothesis that dependency distance accounts for independent variance in production difficulty.

2. Would revised experiments show syntactic complexity effects?

Prior research already suggests that the answer to this question is "no." First, as Fig. 1 illustrates, corpus analyses and production experiments show that most relative clauses have noun combinations that do not yield the predicted effect of dependency distance (Cells A–C; Montag & MacDonald, 2015; Roland et al., 2007; also for the [1a–b] comparison, Reali & Christiansen, 2007). Second, contrary to the claim that long-distance dependencies tax working memory, children, who presumably have lower working memory capacity than adults, produce the long dependency object-extractions (1b) at a higher proportion than adults do (Montag & MacDonald, 2015). McKee, McDaniel, Garrett, Lozoraitis, and Mutterperl (2013) found that adults and older children produce relative clauses *faster* than comparable sections of simple sentences, inconsistent with the idea that dependency distance affects utterance durations. Third, Diessel and Tomasello (2005) measured the accuracy of children's production of relative clauses with a variety of dependency distances (the [1a–b] types and others) and concluded that dependency distance did not predict children's production performance. Thus, there is abundant evidence for non-syntactic factors affecting relative clause production difficulty, but not for dependency distance.

3. Does production require a different sort of theory?

The notion that dependency distance increases the working memory demands and thus production difficulty is borrowed from accounts of parsing discontinuous information in the linguistic signal. Whatever its value in comprehension, this approach is not well suited to production. Most accounts of serial ordering assume a contextual representation in a hierarchical plan (Botvinick & Plaut, 2006), with difficulty owing to interactions with context and to past production history; this context-guided process (i.e., the message-guided process in language production) does not yield the same predictions as the dependency distance account. For example, Gillespie and Pearlmutter (2011) argued that some putative syntactic distance effects could instead stem from semantic properties of the message affecting the timing of utterance planning. Thus, while there are clearly forces that affect word order and the distance between phrases in the utterance plan, these forces likely are not purely syntactic ones like dependency distance. And Fitz, Chang, and Christansen's (2011) computational model of language production successfully simulated relative clause difficulty in children and adults (the [1a–b] types and others) without any distance component. Their model has more difficulty producing object-extractions than subject-extractions, but it does not maintain dependencies any longer when producing one sentence type or the other. Difficulty in the model instead owes to other factors, including

the availability of alternative structures to express a message, the similarity among various sentence types that the model has experienced, and the frequency of those experiences.

Like SBSLF, we have noted that frequency must itself have causes. In our account, the motivations behind speakers' implicit choices of sentence structure (and thus structure frequency) largely stem from the nature of lexical retrieval and semantic interference between words during utterance planning, which promote certain lexico-syntactic combinations over others, such as the patterns in Fig. 1 (Gennari et al., 2012; MacDonald, 2013; Montag & MacDonald, 2014). Although one production bias (Plan Reuse, Mac-Donald, 2013) is at least partially lexically independent, the primacy of words (not syntax) in utterance planning underlies our belief that at least in the embedded clauses like (1a–c), dependency distance does not contribute to accounts of production difficulty. Dependency distance claims abound in the literature, but in both comprehension and production, relative clause researchers' repeated sampling from a narrow lexical set with atypical results (Cell D in Fig. 1) yields the illusion that dependency distance has a independent explanatory value. We have noted above how a broader set of materials changes the picture entirely in production. The same is true in comprehension, where dependency distance accounts for no additional variance when materials' lexical-thematic properties are considered (Gennari & MacDonald, 2008). Thus, we see abundant reason to dispense with the dependency distance construct for the structures that SBSLF investigate; their results do not prompt any revision of that view.

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