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RESEARCH REPORT

Strategic Origins of Early Semantic Facilitation in the Blocked-Cyclic Naming Paradigm

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In the blocked-cyclic naming paradigm, participants repeatedly name small sets of objects that do or do not belong to the same semantic category. A standard finding is that, after a first presentation cycle where one might find semantic facilitation, naming is slower in related (homogeneous) than in unrelated (heterogeneous) sets. According to competitive theories of lexical selection, this is because the lexical representations of the object names compete more vigorously in homogeneous than in heterogeneous sets. However, Navarrete, del Prato, Peressotti, and Mahon (2014) argued that this pattern of results was not due to increased lexical competition but to weaker repetition priming in homogeneous compared to heterogeneous sets. They demonstrated that when homogeneous sets were not repeated immediately but interleaved with unrelated sets, semantic relatedness induced facilitation rather than interference. We replicate this finding but also show that the facilitation effect has a strategic origin: It is substantial when sets are separated by pauses, making it easy for participants to notice the relatedness within some sets and use it to predict upcoming items. However, the effect is much reduced when these pauses are eliminated. In our view, the semantic facilitation effect does not constitute evidence against competitive theories of lexical selection. It can be accounted for within any framework that acknowledges strategic influences on the speed of object naming in the blocked-cyclic naming paradigm.

Keywords: word production, lexical selection, blocked naming paradigm

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A key issue for current theories of lexical access is whether or not the selection of a word from the mental lexicon is a competitive process. According to the lexical access by competition view (e.g., Levelt, Roelofs, & Meyer, 1999; Roelofs, 1992), a lexical entry can be selected as soon as its activation exceeds the summed activation of its competitors by a sufficient amount of activation. That is, the time of selection depends on the number of competing lexical representations and their levels of activation. In noncompetitive theories, by contrast, the most activated entry at the time of selection is selected, irrespective of the activation levels of coactivated entries (e.g., Dell, 1986; Oppenheim, Dell, & Schwartz, 2010). When the differences between activation levels are small, a booster mechanism amplifies the activation levels until one item stands out and can be selected (Oppenheim et al., 2010, p. 231). The more often the booster mechanism must be engaged the longer lexical retrieval will take.

Much of the evidence bearing on models of lexical selection comes from studies using paradigms where speakers select target words in the presence of semantically (typically categorically) related or unrelated words. Commonly used paradigms are the picture–word interference paradigm, where speakers name objects while seeing or hearing distractor words (e.g., Glaser & Düngelhoff, 1984), and the continuous naming paradigm, where speakers name several semantically related objects in close succession (Howard, Nickels, Coltheart, & Cole-Virtue, 2006). For the results obtained in both paradigms, competitive and noncompetitive theories of lexical selection have offered explanations (Belke, 2013; Navarrete et al., 2014; Spalek, Damian, & Bölte, 2013).

In the present study, we used a third relevant paradigm, the blocked-cyclic naming paradigm (Belke, Meyer, & Damian, 2005; Damian & Als, 2005; see also Damian, Vigliocco, & Levelt, 2001): Participants name blocks of objects from the same semantic

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category (homogeneous context) or from different semantic categories (heterogeneous context). The blocks feature small sets of objects presented in cycles, with each cycle presenting all members of the set once in varying orders. The typical results of standard blocked-cyclic naming experiments are (a) no difference between the naming contexts or semantic facilitation in the first cycle; (b) semantic interference in the following cycles; (c) stability of this interference effect, that is, no further increase, across cycles (for review see Belke & Stielow, 2013; Crowther & Martin, 2014).

Several accounts have been proposed for this specific pattern of results: Belke Meyer, and Damian (2005) argued that effects of lexical competition might only be visible after sufficient activation had accumulated in the network of category coordinates tested in a homogeneous set. Similarly, Damian and Als (2005) suggested that initially short-lived semantic facilitation mediated by the category node at the conceptual level cancelled out longer-lasting semantic interference at the lexical level. According to their account, semantic interference is more long-lived, as naming an object strengthens the links between its semantic features and its lexical entry (incremental learning). When naming objects in a homogeneous context, this exacerbates the competition among the set members. In the heterogeneous context, by contrast, incremental learning does not affect the naming times of the other members in the set as they do not belong to the same semantic category as the target (see Belke, 2013, for a related proposal incorporating incremental learning at the conceptual level).

Oppenheim, Dell, and Schwartz (2010) put forward an account of the results of blocked-cyclic naming studies in a model of lexical selection without competition. In their model, naming an object strengthens the links between its semantic features and its lexical representation. In addition, the links to semantic features are weakened for lexical representations of coactivated, but not selected category coordinates. For instance, if a horse is to be named, the lexical entries of "horse" and "pig" may be activated but only "horse" will be selected. The incremental learning mechanism will strengthen the links between "horse" and its semantic features (repetition priming) and simultaneously weaken all links between its competitors (e.g., "pig") and their semantic features. If "pig" is to be named next, its lexical entry accumulates activation less efficiently than "horse" did previously because of its weakened links. Once the lexical entry of "pig" has been selected, however, its links are strengthened while the links between "horse" and its semantic features are weakened as it was coactivated, but not selected, when "pig" was retrieved.

Navarrete et al., (2014) argued that on this account, the interference effect in blocked-cyclic naming might not be a lexical interference effect but might result from reduced repetition priming in homogeneous as compared to heterogeneous contexts. Repetition priming, mediated by incremental learning, will take its full effect in heterogeneous sets, rendering naming increasingly efficient over cycles. In homogeneous sets, however, an item whose representations have been accessed and strengthened on one trial may be weakened on the next trial, as it will then be a coactivated same-category alternative to a different target. This reduces the net repetition priming effect in homogeneous sets.

Navarrete et al. (2014) further pointed out that the semantic facilitation effect sometimes seen in the first cycle was difficult to account for under the competition hypothesis. They demonstrated that semantic facilitation was maintained over many repetitions of the materials when the sets were not repeated immediately in a cyclic fashion but were mixed with other sets. However, when, in the second part of one of their experiments (Experiment 2B), cyclic repetition was introduced, the polarity of the effect reversed in the second and third of three cycles. These findings are consistent with the predictions from their model.

The authors argue that the findings from the first part of their experiment cannot be reconciled with competitive theories of lexical access as such theories would predict that highly coactivated members of the same semantic category should cause semantic interference rather than persistent facilitation. However, according to all current accounts of cyclic blocking effects in the competitive framework, the effect results from a trade-off between conceptual facilitation and lexical interference (Abdel Rahman & Melinger, 2007; Belke, 2013; Damian & Als, 2005). This implies that conceptual facilitation may sometimes override lexical interference, for instance, when there are strong semantic priming effects: Participants are likely to notice the shared semantic category of the items in homogeneous contexts and might use this knowledge to predict the category of the other items in the set. On this view, the semantic facilitation effect in the first cycle in some studies may be a strategic effect (Abdel Rahman & Melinger, 2007; Belke, 2017; Damian et al., 2001; Oppenheim et al., 2010). Reviewing previous studies using the blocked-cyclic paradigm, Belke (2017) pointed out that the experiments differed with respect to whether the homogeneous and heterogeneous lists were administered in alternation or in a blocked fashion, for example, by testing all homogeneous lists before the heterogeneous ones or vice versa. Consistent semantic facilitation in Cycle 1 was only observed when the lists were blocked by context, arguably because the semantic manipulation is particularly obvious with that kind of list presentation. With an alternating list presentation, there was typically no context effect in Cycle 1, suggesting that the (strategic) facilitation effect failed to override the lexical interference effect. Finally, when participants were engaged in a concurrent working memory task (Belke, 2008), semantic interference was observed from Cycle 1 onward, arguably because the memory load disrupted participants' strategic use of the shared category information (Oppenheim et al., 2010). In light of these findings, a potentially important feature of the procedure used in the experiments by Navarrete et al. (2014) is that the sequence of 600 trials was partitioned into minisequences of five trials, corresponding to successive sets. After every fifth trial, there was a pause and participants reinitiated the sequence by pressing a button. This parsing of the string of pictures may have allowed participants to exploit the semantic relatedness of the items in some of the sets: When the first two exemplars of a set of objects were from the same semantic category, participants could predict the category of the following three items. Indeed, Navarrete et al. (2014) showed that the facilitation effect increased over positions in the set. We hypothesize that the effect vanishes when the pauses between sets are eliminated.

The aim of the present experiment was to assess this hypothesis. We ran two versions of Experiment 2B reported by Navarrete et al. (2014). One version, dubbed the with-pauses condition, was a near-replication of the original experiment, albeit in Dutch. The second version was identical to the first except that the pauses after each set were eliminated (without-pauses condition). Establishing

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that the semantic facilitation effect hinges on the presence of pauses between sets is of theoretical importance for two reasons: First, it tests the claim that participant strategies, especially the use of inferred category knowledge, plays an important role in blocked-cyclic naming and needs to be integrated into accounts of the effects seen in the paradigm. Second, it assesses the validity of the experimental design used by Navarrete et al. (2014) for testing theories of lexical selection in word production. As outlined above, these authors take the context effect to be facilitatory rather than inhibitory, arguing that it is the immediate cyclic repetition of sets within a block of trials alone that turns the facilitatory effect into an inhibitory effect. They demonstrated that facilitation emerged as soon as the cyclic presentation was removed from the experimental design and the item sets were not repeated immediately but interleaved with other sets. We propose that the facilitation they observed was a strategic effect that hinged on the presence of pauses segmenting the list.

The structure of our experiment was the same as in Experiment 2B in Navarrete et al. (2014), apart from the absence of the pauses in the without-pauses condition. In the first two presentations, all target objects—five exemplars each from six semantic categories and 20 fillers—were shown in sets of five unrelated objects (see Figure 1). All sets together constituted a block, with each set being presented once per block in Presentations 1 and 2. In Presentations 3 to 6, the target objects from three semantic categories were shown in the same sets as in Presentations 1 and 2. The target objects from the remaining three categories were reassembled into semantically homogeneous sets, each featuring five exemplars of

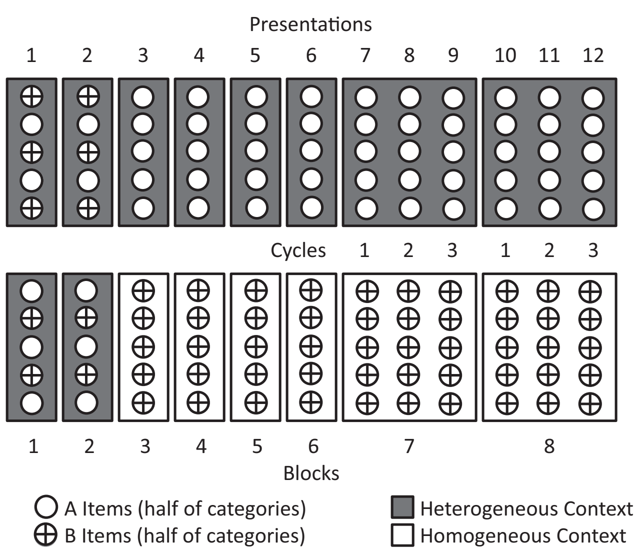

Figure 1. Structure of the experiment (adapted from Figure 4 in Navarrete et al., 2014): For the first two presentations, the objects were grouped into semantically unrelated sets consisting of target and filler objects (heterogeneous context). From Presentation 3 onward, the target objects of three semantic categories (B items) were assigned to new sets that consisted of same-category target objects only (homogeneous context). The target objects of the remaining three categories were used in the same semantically unrelated sets as in the first two presentations (A items; heterogeneous context). For Presentations 7 to 9 and 10 to 12, the same sets were used as in Presentations 3 to 6, but each set was presented in three cycles per block, that is, it was shown three times in immediate succession.

the same semantic category. Again, the sets were presented once per block. In Presentations 7 to 9, the same sets were used as in Presentations 3 to 6, but each set was immediately repeated twice per block, creating three presentation cycles, as in a standard blocked-cyclic naming experiment. The same happened in Presentations 10 to 12.

In the with-pauses condition, there was a pause after each presentation of a set, that is, after every five trials, and participants pressed a button to see the next item set. In the without-pauses condition, there was only one pause after 300 trials, halfway through the experiment. In the with-pauses condition, we expected to replicate the pattern of results seen by Navarrete et al. (2014)—semantic facilitation in Presentations 3 to 6 and in the first cycles of the cyclic presentation (Presentations 7 and 10) that reverses to interference as soon as the lexical interference effect is strong enough to override the semantic facilitation effect, that is, in Presentations 8 to 9 and 11 to 12. In the without-pauses condition, we expected the same pattern for Presentations 7 to 9 and 10 to 12; but, importantly, no or reduced semantic facilitation in Presentations 3 to 6.

Method

Participants

Forty-one native speakers of Dutch (mean age: 21.66 years, *SD* = 2.28) were tested. All gave informed consent to participate. Ethical approval of the research was obtained from the Ethics Board of the Social Sciences Faculty of Radboud University.

Materials

The materials consisted of 50 colored photographs: 30 experimental items, drawn from six semantic categories, and 20 fillers (see Appendix). Sixteen targets and 11 fillers were identical to those used by Navarrete et al. (2014). The names of the items were on average 4.28 phonemes long (*SD* = 1.13) and had an average log-transformed word frequency of 2.84 (*SD* = 0.62) in the SUBTLEX-NL database (Keuleers, Brysbaert, & New, 2010). The size of the pictures was 300 × 300 pixels, corresponding to 3° of visual angle for participants.

Design

We adapted the item sequences used by Navarrete et al. (2014) to our materials. There were 12 presentations of all items. For each presentation, the objects were grouped into sets of five objects with phonologically unrelated names. For the first two presentations, the objects were grouped into semantically unrelated sets consisting of target and filler objects (heterogeneous context). From Presentation 3 onward, the target objects of three semantic categories were assigned to new sets that consisted of same-category target objects only (homogeneous context) and the remaining filler objects were assigned to filler-only sets. The target objects of the remaining three categories were used in the same semantically unrelated sets as in the first two presentations (heterogeneous context). The categories featuring in homogeneous and heterogeneous sets from Presentation 3 onward were counterbalanced across participants. In Presentations 1 to 6, all sets were presented

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once per block in random order with the order of items within the sets varying randomly. For Presentations 7 to 9, the same sets were used as in Presentations 3 to 6, but each set was presented in three cycles per block; that is, it was shown three times in immediate succession (Presentations 7 to 9). Then the next set was shown three times and so forth until all sets had been presented. Presentations 10 to 12 featured another three cycles per set and only differed from Presentations 7 to 9 in the order of presentation of the sets. The presentation mode used in Presentations 7 to 9 and 10 to 12 corresponds to that used in the standard blocked-cyclic naming paradigm. Items with phonologically related names did not appear on successive trials.

In the with-pauses condition, there were short pauses after every fifth trial, that is, after every set, whereas in the without-pauses condition, there was only one pause after 300 trials. The same sequences were used for the participants in the two conditions. Twenty-one participants completed the with-pauses and 20 the without-pauses condition (we accidentally tested one participant too many and did not exclude her).

Procedure

Participants were tested individually in a sound-attenuated room. They sat at a comfortable viewing distance (roughly 60 cm) in front of the computer screen. They were asked to name each photograph as quickly and accurately as possible. Participants in the with-pauses condition heard that there would be a short pause after every fifth trial, whereas participants in the without-pauses condition heard that there would be a pause half-way through the experiment. Participants restarted the experimental sequence after a pause when they felt ready to continue.

The experiment was controlled by Presentation (Version 14.3, www.neurobs.com) software. The trial structure was the same as in the study by Navarrete et al. (2014): A fixation cross was shown for 250 ms, 450 ms, 650 ms, or 850 ms, with all fixation durations occurring equally often across the experiment. The fixation cross was immediately followed by a picture, shown for 500 ms. The participant's response onset was recorded using a voice key. The next trial began 1,500 ms after the onset of the response or, when no response was recorded, 3 s after picture onset.

Data Preparation

Analyses were restricted to target objects. The participants' utterances were transcribed and categorized as correct or incorrect. For some pictures, two or more near-synonyms were frequently used and were accepted as correct. The Appendix lists the dominant name for each item. Utterances featuring hesitations or filled pauses were treated as errors. Speech onset latencies for correct utterances were determined manually using Praat software. We first excluded latencies below 250 ms and then latencies deviating by more than 2.5 standard deviations from a participant's mean (2.71% of the data).

Results

The average error rate across Presentations 1 and 2 was 8%. From Presentation 3 onward, the error rates were 6.5% in the homogeneous and 5.5% in the heterogeneous condition. Analyses of the logit error rates showed that they were not systematically affected by the experimental conditions.

We will first review our results descriptively. The average naming latencies per condition are shown in Figure 2. Latencies were substantially longer in the first than in the following presentations. In Presentations 3 to 6 of the with-pauses condition, the latencies were shorter in the homogeneous than in the heterogeneous condition, as had been observed by Navarrete et al. (2014). Importantly, this effect was numerically smaller in the without-pauses condition (see Table 1). From Presentation 7 onward the items were presented cyclically, such that the members of a given set were tested three times each before a new set of items was tested. Presentations 7 and 10 corresponded to the first cycles of traditional blocked-cyclic naming experiments; Presentations 8/11 and 9/12 to the second and third cycles, respectively. As reviewed in the introduction, the context effect in the first cycle typically differs from that in the second and third presentation cycle, with early cycles showing no effect or facilitation and later cycles showing interference. Indeed, we found that participants' naming latencies were shorter in the homogeneous than in the heterogeneous contexts in Presentations 7 and 10. This pattern reversed in Presentations 9 and 12, with Presentations 8 and 11 yielding neither facilitation nor inhibition.

Because we had formulated different hypotheses for the noncyclic presentation of the materials, the first cycle of the cyclic presentation of the materials and the following cycles, we analyzed the latencies for these sections of the experiment separately. Latencies were log-transformed before analyses. Mixed-effect modeling was used to assess the effects of pause condition (with-pauses, without-pauses), context (homogeneous, heterogeneous), block (cyclic presentation only; Block 1: Presentations 7–9, Block 2: Presentations 10–12), and Presentation (3 to 6, and 8/11, 9/12, respectively). Context, pause condition, and block were deviation coded (homogeneous = -0.5, heterogeneous = 0.5; with-pauses = -0.5, without-pauses = 0.5; Block 1: -0.5, Block 2: 0.5). For the analysis of Presentations 3 to 6, presentation was centered, coding Presentations 3 to 6 as -2, -1, 1, 2. For the analyses of the last two cycles of the cyclic runs through the material, Presentations 8/11 and 9/12 were deviation-coded as -0.5 (second cycle) and 0.5 (third cycle).[1] Factors were judged as significant when the absolute *t*-value exceeded 2 (Baayen, Davidson, & Bates, 2008). The final models for each section of the experiment are summarized in Table 1.

For Presentations 3 to 6, all main effects were significant. The interaction of presentation with context was significant, reflecting that the context effect increased across presentations (see Table 1). Critically, the interaction of context and pause condition was significant, reflecting that the semantic facilitation effect was stronger in the with-pauses than in the without-pauses condition.

[1] Models were initially specified to include the maximum random effects structure, including random intercepts for participants and items as well as random slopes for context, block (if applicable), and presentation (if applicable) for participants and for pause condition, context, block (if applicable), and presentation (if applicable) for items. When the maximally specified models failed to converge, we dropped the random slope(s) with the least variance until the models converged. If not noted otherwise, we report the results obtained with the model with the full random effects structure.

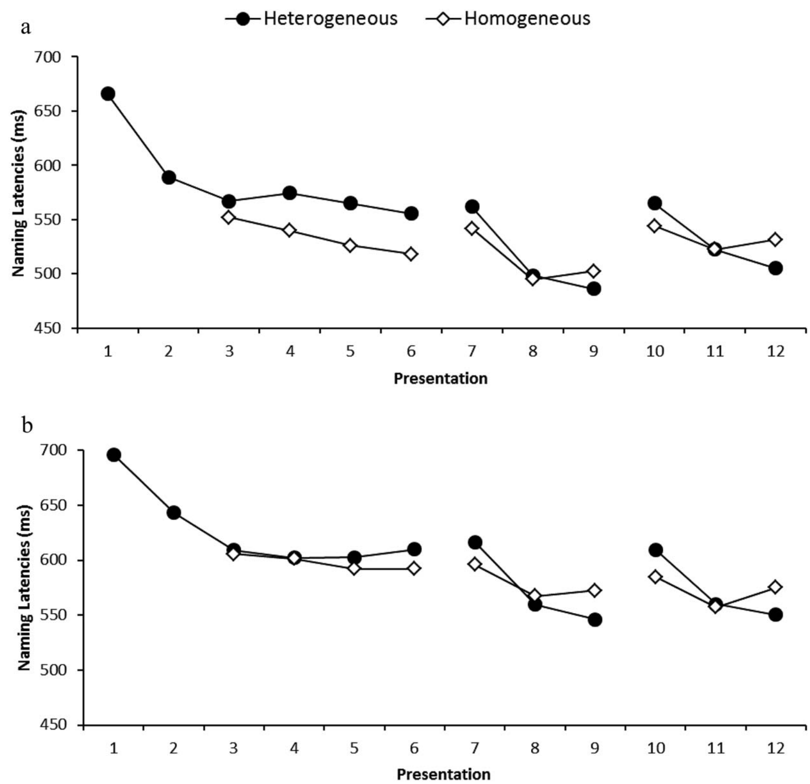

Figure 2. Mean naming latencies by semantic context (homogeneous vs. heterogeneous), presentation and pause condition (with-pauses (top panel) vs. without-pauses (bottom panel)). Error bars represent standard errors of participant means.

Separate analyses of the context effect confirmed that it was significant in the with-pause ($B = -.0291$, $SE = .0064$, $t = -4.58$) but not in the without-pause condition ($B = -.0051$, $SE = .0039$, $t = -1.3$). If the facilitation effect in the with-pause condition had a strategic origin, it should intensify over positions within a presentation, as Navarrete et al. (2014) had reported. In supplementary analyses, we found that this was indeed the case: Figure 3a shows the context effect (homogeneous minus heterogeneous) across positions within a presentation, collapsed across Presentations 3 to 6, for the with-pauses condition and the without-pauses condition. While the facilitation effect intensified considerably over positions in the with-pauses condition, especially from Position 3 onward, it remained stable in the without-pauses condition (slopes: −14.2 ms and 1.8 ms, respectively). To assess this finding statistically, we collapsed the naming latencies in the first two positions (1 and 2) and compared them to those in the last two positions (4 and 5) for each pause condition and context, collapsing over presentations 3 to 6. The model included pause condition and context (deviation coded, see above) and position, coded as −0.5 and 0.5 for the average latencies in Positions 1 and 2 and in Positions 4 and 5, respectively. As we had found before, there were significant main effects of context and pause condition and a significant interaction (all $|t|$s > 3.5). We obtained a significant main effect of position ($B = -0.004355$, $SE = 0.001836$, $t = -2.4$) and position interacted with pause condition ($B = 0.012882$, $SE = 0.003669$, $t = 3.5$), reflecting that the effect of position was stronger in the with-pauses than in the without-pauses condition. Position also interacted with context, reflecting that overall, the facilitation effect was stronger at the later positions (5–6) than at the earlier positions (1–2; $B = -.009423$, $SE = .003444$, $t = -2.7$). Critically, there was a three-way interaction of context, pause condition, and position, reflecting that the context effect intensified over positions in the with-pauses condition but not in the without-pauses condition ($B = .018990$, $SE = .006658$, $t = 2.9$).

Presentations 7 and 10 constitute the first cycles of the two blocks with a cyclic presentation. According to our hypothesis, there should be no effect or facilitation, depending on whether or not participants noticed the shared semantic category of the objects in homogeneous sets and used this knowledge strategically. In a model including context and pause condition as fixed factors, there were significant effects of context and pause condition but no interaction (see Table 1).

To assess how this facilitation came about in the with-pause and the without-pause conditions, we inspected the context effect (homogeneous minus heterogeneous sets) for each of the five positions of Presentation 7 and Presentation 10 (see Figures 3b and 3c). If the effect had a strategic origin, we should see that it intensifies further into each presentation. However, if there was nonstrategic semantic priming, caused by spreading activation at the conceptual level, we should see similar difference scores across all five positions. In line with our predictions, the facilitation effect in Presentation 7 intensified over positions in the with-pause condition (slope: −29.01 ms), whereas there was no apparent effect of position in the without-pause condition (slope: 8.15 ms). In Presentation 10, that is, after a first full cyclic presentation of the materials, both groups showed similarly small effects of position on the difference scores (slopes: −6.91 ms

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Table 1
Results of Analyses of Log-Transformed Reaction Times: Linear Mixed Models of the Results Obtained in Different Sections of the Experiment

Fixed effects	*Beta*	*SE*	*t* value	Effect [± 95% CI] (in ms)[a]
Presentations 3 to 6[b]				
Intercept	2.752799	.006816	403.9*	
Context	−.017110	.004128	−4.1*	−19 [±2]
Pause condition	.043669	.012107	3.6*	51 [±5]
Presentation	−.005060	.001819	−2.8*	3–4: −4 [±2]; 4–5: −7 [±2]; 5–6: −2 [±2]
Context : Pause condition	.023879	.007192	3.3*	With-pause: −31 [±2]; Without-pause: −6 [±2]
Context : Presentation	−.006060	.002841	−2.1*	3: −9 [± 2]; 4: −18 [±2]; 5:−25 [±2]; 6:−27 [±2]
Pause condition : Presentation	.005677	.003550	1.6	
Context : Pause condition : Presentation	.003951	.006323	.6	
Presentations 7 & 10 (first cycles of cyclic blocks)[c]				
Intercept	2.752257	.007969	345.4*	
Context	−.021809	.005454	−4.0*	−23 [±2]
Pause condition	.042853	.014790	2.9*	48 [±5]
Block	−.004143	.004207	−1.0	
Context : Pause condition	.008534	.011041	.8	
Context : Block	−.003296	.008915	−.4	
Pause condition : Block	−.007565	.007891	−1.0	
Context : Pause condition : Block	.001280	.016196	.1	
Presentations 8 & 11 and 9 & 12 (second and third cycles of cyclic blocks)[d]				
Intercept	2.728104	.008183	333.4*	
Context	.004989	.001368	3.6*	12 [±2]
Pause condition	.018671	.007730	2.4*	53 [±5]
Block	.004770	.002064	2.3*	11 [±4]
Presentation	−.002732	.001417	−1.9*	−10 [±4]
Context : Pause condition	.001193	.001368	.9	
Context : Block	−.000139	.001368	−.1	
Pause condition : Block	−.005450	.002095	−2.6*	Block1: 53 [±5]; Block2: 26 [±5]
Context : Presentation	.004282	.001418	3.0*	Presentation 8/11: 3 [±4]; Presentation 9/12: 27 [±4]
Pause condition: Presentation	.001427	.001367	1.0	
Block : Presentation	.000929	.001367	.7	
Context : Pause condition : Block	−.001990	.001368	−1.5	
Context : Pause condition : Presentation	−.000253	.001368	−.2	
Context : Block : Presentation	−.000370	.001368	−.3	
Pause condition : Block : Presentation	.000493	.001367	.4	
Context : Pause condition : Block : Presentation	.001855	.001367	1.4	

Note. Effects were considered significant when |*t*| > 2. Their magnitudes (in ms, with 95% confidence intervals) are based on nontransformed latencies and are given for all significant effects. The following factor codings were used: Context: Homogeneous = −.5, Heterogeneous = .5; Pause condition: With-pauses = −.5, Without-pauses = .5; Presentation: −2, −1, 1, 2 for Presentations 3 to 6, −.5 for Presentations 8 & 11, .5 for Presentation 9 & 12. Block: −.5 (for the first cyclic block including Presentations 7, 8, and 9), .5 (for the second cyclic block including Presentations 10, 11, and 12).
[a] For the two-way interactions, the effect of the factor named first is given for each level of the factor named last. [b] Specification of final model: log_rt ∼ Context * PauseCondition * Presentation + (1 + Context * Presentation | Participants) + (1 + Context + Presentation | Items). [c] First cycles of the two cyclic blocks; specification of final model: log_rt ∼ Context * PauseCondition * Block + (1 + Context * Block | Participants) + (1 + Context * PauseCondition * Block | Items). [d] Second and third cycles of the two cyclic blocks; specification of final model: log_rt ∼ Context * PauseCondition * Block. * Presentation + (1 + Block | Participants) + (1 + PauseCondition + Presentation + Block: PauseCondition + Context: Presentation | Items).

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and −7.85 ms), suggesting that by then participants completed the task in a functionally similar fashion.

Presentations 8 and 11 were both second cycles in the cyclic part of the experiment, and Presentations 9 and 12 were both third cycles. A model including context, block, and presentation (second cycle, third cycle) included significant main effects of presentation, reflecting repetition priming, context, reflecting semantic interference, and pause condition, with participants being faster in the with-pause than in the without-pause condition (see Table 1). In addition, there was a main effect of block, with participants being slower in the second (Presentations 11/12) than in the first block (Presentations 8/9). The effect of pause condition decreased from the first to the second block, yielding a significant interaction of pause condition and block. Finally, there was a significant interaction of context and presentation, reflecting that there was no context effect yet in the second cycle (Presentations 8/11), but that it only emerged in the third cycle (Presentations 9/12).

Discussion

In a typical blocked-cyclic naming experiment, the effects of semantic context are different at different cycles: In the first cycle, there is facilitation or no difference between semantically homogeneous and heterogeneous contexts, whereas in the following cycles there is

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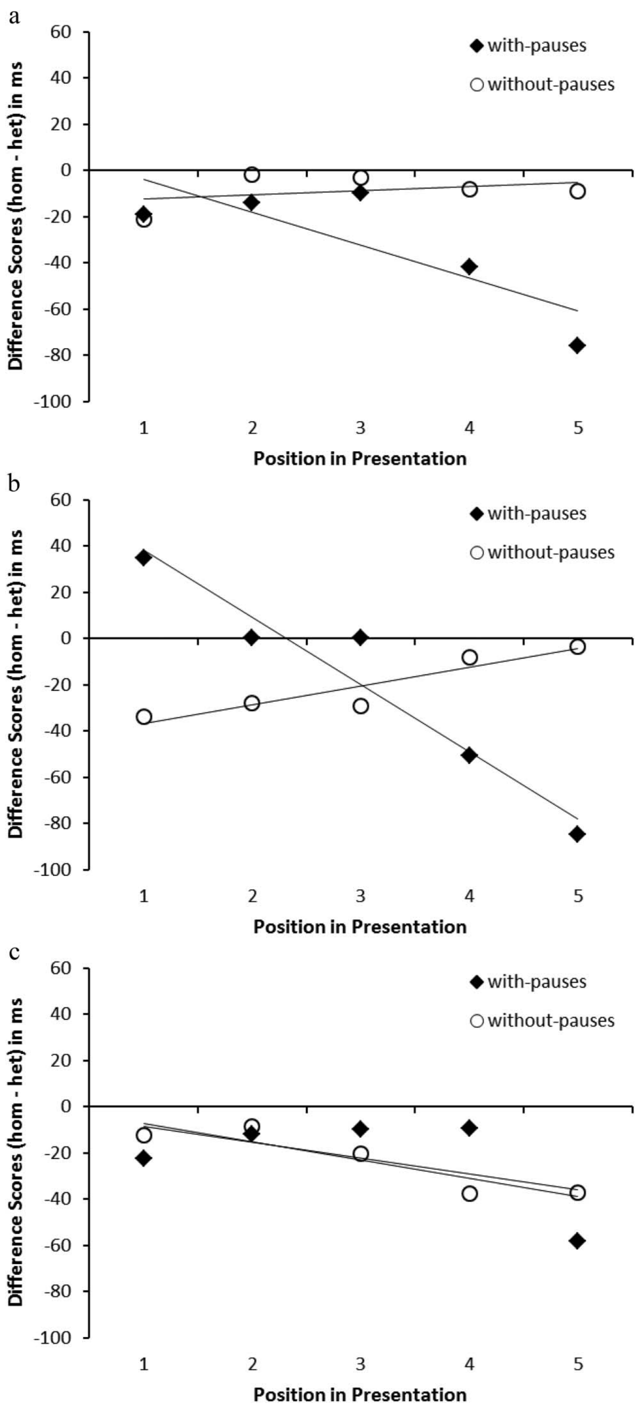

Figure 3. Difference scores (in ms) between the naming latencies in the homogeneous and the heterogeneous contexts in Presentations 3 to 6 (a), Presentation 7 (b), and Presentation 10 (c).

semantic interference. Contrary to this well-established pattern, Navarrete et al. (2014) showed that semantic facilitation persisted over several presentations of the materials when the items were not presented in a cyclic fashion (i.e., items of a set were not repeated in immediate succession), but each set was presented only once. This finding was replicated in Presentations 3 to 6 of the present experiment. Importantly, the facilitation effect vanished when the pauses between set presentations were removed. We surmise that this pattern arose because the pauses structured the experimental lists and highlighted that the objects in some of the sets belonged to the same semantic category. This structuring allowed participants to predict the semantic category of the upcoming objects within these sets, which speeded up their responses. Future research will have to establish how participants noticed and encoded categorical relatedness, that is, whether they relied on visual, conceptual, or linguistic characteristics of the items.

The finding that the facilitatory effect was reduced when the pauses were removed suggests that the effect was largely strategic in nature. Alternatively, one might argue that pauses affected key aspects of the naming process, such as spreading activation or incremental learning. It has often been argued that short-lived semantic priming effects affect naming latencies in the first cycle, cancelling out or overriding the lexical interference effect. By all accounts, such priming effects result largely automatically from spreading activation and should affect the with-pauses and without-pauses condition alike—as the pauses occurred before or after a set of related objects, the amount of automatic semantic priming within sets should be the same for both conditions. The same holds for the effects of incremental learning: Even if such effects decayed during a pause or changed otherwise, this would not affect the semantic effects within a set, as there were no pauses within sets. Moreover, as effects of incremental learning have been shown to span up to eight intervening trials, they are unlikely to be disrupted by a pause. In sum, we do not think that the present findings can be explained by reference to largely automatic priming or learning processes alone.

The second part of the experiment consisted of a standard blocked-cyclic naming experiment. We obtained a small but significant facilitation effect in the first cycles of both the with-pause and the without-pause variants of the experiment. Signs of strategic semantic facilitation were only obtained in the with-pauses condition, that is, when participants could notice and use semantic relatedness in homogeneous sets during Presentations 3 to 6. Further inspection of the data suggests that the differences between pause conditions were carried forth to Presentation 7 (the first cycle of the first cyclic presentation of the materials) but were not seen in Presentation 10 (the first cycle of the second cyclic presentation of the materials). This suggests that by Presentation 10, when participants had worked through a blocked-cyclic naming run once, the with-pause and without-pause groups had adopted similar strategies. The advantage for homogeneous sets turned into a disadvantage when interference induced at the lexical level exceeded the strategic conceptual facilitation. This is seen most clearly in the third cycles (Presentations 9 and 12), with the second cycles showing an equilibrium between the interference and facilitation (Presentation 8 and 11). Such a delayed emergence of the context effect has been reported before (e.g., Abdel Rahman & Melinger, 2007). The interference effect in Cycles 9 and 12 did not arise primarily because the naming latencies increased over cycles in the homogeneous context but mainly because they decreased in the heterogeneous context, mirroring findings from previous studies. Belke (2008, 2013; see also Belke & Stielow, 2013) has argued that this pattern arises because in the blocked-cyclic paradigm participants can encode the objects of each set in the first cycle and subsequently bias the levels of activation of the representations of the objects in the set top-down. In the heterogeneous context, this induces a processing advantage, as the competition is biased toward a single

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exemplar per category. In the homogeneous context, however, the bias is less effective as it does not alleviate the competition among the set members, which are typically all members of the same semantic category. Thus, cumulative semantic interference induced by incremental learning is counteracted by the top-down bias, which explains why the interference effect in blocked naming typically does not accumulate.

A key question arising from this account is *why* participants employ such strategies. In Presentations 3 to 6 of the present experiment, there were only three homogeneous sets along with seven heterogeneous sets; so it is all the more astonishing that participants apparently predicted the semantic categories of upcoming items. It would seem that they attempted to facilitate processing by exploiting structure in the sequence of pictures. Indeed, in our experience, many participants in blocked-cyclic naming experiments report afterward that they found the task easier when the pictures were semantically related, even though this subjective impression does not align with the evidence from their response latencies. In line with this anecdotal evidence, Abdel Rahman and Melinger (2011) found that participants do not display a semantic context effect when they consider the items of a set to be unrelated (coffee, knife, bucket, chair, stream). However, when a title linked all objects of a homogeneous set to a shared context (fishing) the effect emerges. Clearly, participants made use of the title to find structure in the item sets. In the standard version of the blocked-cyclic naming task, which employs categorically related item sets, participants can infer and immediately use the semantic relation between the items. Future research may aim at investigating participants' motivation for employing such information for solving the task at hand more systematically, possibly by giving them more extensive postexperiment questionnaires.

Another issue worthy of investigation is *how* the strategic effects we observed operated and how specific they were to blocked-cyclic naming. As we have reviewed earlier, Belke (2008, 2013; see also Belke & Stielow, 2013) has argued that the blocked-cyclic paradigm allows participants to encode the objects of each set in the first cycle and subsequently bias the levels of activation of the representations of the objects in the set top-down. Such biases are likely to be mediated by left frontal brain regions, specifically the left inferior frontal cortex (LIFG). Semantic processing strategies may be mediated in a similar fashion, leading to a processing advantage for the members of a specific category or the category node itself. Such biases are likely to operate at the conceptual level rather than the lexical level (Belke, 2013; Thomson-Schill & Botvinick, 2006). A prediction following from this proposal is that compared with healthy speakers, patients with deficits in the top-down control of language should benefit less from pauses in the current version of the blocking paradigm than healthy controls. The finding that participants employed semantic prediction strategies when only three out of 10 sets featured semantically related objects suggest that these strategies reflect a general tendency of the production system to employ semantic knowledge top-down in lexical search. Such search strategies would operate in addition to largely automatic semantic priming effects, mediated by spreading activation. It is conceivable that they reflect search strategies similar to those seen in semantic fluency tasks, requiring participants to generate as many exemplars of a given semantic field (e.g., animals, supermarket) as possible (Bose, Wood, & Kiran, in press; Shao, Janse, Visser, & Meyer, 2014). Indeed, Stielow (in press) found for aphasic patients with word finding difficulties and healthy speakers that better performance in a semantic fluency task was associated with reduced interference in the blocked-cyclic naming task.

The novel and most important finding of the present study is the modification of the semantic facilitation effect in the first part of the experiment by the presence or absence of pauses between sets of items. As Navarrete et al. (2014) pointed out, the persistence of the facilitatory effect across repetitions cannot be explained by the account of context effects in blocked-cyclic naming proposed by Belke et al. (2005). However, it is consistent with later accounts (Abdel Rahman & Melinger, 2007; Belke, 2013; Damian & Als, 2005) that take the patterns of results of blocked-cyclic naming experiments as reflecting a trade-off of conceptual facilitation and lexical inhibition. Importantly, the present findings show that conceptual facilitation effect is susceptible to strategic influences. This proposal explains several key findings from blocked-cyclic naming, including the absence of the facilitation effect in the first cycle when naming occurs under a concurrent working memory load (Belke, 2008) or when there is no way of predicting the shared category membership of an upcoming item (Belke, 2013; Damian & Als, 2005). While this proposal can be integrated seamlessly within the framework proposed by Belke (2013, 2017; see also Belke & Stielow, 2013), who takes strategic influences in blocked-cyclic naming into account, it is, as far as we can see, not consistent with the view put forward by Navarrete et al. (2014). They aim to explain the patterns of results of blocked-cyclic naming experiments entirely by reference to largely automatic processes, namely priming and competitive incremental learning.

Given that the impact of pauses on speech onset latencies in a picture naming task may appear to be a rather technical issue, it is important to highlight the broader implications of our findings. First, they illustrate the impact of processing strategies, specifically conceptually mediated predictions, on participants' performance in primed naming tasks. Second, the results are relevant to the contentious issue of whether or not lexical selection involves competition between coactivated lexical units (Spalek et al., 2013). Navarrete et al. (2014) argued that models endorsing selection by competition would predict, contrary to the empirical findings, that speech onset latencies should be slower for homogeneous than for heterogeneous sets when the items are repeated in a noncyclic fashion. In our view, theories postulating competition do not predict this: Instead interference between related items arising during competition for lexical selection can be superseded by facilitation at the conceptual level. When participants strategically use the conceptual information, shorter response latencies will be observed. Thus, the data obtained by Navarrete et al. (2014) and in the present experiment do not rule out that lexical selection is a competitive process.

However, we wish to stress that the data do not unambiguously support this view either. Instead the results can be explained within any framework that acknowledges that word production involves more than the selection of lexical units, and that semantic relatedness between successive items can simultaneously affect processing at different levels, facilitating some processes and hindering others. We will only understand lexical selection if we take this broad set of processes involved in producing a word into account.

References

Abdel Rahman, R., & Melinger, A. (2007). When bees hamper the production of honey: Lexical interference from associates in speech production. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33,* 604–614. http://dx.doi.org/10.1037/0278-7393.33.3.604

Abdel Rahman, R., & Melinger, A. (2011). The dynamic microstructure of speech production: Semantic interference built on the fly. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 37,* 149–161. http://dx.doi.org/10.1037/a0021208

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language, 59,* 390–412. http://dx.doi.org/10.1016/j.jml.2007.12.005

Belke, E. (2008). Effects of working memory load on lexical-semantic encoding in language production. *Psychonomic Bulletin & Review, 15,* 357–363. http://dx.doi.org/10.3758/PBR.15.2.357

Belke, E. (2013). Long-lasting semantic context effects on object naming are necessarily conceptually mediated. *Journal of Memory and Language, 69,* 228–256. http://dx.doi.org/10.1016/j.jml.2013.05.008

Belke, E. (2017). The role of task-specific response strategies in blocked-cyclic naming. *Frontiers in Psychology, 7,* 1955. http://dx.doi.org/10.3389/fpsyg.2016.01955

Belke, E., Meyer, A. S., & Damian, M. F. (2005). Refractory effects in picture naming as assessed in a semantic blocking paradigm. *Quarterly Journal of Experimental Psychology, 58,* 667–692. http://dx.doi.org/10.1080/02724980443000142

Belke, E., & Stielow, A. (2013). Cumulative and non-cumulative semantic interference in object naming: Evidence from blocked and continuous manipulations of semantic context. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology, 66,* 2135–2160. http://dx.doi.org/10.1080/17470218.2013.775318

Bose, A., Wood, R., & Kiran, S. (in press). Semantic fluency in aphasia: Clustering and switching in the course of 1 minute. *International Journal of Communication Disorders*.

Crowther, J. E., & Martin, R. C. (2014). Lexical selection in the semantically blocked cyclic naming task: The role of cognitive control and learning. *Frontiers in Human Neuroscience, 8,* 9. http://dx.doi.org/10.3389/fnhum.2014.00009

Damian, M. F., & Als, L. C. (2005). Long-lasting semantic context effects in the spoken production of object names. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31,* 1372–1384. http://dx.doi.org/10.1037/0278-7393.31.6.1372

Damian, M. F., Vigliocco, G., & Levelt, W. J. M. (2001). Effects of semantic context in the naming of pictures and words. *Cognition, 81,* B77–B86. http://dx.doi.org/10.1016/S0010-0277(01)00135-4

Dell, G. S. (1986). A spreading-activation theory of retrieval in sentence production. *Psychological Review, 93,* 283–321. http://dx.doi.org/10.1037/0033-295X.93.3.283

Glaser, W. R., & Düngelhoff, F. J. (1984). The time course of picture-word interference. *Journal of Experimental Psychology: Human Perception and Performance, 10,* 640–654. http://dx.doi.org/10.1037/0096-1523.10.5.640

Howard, D., Nickels, L., Coltheart, M., & Cole-Virtue, J. (2006). Cumulative semantic inhibition in picture naming: Experimental and computational studies. *Cognition, 100,* 464–482. http://dx.doi.org/10.1016/j.cognition.2005.02.006

Keuleers, E., Brysbaert, M., & New, B. (2010). SUBTLEX-NL: A new frequency measure for Dutch words based on film subtitles. *Behavior Research Methods, 42,* 643–650. http://dx.doi.org/10.3758/BRM.42.3.643

Levelt, W. J. M., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences, 22,* 1–38. http://dx.doi.org/10.1017/S0140525X99001776

Navarrete, E., Del Prato, P., Peressotti, F., & Mahon, B. Z. (2014). Lexical selection is not by competition: Evidence from the blocked naming paradigm. *Journal of Memory and Language, 76,* 253–272. http://dx.doi.org/10.1016/j.jml.2014.05.003

Oppenheim, G. M., Dell, G. S., & Schwartz, M. F. (2010). The dark side of incremental learning: A model of cumulative semantic interference during lexical access in speech production. *Cognition, 114,* 227–252. http://dx.doi.org/10.1016/j.cognition.2009.09.007

Roelofs, A. (1992). A spreading-activation theory of lemma retrieval in speaking. *Cognition, 42,* 107–142. http://dx.doi.org/10.1016/0010-0277(92)90041-F

Shao, Z., Janse, E., Visser, K., & Meyer, A. S. (2014). What do verbal fluency tasks measure? Predictors of verbal fluency performance in older adults. *Frontiers in Psychology, 5,* 772. http://dx.doi.org/10.3389/fpsyg.2014.00772

Spalek, K., Damian, M. F., & Bölte, J. (2013). Is lexical selection in spoken word production competitive? Introduction to the special issue on lexical competition in language production. *Language and Cognitive Processes, 28,* 597–614. http://dx.doi.org/10.1080/01690965.2012.718088

Stielow, A. (in press). *The contribution of executive functions to performance in word retrieval tasks in aphasic patients and healthy controls—A psycholinguistic investigation* (Doctoral dissertation).

Thompson-Schill, S. L., & Botvinick, M. M. (2006). Resolving conflict: A response to Martin and Cheng (2006). *Psychonomic Bulletin and Review, 13,* 402–408.

(*Appendix follows*)

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Appendix

Materials

Names of target pictures organized by semantic category (English Translations in parenthesis):

Fruit: appel (apple), kiwi (kiwi), citroen (lemon), banaan (banana), peer (pear)

Tableware: lepel (spoon), vork (fork), glas (glass), mes (knife), kopje (cup)

Clothes: broek (trousers), muts (cap), jurk (dress), rok (skirt), pyjama (pajamas)

Tools: boor (drill), schaar (scissors), hamer (hammer), tang (tongs), zaag (saw)

Furniture: bed (bed), tafel (table), radio (radio), kruk (stool), spiegel (mirror)

Animals: ezel (donkey), zebra (zebra), olifant (elephant), hert (deer), paard (horse)

Names of fillers:

bal (ball), bloem (flower), boek (book), boom (tree), camera (camera), deur (door), emmer (bucket), hand (hand), kasteel (castle), koekje (cookie), maan (moon), munt (coin), pijl (arrow), pistool (gun), potlood (pencil), sleutel (key), tak (twig), ton (barrel), waaier (fan), zwaard (sword).

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