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Random word generation reveals spatial encoding of syllabic word length

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Existing random number generation studies demonstrate the presence of an embodied attentional bias in spontaneous number production corresponding to the horizontal Mental Number Line: Larger numbers are produced on right-hand turns and smaller numbers on left-hand turns (Loetscher *et al.*, 2008, *Curr. Biol., 18*, R60). Furthermore, other concepts were also shown to rely on horizontal attentional displacement (Di Bono and Zorzi, 2013, *Quart. J. Exp. Psychol., 66*, 2348). In two experiments, we used a novel *random word* generation paradigm combined with two different ways to orient attention in horizontal space: Participants randomly generated words on left and right *head turns* (Experiment 1) or following left and right *key presses* (Experiment 2). In both studies, syllabically longer words were generated on *right-hand* head turns and following right key strokes. Importantly, variables related to semantic magnitude or cardinality (whether the generated words were plural-marked, referred to uncountable concepts, or were associated with largeness) were not affected by lateral manipulations. We discuss our data in terms of the ATOM (Walsh, 2015, The Oxford handbook of numerical cognition, 552) which suggests a general magnitude mechanism shared by different conceptual domains.

The discovery of the spatial-numerical association of response codes (SNARC) demonstrated that as abstract as numbers may seem, their understanding also relies on specific spatial biases (Dehaene, Bossini, & Giraux, 1993). In this study, participants' left-hand responses were faster when they judged parity of smaller numbers (e.g., 1 or 2) while right-hand responses were faster for larger numbers (e.g., 8 or 9), suggesting that accessed number representations are arranged along a Mental Number Line (MNL) with numerical magnitude monotonically increasing from left to right. Numerous studies that followed demonstrated an intimate link between SNARC and visual attention, by showing that SNARC-related processing differences result from attentional displacement (Fischer, Castel, Dodd, & Pratt, 2003; Fischer, Warlop, Hill, & Fias, 2004; Myachykov, Chapman, & Fischer, 2017) and by documenting neuroanatomical links between oculomotor control and mental arithmetic (Knops, Thirion, Hubbard, Michel, & Dehaene, 2009). Furthermore,

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SNARC was validated in studies that employed numerous tasks, with different effectors, including hand, foot, eye, and head movements, and in different modalities, suggesting that it reflects a relatively universal, task-independent, and supra-modal representation of numerical magnitude.

At the same time, an overwhelming majority of the existing SNARC studies address the question of how we *understand* numbers while there are relatively few reports documenting spatial organization of number representations during the retrieval of numerical concepts from memory for the purposes of *production.* It is theoretically possible that spatial-numerical biases only emerge in comprehension tasks when the processor needs to match bottom-up input to the knowledge stored in memory. An initial attempt to address the question of number production was undertaken by Loetscher, Schwarz, Schubiger, and Brugger (2008), using a *random number generation* (RNG) paradigm. In this study, participants were instructed to freely generate numbers between 1 and 30 while turning their heads to the right or to the left, following a metronome cue with a two-second interval (0.5 Hz). On average, participants produced more small numbers after left turns compared to a baseline condition. Follow-up research provided evidence that eye position can predict the forthcoming number in RNG, with saccadic amplitude correlated with the magnitude of the forthcoming number (Loetscher, Bockisch, Nicholls, & Brugger, 2010). Conversely, a study by Fernández, Rahona, Hervás, Vázquez, and Ulrich (2011) demonstrated that number magnitude affects free gaze choice by showing that participants are more likely to choose to look left after fixating small numbers and right after fixating large numbers. Other studies showed similar left-to-right biases in RNG studies involving other effectors: finger tapping (Plaisier & Smeets, 2011; Vicario, 2012) and whole-body turns (Göbel, Maier, & Shaki, 2015; Shaki & Fischer, 2014). Taken together, these production studies demonstrate that spatial-numerical biases do not only accompany bottom-up number processing but are also present during top-down number generation.

The latter conclusion stipulates that both online and offline magnitude representations may contain sensorimotor features (cf. Myachykov, Scheepers, Fischer, & Kessler, 2014). Furthermore, a more general account of spatially organized knowledge representations suggests that spatial-conceptual mappings should not be limited to the number domain. Indeed, similar lateral biases were found in concepts denoting time (Hartmann & Mast, 2012; Ishihara, Keller, Rossetti, & Prinz, 2008; Maienborn, Alex-Ruf, Eikmeier, & Ulrich, 2015), music and sound (Dormal, Dormal, Joassin, & Pesenti, 2012; Marghetis, Walker, Bergen, & Núñez, 2011; Rusconi, Kwan, Giordano, Umilta, & Butterworth, 2006; Xuan, Zhang, He, & Chen, 2007), and political preferences (Sellaro, Hommel, de Kwaadsteniet, van de Groep, & Colzato, 2014). One theory that offers a detailed overview of a potential neuro-cognitive mechanism supporting such spatial-conceptual features of concept representations is A Theory of Magnitude (ATOM; Walsh, 2003, 2015). ATOM argues that number, duration, quantity, pitch, and other similar concepts are all based on *a generalized magnitude system*. Put differently, all these concepts are represented with a partially *overlapping* feature – their relative magnitude (Myachykov *et al.*, 2017).

Albeit being a relatively novel theoretical proposal, ATOM has received considerable empirical support. Some of the relevant studies employed versions of the RNG paradigm. For example, Heinemann, Pfister, and Janczyk (2013) found that number choices in a random generation task can be influenced by auditory information: Smaller digits were produced after a quieter tone was played and larger digits after a louder tone. Similarly, Badets, Bouquet, Ric, and Pesenti (2012) showed that the magnitude of randomly generated numbers can be affected by an unrelated hand prime of varying aperture (large vs. small). Also, a study by Seno, Taya, Ito, and Sunaga (2011) showed that participants' number choices can be biased by previously established temporal (future vs. past) primes. Furthermore, Di Bono and Zorzi (2013) showed that, when asked to randomly generate *letters*, people generate letters that appear earlier in the alphabet on left head turns while a study by Roettger and Domahs (2015) showed that, under certain conditions, the opposite is true – presentation of German singular-marked nouns facilitates subsequent left-hand responses, while plural-marked nouns facilitate subsequent right-hand responses. Finally, a study by Lachmair *et al.* (2016) demonstrated that the accuracy of word recall can be influenced by the body's orientation in space. Together, these random generation studies demonstrate that top-down activation of concepts semantically unrelated to numbers regularly affects the magnitude of freely produced numbers via a shared spatial mapping component, indicating that sensorimotor mappings in numbers and other concepts with magnitude-like properties may overlap.

The common mapping mechanism described by Walsh is argued to be pre-linguistic and universal across knowledge domains. At the same time, it is plausible to expect that linguistic experience may play role in shaping spatial biases since the majority of concepts allow for some form of linguistic encoding. Here, we report two studies using a version of the RNG paradigm adapted, to the *random generation of words*. Our general question relates to whether lateral biases can be traced to the properties of freely generate words rather than numbers. Several dependent variables were considered as relevant: First, we considered magnitude-related variables related to *semantic properties* of the produced words. These included (1) the words' number marking (singular or plural), (2) countability, and (3) the abstract *largeness* of the associated concept (Ren, Nicholls, Ma, & Chen, 2011; Shaki, Petrusic, & Leth-Steensen, 2012). Secondly, we considered syllable length as a more superficial *form-related* property. Our hypothesis was that the words' *semantic* features will encode spatial biases only if participants engage in a deeper analysis of the meanings of the produced words; if their treatment of the task is more opportunistic and shallow, we could still potentially see spatial biases in the words' '*surface'* (e.g., syllabic length) but not semantic properties.

To provide a replication and to generalize our findings beyond a single effector manipulation, we implemented two tasks: We used a metronome-cued head turning manipulation in Experiment 1 (cf. Loetscher *et al.*, 2008) and a key-press manipulation in Experiment 2 where participants had to alternate a left or a right designated key press before producing a word.

Method

Participants

Twenty-tree participants (mean age = 20.9, *SD* = 1.8, 13 females) took part in Experiment 1 (head turns) and another 23 (mean age = 21.7, *SD* = 2.4, 13 females) in Experiment 2 (button-presses). Participants were undergraduate university students. All participants were native English speakers, and they were right-handed in accordance with the Edinburgh handedness inventory with scores ranging from 60% to 100% (*M* = 85.4%, *SD* = 15.93%). The study received institutional ethical approval.

Procedure

Participants were tested individually, in a laboratory cubicle. After signing the consent form, they were assessed for their handedness using an online version of the Edinburgh handedness inventory. After this, the experimental procedure was explained to them in a step-by-step fashion before a short (40-s) practice session took place. An online metronome (http://www.webmetronome.com) was set to alert participants every 3-s.

In Experiment 1, participants alternated right and left head turns to the sound of the metronome and produced any word that came to mind. In Experiment 2, the protocol was the same except that instead of turning their heads, participants were instructed to press a designated key ('|' for the left-hand and '?' for the right-hand manipulation) on the computer keyboard. The exact instructions to participants were as follows: (1) produce *one* word following each head turn/key response, (2) produce the word once the head turn/key response has been completed, (3) avoid repetitions, and (4) avoid naming the objects or persons in the lab (e.g., *computer, keyboard, experimenter, window*). There were no further instructions concerning the word's class, morphology, semantic category, or grammatical number.

Half of the participants started the session with a right-hand turn and the other half with a left-hand turn. Participants were instructed to try to not repeat themselves, to avoid pauses, and move to the next head turn/key press if they failed to produce a word. There were 23 trials per condition in Experiment 1 and 40 trials per condition in Experiment 2. The number of trials was increased in Experiment 2 because in terms of directing lateral attention, we expected the key-press manipulation to be somewhat less effective than the head-turn manipulation (cf. Posner, 1978; Spence, Pavani, & Driver, 2000). The produced words were recorded with the help of a digital recorder before being transcribed into an Excel data sheet for further analysis.

Results

Trials in which participants failed to produce a word were rare – Experiment 1: 0.6% and 0.7% missing responses (after left and right head turns, respectively); Experiment 2: 1.7% and 1.3% missing responses (after left and right key responses, respectively).

The two experimental data sets were combined for further analysis. Word repetitions were preserved in the main analysis; they were removed from the follow-up semantic rating analysis where only unique produced words were used. Each of the produced words was initially scored along the following dimensions: (1) number of syllables (henceforth syllables); (2) whether the given word was plural-marked or not (plural), and (3) whether or not the given word was an uncountable noun (uncountable). In addition, an online norming was carried out to determine how the produced words were judged in terms of (4) *largeness* (see below).

Syllables were considered to be a word form-related measure, whereas plural, uncountable, and largeness were taken to be associated with semantic magnitude or cardinality. For instance, a plural (e.g., *tomatoes* instead of *tomato*) refers to a set of entities with cardinality greater than one. An uncountable noun (*snow*, *sand*, *Africa*, *tennis*, etc.) does not have a plural form and typically refers to a substance, region, or event consisting of smaller constituent elements. The largeness measure was determined as follows. The 1,210 unique words were randomly split into three subsets of 403, 403, and 404 words, respectively. These word subsets were randomly administered to 42 new participants in an online questionnaire, in which each word had to be rated in terms of associated 'largeness', using a Likert scale from 1 (very small) to 7 (very large). Each word was rated by 14 participants, thereby obtaining a measure of perceived semantic magnitude. To illustrate, of the 1,210 unique items produced in the main experiments, the bottom 1% on this measure (average rating = 1.561) contained words such as *earring, tick, pea, chip,* and *needle,* whereas the top 1% (average rating = 6.360) contained words such as *elephant, mountain, sky, space,* and *galaxy*.

The four measures were aggregated into means (respectively probabilities) per participant and condition. Table 1 shows grand means (and *SE*s) per experiment, condition, and measure; also shown are cross-condition differences (left−right) and corresponding *SE*s per experiment and measure.

Inferential analyses were performed on the subject-aggregated data per experiment. Since the dependent variables (based on counts, probabilities, and ratings) were likely to violate the requirements for parametric testing, we used non-parametric bootstrapping over 10,000 resamples to derive two-tailed 95% confidence intervals (bias-corrected and accelerated) for the cross-condition difference per experiment, as well as corresponding two-tailed *p*-values under the null hypothesis (see e.g., Efron & Tibshirani, 1993). These analyses confirmed a significant effect of condition (left vs. right) in the syllables measure both for Experiment 1 (CI [−0.169, −0.034], $p = .010$) and for Experiment 2 (CI [−0.118, −0.015], $p = .024$). To further corroborate these results, we conducted more detailed distributional analyses (based on *mixed effects ordinal logistic regression*) which confirmed the effect of lateral attention (left vs. right) on numbers of syllables per word produced. These supplemental analyses are reported in the Appendix to this paper.

In contrast, the bootstrapping analyses showed no reliable cross-condition differences in any of the semantic measures (plural, uncountable, and largeness), neither for Experiment 1 (all ps > .3) nor for Experiment 2 (all ps > .5).

In terms of effect size (Cohen's *d* for repeated measures), the condition effect on syllables was at least 'medium' both in Experiment 1 ($|d| = .626$) and in Experiment 2 ($|d| = .527$). By comparison, the largest (non-significant) cross-condition difference in any of the semantic measures obtained $|d| = .196$ (largeness, Experiment 1) and was in the opposite direction to the effect on syllables.

Control variables

Some previous studies showed that word and, more generally, item *frequency* may modulate the associated spatial biases (Hutchinson & Louwerse, 2014; Kadosh, Henik, & Walsh, 2009). To address this potential confound, we performed an additional analysis that took into account the lexical frequencies of the words produced in both Experiments as well as their chance of being repeated by the same participant. Table 2 shows

Table 1. Syllabic length and semantic feature data in Experiments 1 (head turn) and 2 (key press)

	Syllables		Plural		Uncountable		Largeness	
	Mean	*SE*	Mean	*SE*	Mean	*SE*	Mean	*SE*
Experiment 1 (head)								
Left	1.596	0.054	0.084	0.011	0.137	0.018	3.651	0.072
Right	1.698	0.063	0.077	0.016	0.137	0.017	3.604	0.075
Diff	−0.102	0.035	0.007	0.014	0.000	0.017	0.047	0.049
Experiment 2 (key)								
Left	1.524	0.044	0.110	0.019	0.115	0.017	3.579	0.056
Right	1.587	0.042	0.105	0.017	0.124	0.016	3.563	0.064
Diff	−0.063	0.025	0.005	0.010	−0.009	0.016	0.016	0.032

probabilities of repetition (p(rep)) as well as average COCA (Davies, 2008), respectively, BYE-BNC (Davies, 2004) word counts per million, by levels of condition (left, right) and Experiment.

Repetition probabilities and overall lexical frequencies were higher in Experiment 2 than in Experiment 1, but there were no reliable cross-condition differences in these control variables, neither in Experiment 1 (p(rep): CI [−0.019, 0.021], p = .913; COCA: CI [−37.3, 39.7], p = .927; BNC: CI [−34.9, 30.9], p = .943) nor in Experiment 2 (p(rep): CI [−0.030, 0.079], p = .368; COCA: CI [−53.4, 158.8], p = .604; BNC: CI [−42.0, 142.7], p = .555). Thus, it appears safe to conclude that the registered Syllable effect is independent of such variables.

Discussion

Across two random word generation (RWG) experiments with different lateral cue manipulations (head turns in Experiment 1, key presses in Experiment 2), we found an original, horizontally arranged SNARC-like effect in the syllabic length of freely produced words: Participants produced syllabically longer words when their attention was oriented to the right and syllabically shorter words when their attention was oriented to the left, respectively. Given that this effect was registered using two different attentional manipulations, the results are unlikely to depend on a particular type of attentional orientation. Overall, our findings extend the scope of the ATOM theory (Walsh, 2003) by documenting a lateral Mental Magnitude Line (Holmes & Lourenco, 2011) for syllabic word length – a previously underexplored feature which is more related to form rather than meaning. This finding provides a confirmatory answer to the first of our experimental questions: Whether the lateral spatial biases previously found in other conceptual domains would manifest in freely generated words.

Furthermore, our findings suggest a relatively distinct nature of the observed effect and its independence from the words' semantic properties and frequency. Indeed, meaning-related aspects such as the words' grammatical number marking, countability, and associated conceptual features (e.g., *largeness*, as established in a separate rating study) were found to be largely unaffected by our attentional manipulations. This finding informs our second question by showing that the words generated outside of any communicative or semantic context are the result of a semantically shallow process. Note that the only previous study demonstrating *semantic* spatial biases (e.g., valence, time) using a *word*

Table 2. Repetition probabilities and corpus frequency data in Experiments 1 (head turn) and 2 (key press)

	p(rep)		COCA		BNC	
	Mean	*SE*	Mean	*SE*	Mean	*SE*
Experiment 1 (head)						
Left	0.021	0.010	118.6	13.1	94.3	10.6
Right	0.020	0.008	116.8	15.7	95.5	13.7
Diff	−0.001	0.010	1.8	18.3	−1.2	15.7
Experiment 2 (key)						
Left	0.190	0.034	292.7	111.4	256.6	104.6
Right	0.165	0.032	257.5	94.0	220.8	85.3
Diff	0.025	0.026	35.9	62.6	35.8	54.1

production task (Lachmair *et al.*, 2016) did so by using *a recall* task where sufficient semantic analysis is necessary during word encoding. Our production task encouraged the retrieval of 'decontextualized' words that were presumably encoded primarily in terms of their surface properties, such as word length, independent of their semantics. To further test this explanation, one would need to use a semantically deeper production task that should lead to the retrieval of words that encode semantic components associated with spatial biases as well as the spatial biases associated with word length.

Second, while this is not the first time that words were shown to exhibit SNARC-like effects, only few studies addressed the issue of the relative magnitude encoded in the word's surface *form* (Di Bono & Zorzi, 2013; Roettger & Domahs, 2015). The results of Roettger and Domahs are similar to the ones reported here in that they show facilitation of lateral responses as a function of singular/plural noun forms. At first glance, this result seems to be at odds with our own findings whereby syllabic length, but not singular/plural marking of words, was affected by lateral attention. However, not only were there differences in task – word generation in the present studies vs. word comprehension in Roettger and Domahs (2015) – but more importantly, there might be a potential confound in the German word stimuli used by Roettger and Domahs (2015): Note that the majority of German nouns have an additional syllable in their plural compared to their singular form (e.g., *Mann* [man] – *Männer* [men]; *Frau* [woman] – *Frauen* [women]; *Kind* [child] – *Kinder* [children]); given that at least two of the nouns (out of a total of only four) in the Roettger and Domahs (2015) study were affected by this confound, it could well be that their findings were driven by syllabic length rather than number marking (or associated semantic cardinality), which would actually be in line with our own data. One might even speculate whether the present SNARC-like effect on syllabic length could partially explain previous findings on random *number* generation (Loetscher *et al.*, 2008) – after all, higher numbers (e.g., twenty-two) tend to have syllabically longer names than lower numbers (e.g., three). This could be an interesting avenue for future research. At the very least, our results suggest that syllabic length of linguistic denominators should be controlled for when studying SNARC-like effects, even in seemingly non-linguistic domains.

It has to be noted that as a novel finding, the lateral RWG effect on syllabic length needs further and deeper exploration. For example, note that we did not control participants' eye movements in Experiment 2: While a lateral key-press manipulation is arguably more subtle than head turning, it still allows involuntary eye movements to accompany individual clicks. This leaves space for a more thorough examination of the attentional mechanisms underlying the RWG effect, especially since previous studies documented a bidirectional link between eye movements and random number generation (Loetscher *et al.*, 2010). In future experiments, we will introduce direct control of oculomotor behaviour via eye-tracking in order to investigate the degree of automaticity of the RWG effect as well as its dependence on overt attentional displacement without turning the whole head.

Another intriguing aspect of the present findings is the interplay between the spatial-conceptual mapping encoded in word length and other previously documented SNARC-like effects. According to the ATOM theory, a generalized magnitude component may support conceptual representations in different knowledge domains – numbers, time, size, duration, etc. If the underlying magnitude component is indeed shared between different representations, then we may expect cross-domain priming effects between word length and other representational features. Some recent reports confirm that two seemingly different representations indeed exhibit cross-domain priming effects (Lachmair, Dudschig, de la Vega, & Kaup, 2014; Myachykov *et al.*, 2017; Scheepers *et al.*, 2011; de la Vega, De Filippis, Lachmair, Dudschig, & Kaup, 2012). Neither of these reports, however, (1) use a free production task nor (2) address the surface-form features similar to the syllabic length examined here.

Furthermore, our findings suggest important potential insights with regard to the effects reported in Roettger and Domahs (2015) and Loetscher *et al.* (2008). Neither of these nor similar studies controlled for the word-level features of the generated numbers (e.g., syllabic length, grammatical number). On the one hand, future studies will need to address potential interplay (or the lack of thereof) between the numerical magnitude and the word-level magnitude-related features (e.g., syllabic length, grammatical number, word compositionality). On the other hand, future research will need to investigate potential interactions between the word-level magnitude-related features and the spatial-conceptual biases (e.g., valency, time, spatial semantics).

One final note needs to be made regarding hemispheric asymmetry and language processing. It is possible that there was a left-hemispheric language processing advantage in the rightward trials in our study (Hellige & Cox, 1976; Lempert & Kinsbourne, 1982; Walker, Wade, & Waldman, 1982) potentially leading to a facilitated access to a wider lexicon including longer words (also see Brugger, Loetscher, Graves, & Knoch, 2007). Future studies are necessary in order to better understand the underlying neuroanatomical and behavioural properties of the syllabic length effect with regard to hemispheric language processing asymmetry and other form-based features in the taxonomy of studies on spatial-conceptual mapping.

Overall, the two studies reported above demonstrate a lateral syllabic length bias in the freely produced words. Importantly, the reported syllabic length effect was independent of the lexical-semantic and conceptual features previously shown to be associated with lateral and, more generally speaking, spatial biases. Our findings support universalist theories of magnitude representation (Walsh, 2003) and provide novel insights into the nature of lexical representations.

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Appendix

Although the bootstrap analyses reported in the paper do not rely on parametric assumptions, they may be criticized for glossing over potentially important details in the underlying response distributions. Note that data were aggregated into participant $\times$ condition means prior to bootstrapping, and that those means could potentially be affected by rare responses, outlier trials, etc.

Here, we take another look at the syllables data from the two experiments, focusing only on the dependent variable for which reliable cross-condition differences were detected.

The table below shows the observed distributions of syllable counts per word as a function of Experiment (1 = head turn, 2 = key press) and lateral attention condition (left vs. right). As can be seen, all words ranged in length from one syllable (e.g., ‘snow’) to a maximum of five syllables (e.g., ‘university’), with one-syllable words representing the most dominant category (ca. 56% of all words produced). Moreover, it is suggested that in both experiments, the percentage of one-syllable words is lower in the right lateral attention condition relative to the left lateral attention condition, and correspondingly, that words with more than one syllable tend to be more frequent in the right than in the left lateral attention condition.

Observed percentages (raw counts in brackets) for numbers of syllables per word produced, broken down by Experiment (1 = head turns, 2 = key presses) and condition (left, right)

	Number of syllables				
	1	2	3	4	5
Exp 1 (head)					
Left	56.8 (291)	30.3 (155)	10.2 (52)	1.8 (9)	1.0 (5)
Right	48.9 (250)	36.2 (185)	11.4 (58)	3.1 (16)	0.4 (2)
Exp 2 (key)					
Left	60.3 (540)	29.7 (266)	8.0 (72)	1.7 (15)	0.3 (3)
Right	57.8 (521)	29.1 (262)	10.3 (93)	2.2 (20)	0.6 (5)

Since numbers of syllables per word are rank-ordered ($1 < 2 < 3 < 4 < 5$), we re-analysed these frequency distributions using *mixed effects ordinal logistic regression*, as implemented in the `clmm()` function of the R package `ordinal` (Christensen, 2018). Specifically, we modelled cumulative logits for numbers of syllables per word in terms of a 2×2 design including Experiment and condition as fixed effect predictors. Both predictors were entered into the model in mean-centred form (deviation coding) and we assumed flexible response thresholds for the analysis (`clmm()` default). Moreover, by-participant intercepts and by-participant slopes on condition were entered into the model as random effects terms – the former to account for inter-individual variation in the overall response distribution and the latter to account for inter-individual variation in the effect of condition. (Experiment was between-subjects, meaning that no random slope could be estimated for this predictor). *p*-values were determined via likelihood-ratio model comparisons.

The analysis corroborated our previous findings: There was a significant main effect of condition ($b = 0.189$, $SE = 0.076$, ${}_{LR}\chi^2(1) = 6.259$, $p = .012$) with a positive parameter estimate indicating that syllable-count distributions shifted towards longer words in the right lateral attention condition. The main effect of Experiment was not reliable ($b = -0.246$, $SE = 0.168$, ${}_{LR}\chi^2(1) = 2.084$, $p = .149$), suggesting that syllable-count distributions were comparable across experiments. Finally, although the effect of condition appeared descriptively more subtle in Experiment 2 than in Experiment 1, the Experiment $\times$ condition interaction did not approach significance ($b = -0.149$, $SE = 0.155$, ${}_{LR}\chi^2(1) = 0.929$, $p = .335$).

To conclude, the main assertion of our paper (that syllabically longer words are being produced when attention is directed to the right) also holds out against analyses that take detailed distributional information into account.