To /b/ or Not to /b/:

Preparation of Contingent Phonological Starting Points in Word Production

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Abstract

Preparation of unattached phonological fragments such as word-initial consonants has been conceived of as *partial production* and thus as revealing fundamental processes of phonological encoding in language production. However, recent evidence of flexible preparation (O'Séaghdha & Frazer, 2014) challenges the partial production view. Instead, preparation may be mediated by high-level attention to meta-linguistically accessible elements, such as starting points for phonological encoding. If so, preparation may occur even if it is often inapplicable. In a word naming experiment, preparation was equally present for sets containing three consistent items whether they were embedded with single or with multiple inconsistent exceptions. Unlike in previous work, preparation was not evident immediately after single inconsistent items. These results lead us to further specify the theory of attentional form preparation as follows: Preparation of starting points in word production not only involves sustained attention to an abstract symbolic construal of the current task situation (e.g., /b/s are relevant), but also opportunistic transient deployment of that construal in conjunction with target word selection. This proposal underscores the need for coordination among distinct processes of anticipatory preparation and actual word production. More broadly, phonological encoding provides a rich but underexplored domain for the study of complex attention.

Keywords: Form preparation, meta-phonology, transient attention, starting points, word production

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Speakers may preselect words before they are spoken. For example, English nouns may be selected in conjunction with the adjectives that precede them (Damian & Dumay, 2007, 2009), and key-words in late sentence position may be activated early in sentence formulation (Dell & O'Séaghdha, 1992). This means that components of the phonology of these words may also be pre-activated, providing a potential benefit to their later encoding (see Opperman, Jescheniak & Schriefers, 2010). From this perspective, word beginnings are particularly salient components. Anticipatory speech errors and exchanges attest that phonological ingredients, especially onsets, are pre-activated before the words are spoken (see Goldrick, 2014; Meyer, 2000 for reviews). For example, classic spoonerisms such as *sons of toil* → *tons of soil* often involve onset exchanges. Thus, speakers plan ahead, conceptually and phonologically, in a system where phonemic *starting points* (see Jacobs & Dell, 2014) and other fragments (see O'Séaghdha, 2015) may be activated somewhat independently of whole word representations. Because of their positioning as starting points for encoding, as well as their metalinguistic accessibility, phonological word beginnings may receive distinct attention in the push and pull of language production.

This anticipatory capability with respect to phonological word beginnings is harnessed in the *form preparation* experimental procedure (Meyer, 1990, 1991; see also Roelofs 2006; Alario et al., 2007). In form preparation, speakers benefit from knowing the probable beginnings of small sets of words (O'Séaghdha & Frazer, 2014). To focus

preparation on word beginnings rather than on particular words, the words are scheduled unpredictably. That is, speakers expect to use the component, but don't know which word from the set will next convey it. In a related condition, some or all items share a phonological component such as the first consonant. In the unrelated control condition, items do not systematically share any components, and so no phonological preparation is possible. In variants of form preparation, the individual target words may be cued by associates (e.g., mane → lion), by pictures, or, as in the current work, by printed presentation of the words themselves (Meyer, 1991; Roelofs, 2006; O'Séaghdha & Frazer, 2014).

Form preparation effects are notoriously fragile, seemingly eliminated by any variability in the target set (e.g., Damian & Bowers, 2003; Roelofs & Meyer, 1998; Roelofs, 1999; see O'Séaghdha & Frazer, 2014, for review). One explanation of this fragility has been that preparation involves *partial production* of potential target words (Roelofs, 1997; Levelt, Roelofs & Meyer, 1999) within a suspend-resume process. In this view, speakers initiate production of the shared component of target words at an abstract phonological level prior to selection of particular words, but they cannot do so if the component is not shared by all items (see below for an alternative account). Thus, a consistent consonant can be assigned to word-initial position (Roelofs, 1997). Production is suspended at this point, and *resumed* when a particular target word is selected (e.g., for CAT, /k/... + /æt/ → /kæt/). In this framework, evidence concerning what can be beneficially prepared provides direct insight into underlying aspects of phonological encoding (Roelofs, 1997). For example, the benefit of phonemic beginnings (starting points), but not of phonemic endings, indicates that

phonological encoding entails sequential assembly of phonological words from phonemes or phoneme clusters in Indo-European languages (Meyer, 1991; see Levelt et al., 1999; O'Séaghdha & Marin, 2000). In contrast to Indo-European languages, the absence of an initial consonant preparation benefit under most circumstances in Chinese languages, and in Japanese, suggests that phonological retrieval from memory and word-form assembly do not initially operate with phonemic segments in those languages (see O'Séaghdha, Chen & Chen, 2010, for Mandarin Chinese; Kureta, Fushimi & Tatsumi, 2006, for Japanese). It also suggests that the mere recurrence of shared components is not sufficient to engender a benefit. Therefore, form preparation appears to be a controlled volitional process rather than being an instance of automatic *implicit priming*. Attentional processes involving meta-phonological representation may be necessary to enable preparation benefits (O'Séaghdha & Frazer, 2014). In this view, speakers of Indo-European languages naturally retrieve and direct attention to internal representations corresponding to phonemic word onsets, but speakers of Chinese and Japanese may retrieve and spontaneously attend to other components, such as syllables (Chinese) and morae (Japanese), as phonological starting points (O'Séaghdha, 2015).

An attentional perspective accommodates cross-language differences, and also brings the partial production view of form preparation into question. Whereas the partial production view holds that preparation is all-or-none, O'Séaghdha and Frazer (2014) found that it was graded and adjustable in natural tasks, picture naming and visual word naming. Specifically, onset preparation with English language materials occurred in these tasks for variable sets that contained inconsistent exceptions (O'Séaghdha & Frazer, 2014).

Importantly, although preparation was reduced relative to previous experiments with fully consistent sets (e.g., Roelofs, 2006), it was robust immediately after inconsistent items. Because a consistent target always followed an inconsistent one, rapid reinstatement of preparation after an exception makes sense. Based on these outcomes, O'Séaghdha and Frazer proposed an alternative attentional account of form preparation in which preparation is distinct from actual production. In this view, sustained attention (e.g., Braver, 2012) to symbolically available elements, especially starting points, activates phonological ingredients that are incorporated into productions when consistent target words are encoded. Crucially, words are encoded wholistically, rather than via a suspend-resume mechanism. The form preparation benefit results from the intersection of an attentional process directed to unattached phonological fragments with whole-word phonological encoding.

The current research, guided by the attentional perspective, extends the boundaries of form preparation research. Specifically, we examined whether form preparation occurs with several inconsistent items intermixed with consistent ones in a set of words. On the standard view, preparation is already derailed by even one exception item, and so multiple inconsistent items would certainly make preparation impossible. Under an attentional view, if speakers ignore consistency when it is diluted, preparation might also be weakened, perhaps to the point of invisibility, when there are multiple inconsistent words. However, the attentional perspective also allows another possibility, namely that speakers may focus on consistent properties even in the presence of multiple inconsistent items. Participants need not track the inconsistent items individually but rather can treat them as a set defined

by negation of the property shared by the consistent items (e.g., ‘not /b/’), thus enabling attention to the positive property (e.g., /b/) to be maintained. From this perspective, multiple inconsistent items would lead to reduction rather than to a complete breakdown of preparation. For example, the increased attentional demands of multiple exceptions could lead to a reduction in sustained attention to the consistent property. In addition, it might lead to reduced application of transient attention in conjunction with production of particular words.

We now spell out more specific predictions based on the attentional account. In the single inconsistent condition, because consecutive items never repeat, it is 100% certain that a consistent item will follow an exception. Subsequently, the probability of another consecutive consistent item is $.66$ ($2/3$). Preparation should therefore occur immediately following the inconsistent item (as established by O’Séaghdha & Frazer, 2014), as well as on following consistent items. With multiple inconsistent items, the probability of a consistent item following an inconsistent one is much less. In the 3-inconsistent condition implemented in our experiment, the probability of a consistent item immediately following an inconsistent one was $3/5$ (60%), and the probability of a subsequent consistent item was $2/5$ (40%). Accordingly, the probability of extended consistent runs was much lower in 6-item sets, reaching a negligible level for runs of 4 or 5. These considerations leave a range of possibilities for the strength of preparation in the multiple-inconsistent condition. At one extreme, participants could adopt a sustained strategy and always prepare the consistent response. Alternatively, they could tune preparation to the contingencies (to the extent that they process them), or they could adopt some other strategy. However, except for a strong

always-prepare approach, the circumstances always disfavor the multiple-inconsistent condition, and so we predicted less preparation in this condition than in the single inconsistent condition. Based on our previous work (O'Séaghdha & Frazer, 2014), we predicted a preparation benefit immediately following a single exception, but not in the multiple-inconsistent condition.

Experiment: Form preparation with one or three inconsistent items

We modified the design of Experiment 2 of O'Séaghdha and Frazer (2014) by adding a condition with 6 words, three of them inconsistent, to the condition with 4 words and a single exception. In other respects, the design and procedure were not substantively changed. Participants encountered sets of 4 words (3 consistent, 1 inconsistent), sets of 6 words (3 consistent, 3 inconsistent), and corresponding unrelated control sets, and then named the individual words in each set 3 times as they appeared in random order without immediate repetitions. As in O'Séaghdha and Frazer, the procedure was repeated in a second phase to allow potential strategic effects to emerge. The primary interest was whether preparation occurred in the multiple inconsistent condition, and whether it differed from preparation in the single-inconsistent condition.

We used a word naming task rather than picture naming. Previous work by Roelofs (2006) with form preparation, and by Nozari, Kittredge, Dell and Schwartz (2010) concerning naming by aphasics, suggests that picture naming and word naming are roughly equivalent in the phonological phase of encoding despite differences in their pre-phonological retrieval demands. Moreover, our own previous work (O'Séaghdha & Frazer, 2014) showed a

comparable preparation benefit in picture naming and word naming, suggesting that indeed the latter captures the relevant processes at the stage of phonological encoding.

Method

Participants. Twenty-nine participants were recruited through campus announcements. They received a small payment in compensation for their time. All participants were native speakers of English.

Design. There were three factors, Set Size (4 or 6), Relatedness (Consistent, Inconsistent, Unrelated), and Phase (first, second). The dependent measure was naming time. The order of sets was randomized for each participant. Related items in each set of 6 words were segregated into two triplets which were assigned to the consistent condition for sets of 4 and 6, respectively. Triplet assignment was counterbalanced over set size. Inconsistent items, constructed from the unassigned triplets, were counterbalanced in three sub-versions of each set size 4 condition (see Materials for details). All inconsistent items were used for set size 6.

Materials. Six sets of six monosyllabic words were selected from the English Lexicon Project (Balota et al., 2007). Each set had a different onset consonant as shown in Table 1. All of the words were monosyllabic, and fell in a restricted naming latency range between 530ms and 630ms. By selecting items based on prior naming latencies we reduced variance and circumvented the need to control multiple other underlying variables (see O’Séaghdha & Frazer, 2014).

Related homogeneous sets were divided into two triplets. These were assigned as consistent items for sets of 4 and 6, respectively, in one version of the experiment, and vice

Table 1. The Six Sets of Six Monosyllabic Words Organized in Related and Unrelated Groups .

Participants Received Either Consistent Items 1-3 or 4-6 with 1 or 3 Inconsistent Items in Related Conditions. See Text for Additional Details.

		Related					
		/b/	/g/	/d/	/t/	/k/	/p/
Unrelated	1	beach	goose	dorm	teal	care	pot
	2	bulb	golf	dust	tank	court	pig
	3	bath	gas	dad	turf	cab	pulse
	4	boot	girl	deer	test	cop	path
	5	bush	gear	dart	tool	cave	pear
	6	boss	gate	desk	toad	cook	pole

versa in the other. Thus, for any participant, all items were processed in consistent conditions, but the consistent items were different for sets of 4 and for sets of 6. For sets of 6, the accompanying inconsistent items were scrambled distributions of the remaining items, such that three different onsets occurred with each consistent triplet. For sets of 4, a scrambled version of one third of the remaining items (corresponding to one horizontal unrelated set in Table 1) was used, and these thirds were rotated in 3 sub-versions of the experiment. Thus, if a participant received items 1-3 vertically as consistent items, they received the items in the 4th, 5th, or 6th row, scrambled so that all were inconsistent, as single inconsistent items. Finally, the unrelated controls were sets with no consistent items. For the 6-item condition, the unrelated sets were the 6 horizontal groups shown in Table 1. For the 4-item condition, the unrelated controls for each subgroup were heterogeneous

arrangements of the same words those participants received in the related (3 consistent + 1 inconsistent) sets of 4. Overall, each participant produced the same words in related (consistent and inconsistent) and unrelated conditions, and over participants all words were tested in all conditions.

Procedure. Subjects participated in the experiment on a Dell Optiplex computer running E-prime 2.0. Voice responses were collected through a voice-key microphone that was connected to the computer through a Serial Response Box. An audio recording device was used to create a complete session record for coding of errors or further analysis.

Participants were first briefed on the procedure and had the opportunity to ask clarifying questions. They completed 2 practice sets. Next, they received 12 sets of four and 12 sets of six words, half of them unrelated (all items heterogeneous) and half related (containing three consistent and 1 or 3 inconsistent items) (see Materials). The sets were presented in random order.

Prior to testing, the words in a set appeared together, vertically, on the screen and the participant read them aloud. The experimenter corrected any mispronunciations before continuation of the testing phase. The instruction for the test trials was to produce words as quickly and as accurately as possible as they appeared individually on the screen.

Participants initiated testing for a set by pressing a start key. An asterisk accompanied by a tone cued where the words would appear on the screen. A word from the set then appeared where the cue had been for 1150 ms, or until a response was registered by the voice-key. If the response was not on time or the microphone did not pick up the voice, the message 'Too Slow' accompanied by a tone appeared for 500 ms. The next cue appeared

1250 ms after the voice-key was triggered or 1000 ms after the 'Too Slow' message. Testing continued until all the words in a set had been presented three times with no immediate repetitions.

The procedure was repeated in a second experimental phase that was identical except for re-randomization of the order of sets. There was an opportunity to rest between the phases of the experiment. The experimenter remained in the room throughout the experiment. The sessions took about 40 minutes.

Results

Errors were coded against the audio record. Trials were considered errors when there were null (0 ms) or very unrealistic reaction times (< 150 ms), when there was extraneous noise, or when participants made a speech error. Null reaction times occurred if the voice key did not pick up a response or if a participant failed to respond before the deadline. Unrealistic reaction times could result from mouth or extraneous noises. Overall, 3.73% of the data were coded as errors and excluded from the reaction time analysis.

Table 2 displays the reaction time means and standard errors for the different conditions. The data suggest that participants were slower at naming words in sets of six than in sets of four. They were slightly slower in the second phase than the first. Inconsistent words were slightly slower than baseline. Most importantly, there was a small preparation benefit, numerically larger in the second phase, in all consistent comparisons. Preparation does not appear to be modulated by set size.

We conducted an overall linear mixed-effects model analysis in SAS on the correct naming times with Context (Consistent, Inconsistent, Unrelated), Set Size (4, 6) and Phase

Table 2. Mean Naming Latencies and Standard Errors with Net Context Effects Relative to the Unrelated Baseline as a Function of Context, Set Size, and Phase.

		Related		Unrelated	Context Effect	
		Inconsistent	Consistent		Inconsistent	Consistent
<hr/>						
4 Word Sets						
<hr/>						
Phase 1						
	RT	415	406	410	-5	4
	SE	10.16	9.87	9.83		
Phase 2						
	RT	424	412	421	-3	9
	SE	10.33	9.90	9.85		
6 Word Sets						
<hr/>						
Phase 1						
	RT	426	418	422	-5	4
	SE	9.86	9.87	9.79		
Phase 2						
	RT	436	429	436	0	7
	SE	9.90	9.90	9.79		
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(1, 2) as fixed effects, and participants and items as random effects. By participant and by item intercepts and slopes were included (see Barr, Levy, Scheepers & Tily, 2013). Both

Phase and Set Size were significant. Participants were 10 ms slower at producing the words in the second phase than the first, $F(1, 28) = 7.82, p = 0.009$. Responses were 11 ms slower in sets of six than in sets of four, $F(1, 28) = 24.29, p < .0001$, suggesting a complexity cost. The primary interest is the effect of Context (416 consistent, 425 inconsistent, 422 unrelated,) which was significant, $F(2, 56) = 10.52, p < .0001$. There were no interactions between the fixed effects. Contrary to prediction, the context effect was not modulated by set size, $F < 1$ (see Table 2).

The crucial question is whether the modest preparation benefit for consistent items is significant. Therefore, we conducted a second, narrower analysis, excluding the inconsistent condition, and testing the consistent condition directly against the unrelated baseline. This analysis showed main effects of Phase and Set Size as before [Phase: $F(1, 28) = 7.72, p < .001$; Set Size: $F(1, 28) = 24.39, p < .0001$]. The Context effect was significant, $F(1, 28) = 8.43, p = .007$. The slight increase in the Context effect in the second phase [Context x Phase interaction] was not significant. More important, the interactions involving Context and Set Size were nonsignificant ($F_s < 1$). Thus, as in the first analysis, there was no indication that the context effect for consistent items varied as a function of number of inconsistent words.

We had predicted more preparation in sets with one inconsistent word than in sets with three, partly because participants could always expect a consistent item immediately following a single exception. O'Séaghdha and Frazer (2014, Experiment 2) found that preparation was evident immediately after single inconsistent exceptions. This indicates either that preparation was sustained through inconsistent items or that it was rapidly

reinstated following them. The post-inconsistent preparation effect in O'Séaghdha and Frazer was 7 ms in the first phase and 12 ms in the second. In the current experiment, the net effect was negligible (0 in Phase 1 and 3 ms in Phase 2). However, preparation of about 15 ms was present for the two subsequent consistent items in Phase 2. These patterns were not seen in the 3-inconsistent condition where preparation followed no clearly discernible pattern. Although the absence of preparation immediately following single exceptions is striking, the data are otherwise not compelling enough to warrant an exploratory post-hoc analysis. However, the disparity between O'Séaghdha and Frazer's and the current single-inconsistent data influenced the following elaborated discussion of controlled form preparation.

Discussion

We observed a preparation benefit in word naming for consistent items sharing an onset consonant whether they were embedded in small sets with one inconsistent item or in larger sets with three inconsistent words. Surprisingly, the benefit was not statistically different for sets with single and those with multiple inconsistent words. The finding clearly favors an attentional view of form preparation over the traditional production pathway account in which form preparation depends on unanimity among set members. It supports the conclusion of previous work (O'Séaghdha & Frazer, 2014) that form preparation is not a manifestation of implicit priming but rather is a controlled process. However, there are also remaining challenges for the attentional view. The preparation effect, though robustly significant, is small, and the equivalence of preparation across set sizes requires explanation. The smaller than expected preparation effect for sets of 4 suggests some accommodation

to the circumstances of variable set sizes. We now outline an account of form preparation for both set sizes.

We suggest that participants were cognizant of the difference between two kinds of related sequences, estimated odds of the occurrence of consistent and inconsistent items for each, and applied preparation accordingly. In sets of 4, with one inconsistent exception, the odds for consistent items were good, at 75%. Participants therefore appear to have adopted a strategy of ignoring inconsistent words, attending to runs of consistent items, and applying preparation in later positions within such runs. After several consistent items, the expectation is diminished, and preparation may dwindle. This strategy is consistent with previous findings with single inconsistent items (O'Séaghdha and Frazer, 2014) with one notable difference: Rather than proactively preparing immediately after an inconsistent exception (a rational strategy), participants appeared to wait for the consistent item to occur and then reactively (Braver 2012) prepare for the following items. This predicts a reduction of about one third in the effect size (6.5 ms here relative to 10 ms in O'Séaghdha and Frazer (2014)). That is, failure to prepare for the immediate post-exception item largely accounts for the decrement in the preparation effect relative to O'Séaghdha and Frazer (2014).

For sets of 6, the probability of a consistent item in the related condition is 50%, and so participants experienced many short alternating runs of consistent and inconsistent items. Participants could use a variety of heuristics centered on alternation of preparation and matching of the equal probability of consistent and inconsistent targets (e.g., guess consistent after inconsistent and vice versa, guess one or two additional consistent items

after a consistent word, and likewise for inconsistent runs, guess opposite after two or three consistent/inconsistent, etc). Because inconsistent and consistent items are equally likely, there is no basis for a fixed expectation following an inconsistent word. Globally, if participants prepared for and encountered consistent items about half the time, they would ‘hit’ about half of the consistent targets by chance. This suggests a net preparation effect of about half the size of preparation in O’Séaghdha and Frazer (2014), which is what we observe. Taken together, these observations account for the reduced preparation for sets of 4, and for the statistical equivalence of preparation with single and multiple inconsistent exceptions.

Intermittent Preparation and Transient Attention

Taking this summary as at least descriptively adequate, we suggest that the findings underline an important distinction between construal of experimental conditions, which is the basis for direction of attention, and the actual deployment of that attention. Our account implies that whereas the construal of the experimental situation in each set size may be stable, the deployment of preparation from trial to trial may be intermittent and may pattern somewhat differently for each set size. In addition, because set sizes were intermixed, it appears that the application of preparation with single exceptions (set size 4) was reduced here relative to circumstances where there was always a single exception (O’Séaghdha & Frazer, 2014, Experiment 2). To adapt a framing from the task-switching literature (e.g., Lien et al., 2005), we suggest that speakers under constant single-exception circumstances may prepare the onset most of the time (O’Séaghdha & Frazer, 2014, Expt 2), but that with the variable set sizes of the current experiment they prepared only some of

the time. In addition, we hypothesize that preparation involves a discrete application of the available task construal and that the strength of activation of selected starting points varies with attentional resources. Thus, the characterization of form preparation by O'Séaghdha and Frazer (2014) as *sustained attention* needs to be revisited.

The separation of preparation and production in our theory creates a requirement for coordination between preparation and actual production. Linking preparation and speech action requires a mechanism, preferably one that is independently motivated in language production theory. One promising direction comes from work by Strijkers and colleagues (Strijkers, Holcomb & Costa, 2011) who discovered a distinct intentional prelude to word production. Their suggestion is that a top-down preparatory signal modulates subsequent activation when a speaker expects to produce a word. We speculate that coordination of preparation and production occurs in conjunction with such a signal, synchronizing activation of the consistent phonological component with production of a specific word.

The title of this paper invokes an ongoing existential crisis of form preparation. Traditionally, the vulnerability of preparation to 'killers' has been viewed as a methodological advantage, making it diagnostic of what can and cannot be phonologically prepared. O'Séaghdha and Frazer (2014) challenged this narrative by showing that preparation is not all-or-none. Rather than revealing fundamental processes of phonological encoding in the production pathway, they argued that form preparation reveals how preparation operates independently of encoding. In this view, the seeming fragility of form preparation is a function of limited attentional resources rather than of the requirements of encoding. The current work further advances this theory by showing that form preparation

is possible even with multiple inconsistent words. However, intermixing single and multiple inconsistent conditions appeared to weaken preparation in the single inconsistent context, leaving the preparation in both conditions precariously small. Aggregate effects do not tell the whole story, however, because preparation is likely to be intermittent in complex-contingency conditions. In addition, the theory of form preparation as mediated through attention opens a new window on the nature of meta-level representation of phonology and raises new questions concerning how abstract preparatory states interface with the processes deployed in actual speech. Our developing theory suggests that speakers have a large say in whether and when to /b/ or not to /b/. More broadly, this research highlights word production as an underexplored arena for the study of controlled attention.

References

- Alario, F.X., Perre, L., Castel, C., Ziegler, J.C. (2007). The role of orthography in speech production revisited. *Cognition*, 102, 464-475.
- Balota, D.A., Yap, M.J., Cortese, M.J., Hutchinson, K.A., Kessler, B., Loftus, B., Neely, J.H., Nelson, D.L., Simpson, G.B., & Treiman, R. (2007). The English lexicon project. *Behavior Research Methods*, 39, 445-459.
- Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of memory and language*, 68(3), 255-27
- Braver, T. S. (2012). The variable nature of cognitive control: A dual-mechanisms framework. *Trends in Cognitive Sciences*, 16, 106-113.
- Damian, M. F. & Bowers, J. S. (2003). Effects of orthography on speech production in a form-preparation paradigm. *Journal of Memory and Language*, 49, 119-132.
- Goldrick, M. (2014). Phonological processing: The retrieval and encoding of word form information in speech production. *The Oxford handbook of language production*, 228-244.
- Jacobs, C. L., & Dell, G. S. (2014). ‘hotdog’, not ‘hot’‘dog’: the phonological planning of compound words. *Language, cognition and neuroscience*, 29(4), 512-523.
- Kureta, Y., Fushimi, T., & Tatsumi, I. F. (2006). The functional unit in phonological encoding: Evidence for moraic representation in native Japanese speakers. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 32, 1102-1119.
- Levelt, W. J. M., A. Roelofs, & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral & Brain Sciences*, 22, 1-75.
- Lien, M. C., Ruthruff, E., Remington, R. W., & Johnston, J. C. (2005). On the limits of advance preparation for a task switch: Do people prepare all the task some of the time or some of the task all the time? *Journal of Experimental Psychology: Human Perception and Performance*, 31(2), 299-315.
- Meyer, A. S. (1990). The time course of phonological encoding in language production: The encoding of successive syllables of a word. *Journal of Memory & Language*, 29, 524-545.

- Meyer, A. S. (1991). The time course of phonological encoding in language production: Phonological encoding inside a syllable. *Journal of Memory and Language*, 30, 69-89.
- Meyer, A. S. (2002). Form representations in word production. In L. R. Wheeldon (Ed.)
Wheeldon, L. (Ed.). *Aspects of language production*. Psychology Press.
- Nozari, N., Kittredge, A. K., Dell, G. S., & Schwartz, M. F. (2010). Naming and repetition in aphasia: Steps, routes, and frequency effects. *Journal of Memory and Language*, 63, 541-559.
- O'Seaghdha, P. G. & Marin, J. W. (2000). Phonological competition and cooperation in form-related priming: Sequential and nonsequential processes in word production. *Journal of Experimental Psychology: Human Perception & Performance*, 26, 57-73.
- O'Seaghdha, P. G., Chen, J.-Y. & Chen, T.-M. (2010). Proximate units in word production: Phonological encoding begins with syllables in Mandarin Chinese but with segments in English. *Cognition*, 115, 282-302.
- O'Séaghdha, P. G. & Frazer, A. K. (2014). The exception does not rule: Attention constrains form preparation in word production. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 40, 797-810.
- O'Séaghdha, P. G. (2015). Across the great divide: Proximate units at the lexical-phonological interface. Special Issue: The production of speech sounds across languages. *Japanese Psychological Research*, 57, 4-21. [Invited lead article for Special Issue]
- Roelofs, A. (1997). The WEAVER model of word form encoding in speech production. *Cognition*, 64, 249-284.
- Roelofs, A., & Meyer, A.S. (1998). Metrical structure in planning the production of spoken words. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 24, 922-939.
- Roelofs, A. (1999). Phonological segments and features as planning units in speech production. *Language and cognitive processes*, 14(2), 173-200.
- Roelofs, A. (2006). The influence of spelling on phonological encoding in word reading, object naming, and word generation. *Psychonomic Bulletin & Review*, 12, 33-37.
- Strijkers, K., Holcomb, P. J., & Costa, A. (2011). Conscious intention to speak proactively facilitates lexical access during overt object naming. *Journal of Memory and Language*, 65(4), 345-362.

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