Pragmatic constraints do not prevent the co-activation of alternative names:

Evidence from sequential naming tasks with one and two speakers

Andreas Mädebach^{1,2}, Franziska Kurtz², Herbert Schriefers³,

& Jörg D. Jescheniak²

¹ Pompeu Fabra University, ² Leipzig University, ³ Radboud University

Word count: 10312 (incl. abstract, tables, and figure captions)

Andreas Mädebach, Center for Brain and Cognition, Pompeu Fabra University, Barcelona, Spain, and Institute of Psychology – Wilhelm Wundt, Leipzig University, Germany; Franziska Kurtz, Institute of Psychology – Wilhelm Wundt, Leipzig University, Germany; Herbert Schriefers, Donders Institute for Brain, Cognition and Behavior, Radboud University, Nijmegen, The Netherlands; Jörg D. Jescheniak, Institute of Psychology – Wilhelm Wundt, Leipzig University, Germany.

Correspondence concerning this article should be addressed to: Andreas Mädebach, Center for Brain and Cognition, Universitat Pompeu Fabra, C/ Ramon Trias Fargas, 25-27, 08005 Barcelona, Spain. E-mail: a.maedebach@gmail.com.

Abstract

We investigated whether the phonological co-activation of alternative names in picture naming (e.g. “fish” for target “shark”) is reduced by contextual constraints which render them inappropriate. In the constraining context, the target naming response was preceded by a naming response to an object from the same category (e.g., an eel) which remained visible during target naming. Therefore, use of the alternative target name “fish” would result (a) in an ambiguous response because of the visual context and (b) in a pragmatically odd response because of the previous naming response. In Experiment 1 the context pictures were named by the participants themselves and in Experiment 2 by a communication partner. In both experiments, interference from distractor words phonologically related (“finger”) versus unrelated (“book”) to the alternative name was observed regardless of context. This finding indicates limited flexibility in lexical activation during speech planning.

Keywords: speech production, lexical access, flexibility, picture-word interference, context effects, joint naming

Introduction

While we are speaking, we constantly make decisions about which words to use. Quite often, different words can be used to refer to the same object. This has been coined the *verbalization problem* (Levelt, Roelofs, & Meyer, 1999; see also Brown, 1958; Cruse, 1977). Our actual choice of words is affected both by our (lexical) knowledge and the situation in which we plan an utterance. Imagine you visit an aquarium in the zoo and you see a shark. As a young child without further knowledge you might simply call it “fish”. Later as an adult with more specific knowledge, you will probably call it “shark”. In the absence of other fish, both names are equally appropriate because any basic-level name (e.g., “fish”) also holds for any corresponding subordinate name (e.g., “shark”). However, in the presence of two or more different fish (e.g., shark and eel), the basic-level name is no longer appropriate for referring to one of them unambiguously. Likewise, it is odd to use the basic-level name to refer to a specific type of fish (e.g., shark) after just having named a different specific type of fish by its subordinate-level name (e.g., “This is an eel. And this is a fish.”). This would leave the hearer in doubt as to which fish is referred to by the basic-level name. In terms of linguistic pragmatics, such an utterance constitutes a violation of the normal rules of communication. Most prominently it violates Grice’s (1975) maxim of quantity. As a result, the words “And this is a fish” seem to carry an extra meaning (e.g., an affective overtone) which is not predictable from their lexical makeup, maybe something like “*This is only* an eel. But *that, that* is a *real (big)* fish” when referring to a shark (see e.g., Cruse, 1977, on the semantic effects of varying the level of specificity; see also Grice, 1975, on pragmatic implicatures). If this is not the meaning intended by the speaker, the appropriate level of specificity should be used instead (e.g., by saying, “This is an eel. And this is a shark.”). There is also

good experimental evidence that a concurrent visual context affects our choice of words. For example, Brennan and Clark (1996) demonstrated that speakers tended to use subordinate names when more than one object from the same basic-level category was depicted on a card they had to describe to an interlocutor.

Recent studies have shown that even though the basic-level name is not produced in such a situation, it becomes nevertheless lexically co-activated up to a phonological level (Jescheniak, Hantsch, & Schriefers, 2005; Jescheniak et al., 2017; Kurtz, Schriefers, Mädebach, & Jescheniak, 2018; see also Jescheniak & Schriefers, 1998; Peterson & Savoy, 1998, for related evidence on synonyms). For example, a distractor word phonologically related to the target picture's basic-level name (e.g., "finger" related to "fish", when "shark" is the target) slows down subordinate-level picture naming compared to an unrelated distractor (e.g., "book"). Importantly, this is also the case even when the target picture is presented together with a context picture from the same basic-level category (e.g., eel; Jescheniak et al., 2005) and when the speaker just heard a request like "name the fish!" before the target picture appeared (Jescheniak et al., 2017). In fact, the interference effects obtained in these situations were similar sized as in control conditions in which unrelated context pictures (e.g., palm tree) or neutral requests ("name the object!") were used. Taken together, these findings suggest that neither a visually constraining context (as implemented in Jescheniak et al., 2005), nor a pragmatically constraining context (as implemented by Jescheniak et al., 2017) can, by itself, prevent or attenuate the lexical co-activation of an alternative name.

How do these findings tie in with present models of language production? In classical models, word retrieval is largely seen as a static process where lexical activation develops autonomously (e.g., Dell, 1986; Dell, Martin, & Schwartz, 2007;

Dell & O'Seaghdha, 1991, 1992; Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Levelt et al., 1991, 1999; Rapp & Goldrick, 2000; Roelofs, 1992). Under this static view, effects of local context (like a visual or a pragmatic context) on lexical activation patterns might not to be expected, which is in line with the findings mentioned above. These models assume that activation spreads automatically and without hindrance to related concepts due to the fixed connections between concepts and conceptual features (e.g., producing "shark" also activates the category fish and other category members such as eel which share the same category node), which then activate the corresponding lexical representations. Under this view, a given context might only affect the eventual choice between alternative names without affecting the preceding activation processes.

More recently, however, it has been suggested that connections between nodes in the conceptual-lexical network may be (temporarily) strengthened or weakened (Abdel Rahman & Melinger, 2009; Howard, Nickels, Coltheart, & Cole-Virtue, 2006; Oppenheim, Dell, & Schwartz, 2010) depending on previous naming episodes. This idea was first proposed to account for semantic interference effects in the blocked-cyclic and continuous naming paradigms (e.g., Belke, Meyer, & Damian, 2005; Belke & Stielow 2013; Damian & Als, 2005; Damian, Vigliocco, & Levelt, 2001; Howard et al., 2006; Scaltritti, Peressotti, & Navarrete, 2017; cf., Roelofs, 2018). Such temporary changes in connection strength as a function of a (more) global context would be more in line with some general context-dependent flexibility of the speech production system.

From this latter perspective, it is surprising that the local contextual constraints of the kind discussed above seem to be rather ineffective, in that they do not seem to affect the degree to which the phonological representation of an alternative name

becomes co-activated. One potential reason for this state of affairs could be that the impact of these contextual constraints is too small to be found with only one such constraint. Another potential reason could be that contextual constraints are more likely to become visible in real communicative situations in which quick and precise lexical selection of only one of the alternative names is of high communicative relevance, for example when two speakers try to reach a shared goal, and in order to be successful they have to use only one of the alternative names.

Outline of the Experiments

We present two picture-word interference experiments that investigated the combined effects of visual and pragmatic constraints on the phonological co-activation of an alternative (basic-level) name (e.g., “fish”) during (subordinate-level) picture naming (e.g., “shark”). In the experiments we implemented two manipulations. First, we varied the context of picture naming, so that the context either rendered the alternative name inappropriate (constraining context) or not (neutral context). Second, in order to assess the phonological co-activation of the alternative name, we contrasted unrelated distractor words and distractor words which were phonologically related to the alternative name.

The context manipulation entailed two features applied simultaneously. First, a visual constraint was established via a context picture that preceded the target picture and remained visible to the speaker until the target picture disappeared. In the constraining context, this context picture came from the same basic-level category as the target picture (e.g., eel, when the target was “shark”). In the neutral context, it came from a different basic-level category (e.g., jeans). Second, a pragmatic constraint resulted from the speaker’s own preceding response to this

context picture (self-produced context word) in Experiment 1, or a different participant's preceding response (other-produced context word) in Experiment 2. In both experiments, the visual and the pragmatic constraint applied simultaneously in the constraining context condition, whereas neither constraint applied in the neutral context condition.

Experiment 2 involved a communication task involving joint picture naming by two participants. This task was set up so that communicative success necessitated the consistent use of the subordinate-level name (for details see below). This contrasts with Experiment 1 in which the use of either of the two alternative names had no communicative consequences. Therefore, we expected the constraining condition to be more salient and hence potentially more effective in Experiment 2. The comparison of Experiment 2 with Experiment 1 thus allows us to test whether the communicative relevance (Experiment 2) versus irrelevance (Experiment 1) of the use of the (subordinate level) target name versus the alternative (basic-level) name matters for the phonological co-activation of an alternative name.

The distractor manipulation (alternative-related vs. unrelated) is the same as in previous related studies. In neutral contexts, distractors phonologically related to an alternative picture name interfere more strongly with the naming response than unrelated distractors (Jescheniak et al., 2005; 2017; Kurtz et al., 2018). This effect can be explained as follows. For related distractors (e.g., "finger"), the distractor activates some of the phonological segments of the (eventually not produced) alternative name (e.g., "fish") which are, at the same time, also activated by the picture. Thus, activation from two sources converges on a non-target representation. By contrast, for unrelated distractors (e.g., "book"), there is no such convergence,

because the distractor activates only phonological segments which do not receive activation from the picture name. Thus, a related distractor reduces the difference in activation between the phonological representation of the target and a competitor (alternative name), rendering target selection more difficult. If the joint force of multiple constraining factors (visual plus pragmatic constraint in Experiment 1 and 2, and/or the addition of the dimension “communicative relevance” in Experiment 2) is capable of temporarily weakening the flow of activation from the picture to the contextually inappropriate (basic-level) name’s phonology, the interference effect should be reduced in the constraining context.

Sample size was determined based on related experiments (Jescheniak et al., 2017) and the following considerations. Because the previous studies (Jescheniak et al., 2005; 2017) on single contextual constraints failed to obtain evidence for context effects on the phonological co-activation of alternative (basic-level) names, we did not only implement multiple contextual constraints simultaneously, but also decided to double the previous participant sample size (i.e., $N = 64$ instead of 32), thus increasing the precision of our point estimates and statistical power (for an estimate of the sensitivity of the present study, see the section on cross-experimental analyses). Moreover, we decided to use sequential analyses (Lakens, 2014; Schönbrodt, Wagenmakers, Zehetleitner, & Perugini, 2017). We conducted one interim analysis ($N = 32$) and one final analysis ($N = 64$) and computed adjusted alpha boundaries using the default settings of the *gsDesign*-package (Anderson, 2016). The boundaries for interim and final analysis were .006 and .048, respectively. Only the final analyses are reported here. All data exclusions, all manipulations, and all measures implemented in the study are reported.

Experiment 1

Experiment 1 was similar to Experiment 4 reported in Jescheniak et al. (2017) in which sequences of four pictures appearing one after another were named within a trial. However, in contrast to that experiment, the pictures remained on the screen until the end of the trial in order to implement a concurrent visual context (see Figure 1 for an illustration). In the constraining context, the target picture was directly preceded by the picture of an object from the same basic-level category (e.g., context picture: eel – target picture: shark), rendering use of the alternative (basic-level) name “fish” for the target contextually inappropriate for two reasons. It would result in (a) an ambiguous naming response because of the current visual context (visual constraint) and (b) in an odd naming response in view of the previous naming (pragmatic constraint). We predicted that related distractors would interfere with the naming response in the neutral context in which the use of the alternative (basic-level) name was not constrained by the (visual and pragmatic) context (e.g., Jescheniak et al., 2005, 2017). The critical question was whether this interference effect would be reduced in the constraining context compared to the neutral context.

Figure 1. Illustration of the sequential naming task in Experiment 1. A single participant named four pictures in each trial. The context and target picture appeared either on position 3 and 4 (as depicted) or on position 1 and 2. Auditory distractors started simultaneously with each picture. Distractor relatedness was only manipulated for the target picture; filler and context pictures were always presented with unrelated distractor words.

Method

Participants. Sixty-four participants, mostly students from Leipzig University, (48 females, mean age: 23.6 years, $SD = 5.5$) took part in the experiment. Two further participants were replaced because of technical difficulties during their experimental sessions. Participants either received course credit or were paid 6 €. In the experiments reported here, all participants were native speakers of German, had normal or corrected to normal vision, and no known hearing deficits.

Materials. We used the materials from Jescheniak et al. (2017).¹ The experimental stimuli were colour photographs of 32 common objects which were preferentially named at the subordinate level. The set was composed of items from 16 basic-level categories with two exemplars per category (e.g., “Aal” [eel] and “Hai” [shark] from the basic-level category “Fisch” [fish], see Appendix for a complete list of

¹ We used a slightly different assignment of the unrelated distractors.

the materials). These stimuli were used as target and context pictures. There was no phonological or morphological overlap between a given basic-level category and its two subordinate exemplars. In addition to these experimental items, we selected two additional items for each basic-level category as fillers.

Thirty-two filler pictures, two from each of the 16 experimental categories, were included to discourage participants from strategically preparing one possible response (for details see below). This resulted in 64 colour photographs with four pictures from each of the 16 basic-level categories (two experimental items and two filler items, respectively).

Phonologically related distractor words shared the initial phoneme sequence with the picture's alternative (basic-level) name (e.g., "Filter" [filter] for the basic-level name "Fisch" [fish]). These 16 distractors (for the 16 basic-level category names) were semantically and associatively unrelated to the subordinate-level target name and its alternative (basic-level) name. An unrelated control condition was created by reassigning the related distractors to the two experimental pictures from a different basic-level category. A separate set of 16 unrelated distractor words was presented with the filler pictures.

All pictures were sized to roughly fill an imaginary square of 250 x 250 pixel (corresponding to 7.3 x 7.3 cm or a visual angle of 7.0° x 7.0° at 60 cm viewing distance). For practice and warm-up trials, 8 additional pictures and distractors were used. Distractor words were spoken by a female native speaker of German, recorded at a sampling rate of 48 kHz, and normalized in amplitude. The duration of these words ranged from 663 ms to 850 ms ($M = 761$ ms, $SD = 57$ ms).

Apparatus. Visual stimuli were presented on a 19 in. TFT-monitor and auditory distractors with closed-back headphones at a comfortable listening volume.

The experiment was controlled by NESU (MPI for Psycholinguistics). Naming latencies were registered with a microphone connected to the hardware voice key. Participants' responses were digitally recorded to allow for offline rechecking, if necessary.

Design. The fully crossed factors type of context (constraining vs. neutral) and distractor relatedness (related vs. unrelated) were measured within participants and within items. In each trial, the visual display consisted of four pictures appearing from left to right. Target position varied systematically (second or fourth position; see below). The sequence of the four experimental conditions (resulting from the crossing of type of context and distractor relatedness) was sequentially balanced across target pictures using a Latin square procedure so that each of the conditions appeared at a different level of repetition for a given target picture across experimental lists. In all, we created 32 pseudo-randomized lists (each of which was used twice) using Mix (Van Casteren & Davis, 2006) with the constraints that (a) target position, context condition, distractor relatedness, and experimental condition (resulting from the crossing of type of context and distractor relatedness) were not repeated on more than three successive trials, (b) the first picture in a display was always from a different basic-level category than the last picture in the preceding trial, and (c) there was at least one trial intervening between targets from the same basic-level category.

The main experiment consisted of 128 trials (32 items x 4 conditions). The target was either the second or the fourth picture, preceded by the context picture (neutral or constraining). Context and target picture were either followed by two filler pictures (e.g., eel, shark, <filler>, <filler>) or preceded by two filler pictures (e.g., <filler>, <filler>, eel, shark). Filler pictures were included to discourage participants from strategically preparing one possible response when trying to anticipate an

upcoming picture, assuming that it might be a semantically related one (as was the case on a substantial proportion of picture sequences). Filler pictures were assigned to each trial with the following constraints: Those preceding context and target picture (a) were from two different basic-level categories, (b) their category was different from the category of both context and target picture, and (c) they were phonologically and semantically unrelated to the target picture. No constraints applied to those fillers following context and target picture. Rather, to detract participants' attention from the (semantically related) context–target picture sequences, we deliberately presented three or four pictures from the same basic-level category in roughly 12% of the trials. For these trials, the target picture was always the second picture, followed by one or two filler pictures from the same basic-level category.

Procedure. Participants were tested individually in a dimly lit room. They were seated comfortably with a viewing distance of about 60 cm to the computer screen. The experimenter was separated from the participants by a partition wall. Before the experiment started, participants were familiarised with the pictures and their subordinate-level names by presenting them a booklet containing all pictures with the respective name written below each picture. Participants were instructed to use these names during the experiment. After inspection of the booklet, each picture appeared once in the centre of the screen and was named by the participant. They were corrected by the experimenter if necessary, after they had completed this block. After the study phase, participants were instructed that their next task would be to name four pictures in a row, each as fast and as accurately as possible. Participants started with a short practice block of 4 trials composed of practice items which were otherwise identical to experimental trials. The experiment proper consisted of four blocks of 32 trials each starting with a warm-up trial. There were short pauses between blocks.

A trial was structured as follows. First, a fixation cross appeared at the left side of the screen, which was replaced by the first picture after 2 s. After 3 s the next picture appeared to the right of the previous one and 3 s after the last (fourth) picture the whole screen was cleared. Pictures were presented at equally spaced and horizontally aligned positions (x-offsets for upper left corner: 95, 375, 655, and 935, constant y-offset for upper left corner: 387 at 1,280 x 1,024 pixels screen resolution). A light grey background was used (RGB 244 244 244). Simultaneously with the onset of each picture an auditory distractor was presented. For the non-target pictures, only unrelated distractors were used. Speech onset latency was only measured for the target picture, beginning at its onset. Use of the correct name was monitored for all pictures on a trial. One trial lasted approximately 14 s.

Analytical approach. We analysed the data using R (R Core Team, 2018). We analysed naming latencies with linear mixed models treating participants and items as crossed random factors (Baayen, Davidson, & Bates, 2008). Models were fitted using the package lme4 (Bates, Mächler, Bolker, & Walker, 2015). To alleviate problems with non-normality and heteroskedasticity of residuals we log transformed naming latencies. Additional analyses on untransformed latencies lead to the same conclusions. These additional analyses are documented in the OSF-repository of the present study.

We aimed to fit models with the maximal possible random-effects structure (Barr, Levy, Scheepers, & Tily, 2013). We started out with a maximal model containing random slopes for relatedness, context, and their interaction for both participants and items. In cases of non-convergence, we step-wise simplified the random structure, by dropping random correlations and the interaction terms before dropping main effect slopes from the model. In case of singular model fits, we first

dropped the interaction before dropping the main effect slopes with an estimated variance (close to) zero. We tested the significance of the fixed effects with likelihood ratio tests. To evaluate the significance of the interaction between context and relatedness we compared the full model with a reduced model containing only the two main effects. To evaluate the significance of the two main effects we compared this reduced model (without the interaction but containing both main effects) to two further models containing only one of the main effects.

Results and Discussion

The raw data and data analysis scripts for the experiments reported here are available via the Open Science Framework (OSF) under: <https://osf.io/gh7n6/>. In the following cases, observations were excluded from further analysis: (a) incorrect or no response for the target picture, (b) disfluency, (c) non-speech sound by the participant triggered the voice key, (d) technical error, and (e) incorrect or no response for the context picture. Trials of type (a) – (c) were counted as errors in the error analysis (3.3% of all observations). Latencies deviating more than 2 *SD* from a participant's and an item's mean per experimental condition were classified as outliers and excluded from further analysis as well (158 observations, 1.9%). This outlier criterion was determined prior to any data analysis and is the same one we used in previous related studies, Jescheniak et al., 2005; 2017; Kurtz et al., 2018). We want to note that analysing the data without outlier removal does not change the results and their interpretation in any substantial way. Table 1 displays mean naming latencies and error rates.

Table 1. Mean naming latencies (in milliseconds) and error rates (in %) of Experiment 1, broken down by type of context and distractor relatedness.

Distractor	Type of context			
	Neutral		Constraining	
	M	%	M	%
Related	801 (12)	4.8 (0.7)	777 (12)	3.3 (0.5)
Unrelated	764 (13)	2.8 (0.4)	752 (12)	2.5 (0.4)
Difference	37 (5)	2.0 (0.6)	25 (5)	0.7 (0.5)
95% CI	[27, 47]	[0.8, 3.2]	[15, 35]	[-0.2, 1.8]

Note. Standard errors of the mean are given in parentheses. Standard errors and confidence intervals are based on cell means by participants.

There was no significant interaction between context type and distractor relatedness, $\chi^2(1) = 1.51$, $p = .220$. There was a significant main effect of context reflecting faster responses with the constraining context, $\chi^2(1) = 9.25$, $p = .002$. The main effect of relatedness was also significant. Alternative-related distractors interfered more strongly with the naming response than unrelated distractors, $\chi^2(1) = 16.91$, $p < .001$.

In the error analysis, the interaction between relatedness and context was not significant, $\chi^2(1) = 1.55$, $p = .213$. There was a significant effect of context. Fewer errors were observed with a constraining context than with a neutral context, $\chi^2(1) = 4.39$, $p = .036$. There was also a significant relatedness effect. Participants made more errors with related distractors than with unrelated distractors, $\chi^2(1) = 11.5$, $p < .001$.

The results from Experiment 1 can be summarized as follows. First, an auditory distractor phonologically related to the target picture's alternative (basic-level) name led to interference, suggesting that the alternative name was phonologically co-activated. Second, having just named a picture from a given basic-level category significantly sped up the (subordinate-level) naming of another picture from that category. This effect is likely due to semantic (category) priming and suggests that the self-produced context word did affect target picture naming. Third, although the interference effect was descriptively smaller in the constraining than in the neutral context (in line with what we had predicted), this difference was not significant.

Experiment 2 put the hypothesis that the co-activation of alternative names is reduced in constraining contexts to another test. We used the same visual and pragmatic constraints as in Experiment 1. But in contrast to Experiment 1, the whole experimental setting now consisted of a communication task that additionally introduced the factor communicative relevance. This factor made the alternative (basic-level) name communicatively inappropriate, and this holds not only for the constraining context but also for the neutral context (for details, see below). If the constraining context (visually and pragmatically constraining) is only effective when the use of the (subordinate level) target name is at the same time also essential for communicative success, the interference effect should be attenuated in the constraining context in Experiment 2 compared to the neutral context in Experiment 2.

Experiment 2

Experiment 2 implemented a communication task involving joint picture naming of two participants. Each of the participants took on one of two speaker roles (henceforth speaker A and speaker B) and these roles alternated from trial to trial (see Figure 2 for an illustration). Importantly, and in contrast to Experiment 1 (and previous related studies), naming the pictures with their alternative (basic-level) names was now not only contextually inappropriate, but also fatal for success in the communication task (for details, see procedure below).

The communication task comprised two naming episodes. In the first naming episode (speaker A), there were no pragmatic or visual constraints. Thus, the first naming episode is parallel to the neutral context condition of Experiment 1, except that the new dimension communicative relevance (implemented via the communication task) was introduced. In the second naming episode (speaker B), the same contextual constraint as implemented in Experiment 1 additionally came into play. In the constraining context condition the two pictures of the second naming episode were from the same basic-level category, whereas they were not in the neutral context condition. Importantly, in contrast to Experiment 1, the contextual constraint was now imposed by the utterance of the other participant. As in Experiment 1 we measured the phonological co-activation of the alternative basic level name by contrasting distractors phonologically related vs. unrelated to the alternative basic level name. We hypothesised that if the constraining context is only effective when the use of the (subordinate level) target name is at the same time also relevant for communicative success, the phonological co-activation of the alternative name should now be reduced in the constraining context compared to the neutral context.

Figure 2. Illustration of the communication task in Experiment 2. Two participants took turns in naming pictures. Participants could hear each other but could not see each other's monitors. In each trial, one participant (speaker A) named a single picture which appeared on his screen (first naming episode). Afterwards, this picture appeared together with a new picture on the screen of the other participant (speaker B). The new picture was to be named by speaker B (second naming episode). Finally, two pictures appeared on the screen of speaker A and s/he stated whether s/he was seeing the same pictures as those that speaker B had just seen (verification task). In both naming episodes auditory distractor words (alternative-related vs. unrelated) were presented simultaneously with the pictures. The speaker roles (A vs. B) alternated between participants from trial to trial.

Method

Participants. Sixty-four participants (forming 32 pairs of speakers), mostly students from Leipzig University, (49 females, mean age: 23.3 years, $SD = 4.7$) took part in the study. An additional pair of participants was replaced because they had both recently participated in a related experiment using the same materials. Participants either received course credit or were paid 12 €.

Materials & Design. Same as in Experiment 1 with the following exceptions. In each trial, the visual stimuli appeared alternately on two monitors. During the first naming episode, a single picture appeared in the centre of speaker A's monitor. In the second naming episode, two pictures appeared side-by-side on speaker B's monitor (with target picture position varying systematically) while speaker A's monitor remained blank. Finally, for the verification task, two pictures appeared on speaker

A's monitor while speaker B's monitor remained blank (see Figure 2). Distractors were presented only to speaker A on the first naming episode, only to speaker B on the second naming episode, and there were no distractors in the verification task.

In all, 32 pseudo-randomized lists were created using the same constraints as in Experiment 1 with the following adaptations: (a) the picture for the first naming episode was always from a different basic-level category than the pictures in the preceding trial, (b) repetition of the target pictures was separated by at least three trials, and (c) there were no more than three successive trials with a "no" response in the verification task (overall 25% of all trials).

In order to keep the length of the whole experiment reasonable, we split the full item set into two subsets that were administered to different participant groups (equally sized), such that each subset included exactly one exemplar from each basic-level category in the first naming episode and the other exemplar in the second naming episode. Because speaker roles alternated between participants in each pair each given participant named all pictures during the experiment (but half of them in the first naming episode and the other in the second naming episode). Each participant received a total of 64 experimental trials (16 experimental items x 2 types of contexts x 2 distractor relatedness conditions) and 64 filler trials (32 filler items x 2 types of context; in the filler trials, only unrelated distractors were used). The same fillers as in Experiment 1 were included, this time to discourage participants from strategically preparing one possible response on the second naming episode. For example, in the constraining context speaker B named the picture of a shark two times (once with a related and once with an unrelated distractor) preceded by an eel on the first naming episode. Due to alternating speaker roles, the picture of a shark was preceded by an eel four times in the whole experiment. In order to prevent

participants from strategic response guessing (e.g., “eel is followed by shark”), the picture of an eel was followed by two different filler pictures in the filler trials. The same was true for the neutral context. In the experimental trials, the first naming episode (speaker A) was always measured in the same distractor condition (related vs. unrelated) as the second naming episode (speaker B).

Apparatus. Same as in Experiment 1, with the following exceptions. Another 19 in. TFT monitor and another microphone for the second participant were added. The closed-back headphones were replaced by two open-back headphones that allowed participants to clearly hear each other’s responses (but not the distractor words presented to the other participant). For technical reasons, online measurement of naming latencies from two speakers at the same time was not possible. Thus, naming latencies were determined offline based on the digital recordings made during the experiment.

Procedure. Same as in Experiment 1, except for the following differences. The two participants sat opposite each other in front of two separate monitors. They could hear each other, but their view was blocked by their computer screens. The study phase began with a written instruction and participants received the same booklets as in Experiment 1. In the familiarization block, the two participants took turns in naming the pictures which alternately appeared on one of the monitors. Each experimental picture appeared once in the centre of the screen for each participant respectively.

The second instruction informed them that their next task was to alternately name the pictures appearing on their screens, each as fast and as accurately as possible and to find out whether they saw the same pictures on their screens. Figure 2 illustrates the two picture naming episodes and the verification task of a single trial.

First, speaker A named a single picture (first naming episode, e.g., “Aal” [eel]). Next, speaker B saw two pictures, the one previously named by speaker A (providing the other-produced context word for speaker B) and a new picture that was either from the same semantic category (e.g., “Hai” [shark]; constraining context) or from a different semantic category (e.g., “Jeans” [jeans]; neutral context). Speaker B’s task was to name the new picture (second naming episode, e.g., “Hai” [shark]).

Consequently, if speaker A had named the first picture with its alternative (basic-level) name (e.g., “Fisch” [fish]), then speaker B would not have known which of the two pictures to name on his/her turn in the constraining condition. Finally, in the last step of each trial (verification task), speaker A saw two pictures, either the two pictures already named by the other speaker and her/himself or the picture named by her/himself and a new picture (e.g., Aal [eel] and Tulpe [tulip]). In the first case, speaker A was to verify that they had seen the same pictures (e.g., by stating “ja” [yes], “genau” [exactly] or the like). In the second case, speaker A was to state which picture s/he had seen instead (e.g., by saying “Nein, Aal und Tulpe” [No, eel and tulip] or the like). To solve this task correctly, it was again mandatory that speaker B had named the (new) picture with its subordinate-level name.

The roles of speaker A and B alternated from trial to trial between the two participants. This ensured that both participants were aware of the fact that naming at the subordinate-level was crucial for communicative success. Each pair of participants started with two short practice blocks containing four trials, respectively, which were identical to experimental trials, except that practice stimuli were used. The first practice block did not contain distractor words. These were introduced in the second practice block. The experiment comprised 4 blocks of 64 trials, each starting with two warm-up trials. There were short pauses between blocks.

In each trial, the picture (pairs) appeared alternately on two monitors (1,280 x 1,024 pixels screen resolution). Pictures were presented in the upper half of one monitor (constant y-offset: 106) and in the lower half of the other (constant y-offset: 618), with one participant only seeing the upper half and the other only the lower half; the other halves were covered by a cardboard mask. All pictures were presented on a light grey background (RGB 244 244 244). On each trial, first, a fixation cross appeared in the centre of the visible part of the first monitor for 500 ms which was replaced by the first picture (x-offset: 515) that was presented for 1 s. Simultaneously with picture onset an auditory distractor word was presented; 1.5 s after the offset of the picture, two pictures appeared on the second monitor (x-offsets: 320, 660). They were presented for 1 s and simultaneously with picture onset an auditory distractor was presented. 2 s after the offset of these pictures, two pictures appeared again on the first monitor (x-offsets: 320, 660). These pictures remained on the screen for 1.5 s. The next trial started 2.5 s after the offset of these pictures. One trial lasted about 10 s.

Analytical approach. Analyses were conducted as described for Experiment 1. As in Experiment 1 analyses of untransformed latencies lead to the same conclusions as the analyses on log transformed latencies we report here. For the first naming episode, only the main effect or distractor relatedness (related vs. unrelated) was analysed. For the second naming episode, main effects of context type, distractor relatedness, and their interaction were analysed.

Results and Discussion

Responses of each participant were recorded and split into trial-wise audio files (each starting at stimulus onset of a given naming episode with a duration of 5 s). CheckFiles (Protopapas, 2007) was used to measure naming latencies offline, based on visual and auditory inspection of the speech files. Errors were coded (and latencies removed) if an incorrect or no response was given. For the second naming episode latencies were also removed (but no error counted) if the context picture had been not named or wrongly named in the first naming episode. After applying these criteria, 7.0% of all observations were marked as erroneous and submitted to two separate error analyses for the first and second naming episode (2.7% and 4.3% errors, respectively). Participants were highly accurate in the verification task (overall: 2.4% errors, constraining context: 2.5% errors, neutral context: 2.4% errors).

RTs and error rates were analysed separately for the two naming episodes. Outlier were removed by using the same criterion as in Experiment 1 (103 observations, 2.5% and 90 observations, 2.2%, for naming episode 1 and 2 respectively). Table 2 displays mean reaction times and error rates.

Table 2. Mean naming latencies (in milliseconds) and error rates (in %) of Experiment 2, broken down by naming episode, type of context and distractor relatedness.

Distractor	Naming episode					
	First			Second		
	Neutral		Neutral		Constraining	
	M	%	M	%	M	%
Related	734 (9)	3.6 (0.5)	870 (11)	5.3 (1.0)	861 (12)	3.6 (0.7)
Unrelated	696 (9)	1.9 (0.4)	827 (11)	4.5 (0.7)	833 (12)	4.0 (0.7)
Difference	37 (4)	1.7 (0.4)	43 (8)	0.8 (1.0)	28 (8)	-0.4 (0.7)
95% CI	[29, 45]	[0.9, 2.5]	[27, 59]	[-1.3, 2.9]	[12, 44]	[-1.8, 1.0]

Note. Standard errors of the mean are given in parentheses. Standard errors and confidence intervals are based on the cell means by participants.

First naming episode. Naming latencies were slower with related distractors than with unrelated distractors. The main effect of relatedness was significant, $\chi^2(1) = 24.1$, $p < .001$. There was also a significant main effect of relatedness on error rates. More errors were made with related than with unrelated distractors, $\chi^2(1) = 12.1$, $p < .001$.

Second naming episode. There was no significant interaction between context type and distractor relatedness, $\chi^2(1) = 1.86$, $p = .173$. There was also no significant main effect of context, $\chi^2(1) = 0.003$, $p = .958$. The main effect of relatedness was again significant. Alternative-related distractors interfered more with the naming response than unrelated distractors, $\chi^2(1) = 20.41$, $p < .001$.

In the error analysis, the interaction between relatedness and context was not significant, $\chi^2(1) = 0.86$, $p = .355$. There was also neither a significant effect of context, $\chi^2(1) = 0.88$, $p = 0.349$, nor of relatedness, $\chi^2(1) = 0.10$, $p = .751$.

The results from Experiment 2 can be summarized as follows. First, an auditory distractor phonologically related to the target picture's alternative (basic-level) name led to interference in both naming episodes. This effect was of roughly the same size across experiments (in the neutral context: 37 ms in Experiment 1, and 38 and 43 ms in the first and second naming episode of Experiment 2). Thus, the additional communicative dimension of Experiment 2 did not reduce the effect. Second, there was no context effect. Hearing the partner naming a categorically related picture in the first naming episode did not affect picture naming speed in the second naming episode. Third, and most importantly, the interference effect was again not substantially reduced by the type of context, suggesting that the alternative (basic-) level names were similarly co-activated in neutral and constraining context.

Cross-experimental analysis

We combined the data from Experiment 1 and second naming episode from Experiment 2 in a cross-experimental analysis to (a) evaluate the apparent difference in the context effect across experiments and (b) maximize statistical power for the critical interaction between context and relatedness. There was no significant three-way interaction of experiment, context and relatedness, $\chi^2(1) = 0.09$, $p = .761$, and no significant interaction of experiment and relatedness in this analysis, $\chi^2(1) = 0.05$, $p = .823$. However, there was a significant interaction between experiment and the context effect, $\chi^2(1) = 4.57$, $p = .033$. This suggests that there was indeed a difference in the context effect between experiments. Most importantly, there was also no significant interaction between context and relatedness in the cross-

experimental analyses, $\chi^2(1) = 3.09$, $p = .079$. This means that either the phonological interference effect is not reduced in the constraining context or that this reduction was too small to be reliably detected across our experiments. We used two approaches to further explore these two possibilities. First, we used data simulations (Brysbaert & Stevens, 2018) to estimate the sensitivity of our design to detect a given reduction of the phonological interference effect in the constraining context. Second, we fitted additional Bayesian mixed effects models using the *brms*-package (Bürkner, 2018) to estimate the evidence against the critical interaction of context and distractor relatedness in the present data.

In order to estimate the sensitivity of the present study we simulated 1,000 data sets with varying degrees of reduction of the phonological interference effect in the constraining context compared to the neutral context. The expected phonological interference effect in the neutral context was based on a parameter estimate of this effect across all available experiments which had tested for this effect using the same material set (i.e., the present data and the data of Jescheniak et al., 2017, and Kurtz et al., 2018). Expected variances across items and participants were based on random effect estimates across these data sets. The expected context effect, for which we had no prior data, was varied in two sets of simulations. One simulation assumed a facilitation effect of the constraining context (as observed in Experiment 1). The other assumed no such effect (as observed in Experiment 2). Whether or not a context effect was simulated had no effect on the estimated power for the critical interaction. All details of the simulations and the scripts to reproduce them are documented in the OSF-project of this study. According to the simulations the present study had ca. 90% power to detect an elimination of the phonological interference effect in the constraining context (80% in Experiment 1 alone, 55% in Experiment 2 alone). In other words, across both experiments the present study was

sufficiently powered to detect an elimination of the phonological interference effect in the constraining context. However, for smaller reductions the present study was not sufficiently powered.

For the Bayesian models we used a maximal random structure and fitted the untransformed latencies to a shifted log-normal distribution. We evaluated the evidence in favour of the interaction by computing Bayes factors for the contrast between a model containing the interaction and a model not containing it. We used weakly informative priors based on prior predictive checks (Schad, Betancourt, & Vasishth, 2019) for all parameters in the model and varied the prior for the critical interaction to examine the influence of this prior on the resulting Bayes Factor (Vasishth, Nicenboim, Beckman, Li, & Kong, 2018). Table 3 displays the Bayes Factors in favour of the null hypothesis (the model without the interaction) and the 95% credible interval for the interaction term (for each experiment and the cross-experimental analysis). As can be seen, zero is contained in all credible intervals irrespective of prior setting. The Bayes factors suggest substantial evidence (i.e., BF 3-10; Wagenmakers et al., 2011) against the interaction when assuming a relatively diffuse prior (i.e., without a-priori constraining the expected size of the interaction much). However, with decreasing prior width (i.e., stronger a-priori constraints on the expected size of the interaction), the data provide neither clear evidence in favour, nor against the null hypothesis.

Table 3. Results of the Bayesian analyses regarding the critical interaction between context type and distractor relatedness in the latency analyses.

	Experiment 1		Experiment 2		Overall	
Prior	95% CI	BF ₀₁	95% CI	BF ₀₁	95% CI	BF ₀₁
normal (0, 0.5)	[-0.06, 0.01]	14.4	[-0.07, 0.01]	9.1	[-0.05, 0.00]	6.9
normal (0, 0.1)	[-0.05, 0.01]	3.0	[-0.07, 0.01]	2.1	[-0.05, 0.00]	1.6
normal (0, 0.05)	[-0.05, 0.01]	1.7	[-0.06, 0.01]	1.1	[-0.05, 0.00]	0.7

Note. Prior settings are and parameter estimates are on the log scale. 95% CI represent the 95% credible interval for the interaction parameter. Bayes Factors (BF₀₁) represent evidence in favour of a model not containing the interaction over a model containing it.

General Discussion

In two picture-word interference experiments we investigated whether multiple contextual factors which constrain the set of appropriate picture names can prevent inappropriate alternative names from becoming phonologically co-activated in a single-speaker task (self-produced context word; Experiment 1) and in a communicative joint naming task (other-produced context word; Experiment 2). There were three main findings. First, in both experiments we observed interference from distractors phonologically related to the alternative (basic level) names compared to unrelated distractors. This suggests that the alternative (basic-level) names became phonologically co-activated in both experiments. Second, in Experiment 1, naming a picture from a given basic-level category sped up the (subordinate-level) naming of a subsequent picture from the same category, likely due to semantic category priming within the conceptual network of the speaker (within-speaker effect; see also Blaxton & Neely, 1983, one-prime condition; Jescheniak et al., 2017, Experiment 4). In

contrast, we found no such effect across speakers in Experiment 2. Third and most importantly, the phonological interference effect was not eliminated in the constraining context condition. This suggests that the co-activation of the alternative (basic-level) names was not eliminated in a situation in which the joint force of multiple constraining factors (simultaneous visual and pragmatic context in Experiment 1 – plus communicative relevance in Experiment 2) rendered the alternative name inappropriate. We will discuss these three findings in turn.

The phonological interference effect we observed across contexts in both experiments replicates findings from previous studies and suggests that alternative picture names become phonologically co-activated during speech planning. Following these previous studies, we interpret this phonological interference effect as an indicator of *phonological* co-activation of alternative picture names (Jescheniak et al., 2005; 2017; Kurtz et al., 2018). A phonological locus is supported by time-course estimates and theoretical considerations (Jescheniak & Schriefers, 1998; see also Jescheniak, Hahne, Hoffmann, & Wagner, 2006). However, if one assumes interactive activation flow between phonological and lexical representations (for a review see Goldrick, 2006), it is hard to rule out some lexical contribution to this effect (e.g., that the alternative-related distractor indirectly increases activation of the lexical representation of the alternative name which then interferes with lexical selection). Whether or not there is some lexical contribution to this effect is not of crucial importance for the present study. We expected that influences of pragmatic constraints on co-activation patterns would originate from prelexical conceptualization processes (e.g., by denoting the required level of specificity for the response in a given pragmatic context in the preverbal message). Consequently, any reduction of phonological co-activation would be expected to be the consequence of a reduction of lexical co-activation. Therefore, if we would have found a reduction of

the interference effect in the constraining context this would have indicated a reduction of both (abstract) lexical and phonological co-activation.

In our interpretation of the phonological interference effect we adopt the view that there is competitive selection at the lexical and phonological levels and that interference effects reflect this competition (e.g., Levelt et al., 1999). However, on an alternative account of the picture-word interference task, selection is non-competitive, and interference effects are assumed to be due to monitoring processes (response-exclusion account, e.g., Dhooge & Hartsuiker, 2010; Mahon, Costa, Peterson, Vargas & Caramazza, 2007). The present study was not designed to distinguish between these accounts, and it is at present unclear whether the response-exclusion account could explain phonological interference effects.² However, let us assume for argument's sake that the phonological interference effect is caused by monitoring processes. Could this explain the relative stability of phonological interference across contexts? Under the response exclusion account, the critical factor for the emergence of interference effects is the response relevance of the distractor words (Mahon et al., 2007). Differences in response relevance have, for instance, been used to explain why there is semantic interference for the distractor “rose” but not for

² The response-exclusion account was proposed to explain semantic interference (Finkbeiner & Caramazza, 2006; Mahon et al., 2007) and distractor frequency effects (Dhooge & Hartsuiker, 2010). To the best of our knowledge no explicit claims have been made regarding phonological (interference) effects. Extending the response-exclusion account to phonological effects appears to be not trivial. For instance, it is unclear how this account would simultaneously explain phonological facilitation and phonological interference. We also want to note that the response exclusion account has been repeatedly criticized on empirical and theoretical grounds and it seems that it cannot provide a satisfactory explanation for many relevant findings in the literature (e.g., Aristei & Abdel Rahman, 2012; Hutson, Damian, & Spalek, 2013; Jescheniak, Matushanskaya, Mädebach, & Müller, 2014; Mädebach, Wöhner, Kieseler, & Jescheniak, 2017; Mädebach, Oppermann, Hantsch, Curda, & Jescheniak, 2011; Mulatti & Coltheart, 2012; Roelofs, Piai, & Schriefers, 2013; Rose, Aristei, Melinger & Abdel Rahman, 2018; Starreveld, La Heij, & Verdonshot, 2013).

the distractor “tulip” when naming the picture of a rose as a “flower” (for discussions see Hantsch & Mädebach, 2013; Navarrete & Mahon, 2013, Mädebach & Hantsch, 2013). This explanation thus assumes that response relevance depends on the appropriateness of the distractor word as a potential response to the target picture. From this perspective, a constraining context – as in the present experiments – should make the competitor less “response relevant” (i.e., easier to exclude as a potential response) and would thus predict a modulation of the interference effect by context. Thus, applying the response-exclusion account to our experimental situation would not predict the relative stability of interference effects across contexts that we observed.

The difference in the main effect of context between experiments was surprising. We had expected to find a similar priming effect of the semantically related context picture in Experiment 1 (within speaker) and in Experiment 2 (between speakers). We believe that this unexpected result may stem from differences in task demands between both experiments. In Experiment 1 identification of the target object was not directly affected by the name of the context object. The target object appeared next to the context object and could be identified regardless of how the context object was named. The situation was different in Experiment 2. Speaker B did not see the screen of speaker A and had to keep the name of the object named by speaker A in mind until he had identified his own target (which was the object which was not named by speaker A). In other words, in Experiment 1 the lexical activation of the context object name could decay relatively quickly. In contrast, in Experiment 2 the context object’s name had to be kept in working memory and thereby lexical activation of the context object probably had to be maintained much longer. Consequently, the context object name might have been a stronger lexical competitor for the target name in the constraining context in

Experiment 2 than it was in Experiment 1. This increased lexical competition in the constraining condition might have counteracted semantic priming at the conceptual level and thus could explain why we did not observe a similar facilitatory context effect in both experiments.

Could a similar argument be made with regard to increased activation and competition from the alternative name in the constraining context? If the co-activation of the basic-level name alternative would be enhanced in the constraining context this might also counteract a hypothetical reduction of such co-activation due to the pragmatic constraints. There is for instance evidence that names of (not to be named) context pictures can become lexically and phonologically co-activated (e.g., Morsella & Miozzo, 2002). Therefore, it may be that the basic-level name alternative is activated to some degree by mere visual processing of the context picture (in Experiment 1 and naming episode 2 of Experiment 2). However, we believe that this possibility does not challenge the broader conclusions of the present study. This possibility entails that the critical reduction of co-activation (during target processing) is not substantially larger than enhanced co-activation due to automatic cascading activation (which is limited, see Goldrick, 2006). Furthermore, in the constraining context the hypothetical reduction of basic level name activation should be similarly affecting processing of the target picture and the context picture because the basic level name would be pragmatically inappropriate for either picture. Therefore, the potential counteracting influence of priming of the basic level name by the context picture would become weaker the stronger the reduction of basic-level activation induced by the pragmatic constraint is. In sum, assuming that there is some (limited) priming of the basic level name by the context picture in the constraining context would in our view still be consistent with our overall conclusion that the production

system has only limited flexibility when adapting co-activation patterns to pragmatic constraints.

One might argue that in the absence of any direct across-speaker effects (i.e., no direct context effect in Experiment 2), we cannot be sure that our participants co-represented their partner's speech. However, this seems unlikely, given the fact that Gambi, van de Cavey, and Pickering (2015) found evidence that merely imagining another person's response interfered with one's own naming in a non-interactive context (participants sat in adjacent soundproof booths and could only peripherally see each other through a small window). If there is evidence for mental co-representation in situations in which it is irrelevant for one's own actions, as was the case in Gambi et al.'s (2015) study, we should expect it even more in a real communicative situation, that is, in a situation in which two speakers must coordinate their responses to reach a common communicative goal and need to listen to their partner in order to be able to perform their own task.

The critical finding of the present study is that the phonological co-activation of alternative names is not eliminated when visual and pragmatic constraints render them inappropriate. This is in line with previous results suggesting that lexical co-activation patterns are not modulated by contextual constraints (Jescheniak et al., 2005; 2017, see Figure 3). When combining the present data with those of our previous study (in which the same material set, but arguably weaker pragmatic constraints were used) the average phonological interference effect is relatively similar across contexts (for the neutral context: 24 ms, 95% CI [10, 38], for the constraining context: 20 ms, 95% CI [9, 32]) and there is no significant interaction between context and phonological interference effect across these studies, $\chi^2(1) = 2.63$, $p = .105$). Taken together all available data suggest that the phonological co-

activation of taxonomically related alternative names (e.g., “fish” for “shark”) is not easily eliminated, even when combining a visually and pragmatically constraining context (Experiment 1 and 2) and adding real communicative relevance to the task (Experiment 2).

Figure 3. Phonological interference effects across pragmatically constraining and neutral contexts: Data taken from Jescheniak et al. (2017) and from the present study. Depicted are fixed effect estimates from linear mixed models fitted separately for each context in each experiment. Error bars represent 95% profile confidence intervals of the fixed effect estimate.

One limitation of the present study is that the data are insufficient to rule out some smaller attenuation of phonological co-activation in the constraining contexts. Both present experiments showed a descriptive trend towards a reduction of the phonological interference effect in the constraining context (37 ms vs. 25 ms for neutral and constraining contexts in Experiment 1 and 43 ms vs. 28 ms in

Experiment 2, respectively). We want to note that, compared to the previous findings (see Figure 3), this trend seems to be driven by a relatively large effect in the neutral context not by a reduction of the effect in the constraining context. Nonetheless, it may be that this trend is indicative of some smaller attenuation of the interference effect which the present study was not sufficiently powered to observe. It may be that the phonological interference effect is specifically indicating competition in the high conflict situation of the picture-word interference task in which lexical selection and phonological encoding is complicated by the presence of a distractor word. If so, it is hard to rule out that there may be a fine-grained adaptation of co-activation patterns in pragmatically constraining contexts, which, however, is not strong enough to overcome or noticeably influence the competition present in the picture-word interference task. Therefore, we want to emphasize that the present study cannot rule out some (small) reduction of phonological co-activation in pragmatically constraining contexts. What the present study demonstrates is that the phonological co-activation of alternative names is not *eliminated* in these contexts. This shows that contextual flexibility of such co-activation is, if it exists, relatively limited.

Limited flexibility of co-activation patterns is particularly surprising for the communication task in Experiment 2 given that studies investigating communicative situations between two participants have shown that speakers take their partner into account when preparing their utterances. For example, Garrod and Anderson (1987) found that participants who had to describe their spatial positions in a maze to each other tended to use the same formulations (e.g., A: “Third row two along”, B: “Second row three along” vs. A: “I’m at C5”, B: “I’m at E1”). Similarly, participants tended to use non-preferred names for pictures when an experimental confederate had named the same picture with the non-preferred name before (Finlayson & Corley, 2012). Moreover, current models of human interaction and dialogue assume that speakers

co-represent and even predict their partner's speech. Pickering and Garrod (2013; see also, Gambi & Pickering, 2016) proposed a simulation route for prediction whereby interlocutors derive the speaker's intention by simulating what they themselves would do if they were in the speaker's shoes and by drawing on current contextual information and adjusting for it. On this account, the basic-level names were clearly inappropriate in the constraining context in Experiment 2 due to current contextual information and especially when predicting the partner's subsequent task. However, we did not find evidence suggesting that the information flow in the conceptual-lexical network is shaped by communicative relevance, at least as implemented via the communication task in our experiment.

Limited flexibility of co-activation patterns is also surprising in light of the ample evidence showing that lexical choices are affected by contextual factors (e.g., Brannigan, Pickering, Pearson, McLean, & Brown, 2011; Brennan & Clark, 1996; Finlayson & Corley, 2013; Jescheniak et al., 2005). How can this seeming discrepancy be explained? We assume that in non-constrained contexts one benefit of the co-activation of alternative names is an increase of lexical flexibility which ultimately aids fluent speech. In non-constraining contexts this co-activation has no cost for communicative success because it does not matter which name is selected. In contrast, in constraining contexts, when lexical flexibility is no longer an option, this co-activation comes with the cost that erroneous selection of an inappropriate alternative name becomes more likely. Therefore, in constraining contexts reducing the co-activation of an inappropriate alternative name would be one way to optimize error control. The present results suggest that this is not the case. Of course, this does not mean that there are no other ways of ensuring that inappropriate names are not (or only rarely) produced. One possibility is that contextual adaptations of lexical choice are achieved by control processes which do not directly prevent the co-

activation (and erroneous selection) of inappropriate name alternatives but instead prevent the ultimate production of an inappropriate name after it got (erroneously) selected. This could be implemented in a comprehension-based monitoring account (e.g., Levelt, 1989; Levelt et al., 1999) which compares whether the output of the production system which is about to be produced corresponds to the preverbal message (which specifies, e.g., the necessary level of specificity of the response). Going one step further, one might also argue that co-activation patterns are only optimized in situations in which there is a high probability of making selection errors. In the present tasks, participants were explicitly instructed to use (the also normally preferred) subordinate-level target names and therefore hardly ever produced the inappropriate alternative basic-level names. Possibly in this situation co-activation patterns were not optimized (i.e., co-activation of alternative names was not inhibited), because mis-selections of inappropriate basic-level names were not likely enough to trigger an optimization of the co-activation pattern. However, we want to note that in a related study, co-activation of alternative names appeared to be of similar size and to be similarly robust when asking participants to produce the non-preferred basic level names instead of the subordinate level names or when not familiarizing participants with the picture names before the experiment proper (Kurtz et al., 2018).

In sum, we want to emphasize that the present data do not suggest that speakers do not adapt their speech to pragmatic constraints. What the present study shows is that the *co-activation* of alternative names preceding lexical selection is relatively robust to pragmatic constraints. The phonological co-activation of alternative names is not eliminated even when multiple constraining factors work hand in hand, and even when the choice of only one particular word becomes essential for communicative success, this pattern does not change. At least for the

type of relations tested in our experiments (e.g., “shark” – “fish”), the speech production system seems to be rather limited in its ability of flexibly adjusting and fine-tuning the lexical activation patterns of alternative names.

Acknowledgments

Our research was supported by the German Research Foundation (DFG JE229/11-1). Andreas Mädebach was supported by a Beatriu de Pinós postdoctoral grant (2017 BP 00180) of the Catalan Government during the writing of this manuscript. We thank Tobias Struck and Ismail Ayoub for assistance in data collection.

Disclosure of interest

The authors report no conflict of interest.

Data availability statement

The data and analysis scripts to reproduce the results presented in this article are openly available via the Open Science Framework at: <https://osf.io/gh7n6/>.

References

- Abdel Rahman, R., & Melinger, A. (2009). Semantic context effects in language production: A swinging lexical network proposal and a review. *Language and Cognitive Processes*, 24, 713–734. <https://doi.org/10.1080/01690960802597250>
- Anderson, K. (2016). gsDesign: Group Sequential Design. Retrieved from <https://CRAN.R-project.org/package=gsDesign>
- Aristei, S., & Abdel Rahman, R. (2013). Semantic interference in language production is due to graded similarity, not response relevance. *Acta Psychologica*, 144, 571–582. <https://doi.org/10.1016/j.actpsy.2013.09.006>
- Baayen, R. H., Davidson, D., & Bates, D. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language*, 59, 390–412. <https://doi.org/10.1016/j.jml.2007.12.005>
- 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, 255–278. <https://doi.org/10.1016/j.jml.2012.11.001>
- Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, 67. <https://doi.org/10.18637/jss.v067.i01>
- Belke, E., Meyer, A. S., & Damian, M. F. (2005). Refractory effects in picture naming as assessed in a semantic blocking paradigm. *The Quarterly Journal of Experimental Psychology Section A: Human Experimental Psychology*, 58, 667–692. <https://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*, 66, 2135–2160. <https://doi.org/10.1080/17470218.2013.775318>
- Blaxton, T. A., & Neely, J. H. (1983). Inhibition from semantically related primes: Evidence of a category-specific inhibition. *Memory & Cognition*, 11, 500–510. <https://doi.org/10.3758/BF03196987>
- Branigan, H. P., Pickering, M. J., Pearson, J., McLean, J. F., & Brown, A. (2011). The role of beliefs in lexical alignment: Evidence from dialogs with humans and computers. *Cognition*, 121, 41–57. <https://doi.org/10.1016/j.cognition.2011.05.011>

- Brennan, S. E., & Clark, H. H. (1996). Conceptual pacts and lexical choice in conversation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 22, 1482–1493. <https://doi.org/10.1037/0278-7393.22.6.1482>
- Brown, R. (1958). How shall a thing be called? *Psychological Review*, 65, 14–21. <https://doi.org/10.1037/h0041727>
- Brysbaert, M., & Stevens, M. (2018). Power analysis and effect size in mixed effects models: A tutorial. *Journal of Cognition*, 1. <https://doi.org/10.5334/joc.10>
- Bürkner, P.-C. (2017). brms : An R package for Bayesian multilevel models using Stan. *Journal of Statistical Software*, 80. <https://doi.org/10.18637/jss.v080.i01>
- Cruse, D. A. (1977). The pragmatics of lexical specificity. *Journal of Linguistics*, 13, 153–368. <https://doi.org/10.1017/S0022226700005363>
- 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. <https://doi.org/10.1037/0278-7393.31.6.1372>
- Damian, M. F., Vigliocco, G., & Levelt, W. J. (2001). Effects of semantic context in the naming of pictures and words. *Cognition*, 81, B77-B86. [https://doi.org/10.1016/S0010-0277\(01\)00135-4](https://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. <https://doi.org/10.1037/0033-295X.93.3.283>
- Dell, G. S., Martin, N., & Schwartz, M. F. (2007). A case-series test of the interactive two-step model of lexical access: predicting word repetition from picture naming. *Journal of Memory and Language*, 56, 490–520. <https://doi.org/10.1016/j.jml.2006.05.007>
- Dell, G. S., & O'Seaghdha, P. G. (1991). Mediated and convergent lexical priming in language production: A comment on Levelt et al (1991). *Psychological Review*, 98, 604–614. <https://doi.org/10.1037/0033-295X.98.4.604>
- Dell, G. S., & O'Seaghdha, P. G. (1992). Stages of lexical access in language production. *Cognition*, 42, 287–314. [https://doi.org/10.1016/0010-0277\(92\)90046-K](https://doi.org/10.1016/0010-0277(92)90046-K)
- Dell, G. S., Schwartz, M. F., Martin, N., Saffran, E. M., & Gagnon, D. A. (1997). Lexical access in aphasic and nonaphasic speakers. *Psychological Review*, 104, 801–838. <https://doi.org/10.1037/0033-295X.104.4.801>

- Dhooge, E., & Hartsuiker, R. J. (2010). The distractor frequency effect in picture–word interference: Evidence for response exclusion. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 36, 878–891.
<https://doi.org/10.1037/a0019128>
- Finkbeiner, M., & Caramazza, A. (2006). Now you see it, now you don't: on turning semantic interference into facilitation in a Stroop-like task. *Cortex*, 42, 790–796.
[https://doi.org/10.1016/S0010-9452\(08\)70419-2](https://doi.org/10.1016/S0010-9452(08)70419-2)
- Finlayson, I. R., & Corley, M. (2012). Disfluency in dialogue: An intentional signal from the speaker? *Psychonomic Bulletin & Review*, 19, 921–928.
<https://doi.org/10.3758/s13423-012-0279-x>
- Gambi, C., & Pickering, M. J. (2016). Predicting and imagining language. *Language, Cognition and Neuroscience*, 31, 60–72.
<https://doi.org/10.1080/23273798.2015.1049188>
- Gambi, C., van de Cavey, J., & Pickering, M. J. (2015). Interference in joint picture naming. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 41, 1–21. <https://doi.org/10.1037/a0037438>
- Garrod, S., & Anderson, A. (1987). Saying what you mean in dialogue: A study in conceptual and semantic co-ordination. *Cognition*, 27, 181–218.
[https://doi.org/10.1016/0010-0277\(87\)90018-7](https://doi.org/10.1016/0010-0277(87)90018-7)
- Goldrick, M. (2006). Limited interaction in speech production: Chronometric, speech error, and neuropsychological evidence. *Language and Cognitive Processes*, 21, 817–855. <https://doi.org/10.1080/01690960600824112>
- Grice, H. P. (1975). Logic and conversation. In P. Cole & J. L. Morgan (Eds.), *Syntax and semantics: Vol. 3. Speech acts* (pp. 41–58). New York, NY: Academic Press.
- Hantsch, A., & Mädebach, A. (2013). What does the articulatory output buffer know about alternative picture names? Evidence against the response-exclusion hypothesis. *Language and Cognitive Processes*, 28, 684–700.
<https://doi.org/10.1080/01690965.2011.595725>
- Howard, D., Nickels, L., Coltheart, M., & Cole-Virtue, J. (2006). Cumulative semantic inhibition in picture naming: experimental and computational studies. *Cognition*, 100, 464–482. <https://doi.org/10.1016/j.cognition.2005.02.006>

- Hutson, J., Damian, M. F., & Spalek, K. (2013). Distractor frequency effects in picture–word interference tasks with vocal and manual responses. *Language and Cognitive Processes*, 28, 615–632. <https://doi.org/10.1080/01690965.2011.605599>
- Jescheniak, J. D., Hahne, A., Hoffmann, S., & Wagner, V. (2006). Phonological activation of category coordinates during speech planning is observable in children but not in adults: Evidence for cascaded processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 32, 373–386. <https://doi.org/10.1037/0278-7393.32.3.373>
- Jescheniak, J. D., Hantsch, A., & Schriefers, H. (2005). Context Effects on Lexical Choice and Lexical Activation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 31, 905–920. <https://doi.org/10.1037/0278-7393.31.5.905>
- Jescheniak, J. D., Kurtz, F., Schriefers, H., Günther, J., Klaus, J., & Mädebach, A. (2017). Words we do not say - context effects on the phonological activation of lexical alternatives in speech production. *Journal of Experimental Psychology: Human Perception and Performance*, 43, 1194-1206. <https://doi.org/10.1037/xhp0000352>
- Jescheniak, J. D., Matushanskaya, A., Mädebach, A., & Müller, M. M. (2014). Semantic interference from distractor pictures in single-picture naming: Evidence for competitive lexical selection. *Psychonomic Bulletin & Review*, 21, 1294–1300. <https://doi.org/10.3758/s13423-014-0606-5>
- Jescheniak, J. D., & Schriefers, H. (1998). Discrete serial versus cascaded processing in lexical access in speech production: Further evidence from the coactivation of near-synonyms. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 24, 1256–1274. <https://doi.org/10.1037/0278-7393.24.5.1256>
- Kurtz, F., Schriefers, H., Mädebach, A., & Jescheniak, J. D. (2018). Incremental learning in word production: Tracing the fate of non-selected alternative picture names. *Journal of Experimental Psychology: Human Perception and Performance*, 44, 1586-1602. <https://dx.doi.org/10.1037/xhp0000558>
- Lakens, D. (2014). Performing high-powered studies efficiently with sequential analyses. *European Journal of Social Psychology*, 44, 701–710. <https://doi.org/10.1002/ejsp.2023>

- Levelt, W. J. M. (1989). *Speaking: From intention to articulation*. Cambridge, MA: MIT Press.
- Levelt, W. J., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences*, 22, 1–75.
<https://doi.org/10.1017/S0140525X99001776>
- Levelt, W. J., Schriefers, H., Vorberg, D., Meyer, A. S., Pechmann, T., & Havinga, J. (1991). The time course of lexical access in speech production: A study of picture naming. *Psychological Review*, 98, 122–142. <https://doi.org/10.1037/0033-295X.98.1.122>
- Mädebach, A., & Hantsch, A. (2013). Explaining semantic facilitation and interference effects in the picture–word interference task—A rejoinder to Navarrete and Mahon (2013). *Language and Cognitive Processes*, 28, 717–722.
<https://doi.org/10.1080/01690965.2013.770891>
- Mädebach, A., Oppermann, F., Hantsch, A., Curda, C., & Jescheniak, J. D. (2011). Is there semantic interference in delayed naming? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 37, 522–538.
<https://doi.org/10.1037/a0021970>
- Mädebach, A., Wöhner, S., Kieseler, M.-L., & Jescheniak, J. D. (2017). Neighing, barking, and drumming horses—Object related sounds help and hinder picture naming. *Journal of Experimental Psychology: Human Perception and Performance*, 43, 1629–1646. <https://doi.org/10.1037/xhp0000415>
- Mahon, B. Z., Costa, A., Peterson, R., Vargas, K. A., & Caramazza, A. (2007). Lexical selection is not by competition: A reinterpretation of semantic interference and facilitation effects in the picture-word interference paradigm. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 33, 503–535.
<https://doi.org/10.1037/0278-7393.33.3.503>
- Morsella, E., & Miozzo, M. (2002). Evidence for a cascade model of lexical access in speech production. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 28, 555–563. <https://doi.org/10.1037/0278-7393.28.3.555>
- Mulatti, C., & Coltheart, M. (2012). Picture–word interference and the response–exclusion hypothesis. *Cortex*, 48, 363–372.
<https://doi.org/10.1016/j.cortex.2011.04.025>

- Navarrete, E., & Mahon, B. Z. (2013). A rose by any other name is still a rose: A reinterpretation of Hantsch and Mädebach. *Language and Cognitive Processes*, 28, 701–716. <https://doi.org/10.1080/01690965.2012.682071>
- 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. <https://doi.org/10.1016/j.cognition.2009.09.007>
- Peterson, R. R., & Savoy, P. (1998). Lexical selection and phonological encoding during language production: Evidence for cascaded processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 24, 539–557. <https://doi.org/10.1037/0278-7393.24.3.539>
- Pickering, M. J., & Garrod, S. (2013). An integrated theory of language production and comprehension. *Behavioral and Brain Sciences*, 36, 329–347. <https://doi.org/10.1017/S0140525X12001495>
- Protopapas, A. (2007). Check Vocal: A program to facilitate checking the accuracy and response time of vocal responses from DMDX. *Behavior Research Methods*, 39, 859–862. <https://doi.org/10.3758/BF03192979>
- R Core Team. (2018). R: A language and environment for statistical computing.
- Roelofs, A., Piai, V., & Schriefers, H. (2013). Context effects and selective attention in picture naming and word reading: Competition versus response exclusion. *Language and Cognitive Processes*, 28, 655–671. <https://doi.org/10.1080/01690965.2011.615663>
- Rose, S. B., Aristei, S., Melinger, A., & Abdel Rahman, R. (2019). The closer they are, the more they interfere: Semantic similarity of word distractors increases competition in language production. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 45, 753–763. <https://doi.org/10.1037/xlm0000592>
- Schad, D. J., Betancourt, M., & Vasishth, S. (2019). Toward a principled Bayesian workflow in cognitive science. *ArXiv:1904.12765 [Stat]*. Retrieved from <http://arxiv.org/abs/1904.12765>
- Vasishth, S., Nicenboim, B., Beckman, M. E., Li, F., & Kong, E. J. (2018). Bayesian data analysis in the phonetic sciences: A tutorial introduction. *Journal of Phonetics*, 71, 147–161. <https://doi.org/10.1016/j.wocn.2018.07.008>

Vienna, Austria: R Foundation for Statistical Computing. Retrieved from

<http://www.R-project.org/>

Rapp, B., & Goldrick, M. (2000). Discreteness and interactivity in spoken word production. *Psychological Review*, 107, 460–499. <https://doi.org/10.1037/0033-295X.107.3.460>

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

Roelofs, A. (2018). A unified computational account of cumulative semantic, semantic blocking, and semantic distractor effects in picture naming. *Cognition*, 172, 59–72. <https://doi.org/10.1016/j.cognition.2017.12.007>

Scaltritti, M., Peressotti, F., & Navarrete, E. (2017). A joint investigation of semantic facilitation and semantic interference in continuous naming. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 43, 818–823. <https://doi.org/10.1037/xlm0000354>

Schönbrodt, F. D., Wagenmakers, E.-J., Zehetleitner, M., & Perugini, M. (2017). Sequential hypothesis testing with Bayes factors: Efficiently testing mean differences. *Psychological Methods*, 22, 322–339. <https://doi.org/10.1037/met0000061>

Starreveld, P. A., La Heij, W., & Verdonchot, R. (2013). Time course analysis of the effects of distractor frequency and categorical relatedness in picture naming: An evaluation of the response exclusion account. *Language and Cognitive Processes*, 28, 633–654. <https://doi.org/10.1080/01690965.2011.608026>

van Casteren, M., & Davis, M. H. (2006). Mix, a program for pseudorandomization. *Behavior Research Methods*, 38, 584–589. <https://doi.org/10.3758/BF03193889>

Wagenmakers, E.-J., Wetzels, R., Borsboom, D., & van der Maas, H. L. J. (2011). Why psychologists must change the way they analyze their data: The case of psi: Comment on Bem (2011). *Journal of Personality and Social Psychology*, 100, 426–432. <https://doi.org/10.1037/a0022790>

Appendix

List of the experimental pictures and distractors. English translations are given in brackets.

Target name	Alternative (basic-level) name	Related distractor	Unrelated distractor
Palme [palm tree]	Baum [tree]	Bauer [farmer]	Foto [photograph]
Tanne [fir]	Baum [tree]	Bauer [farmer]	Foto [photograph]
Rose [rose]	Blume [flower]	Bluse [blouse]	Karren [barrow]
Tulpe [tulip]	Blume [flower]	Bluse [blouse]	Karren [barrow]
Hai [shark]	Fisch [fish]	Filter [filter]	Bauer [farmer]
Aal [eel]	Fisch [fish]	Filter [filter]	Bauer [farmer]
Jeans [jeans]	Hose [trousers]	Hobel [plane]	Nutria [nutria]
Leggings [leggings]	Hose [trousers]	Hobel [plane]	Nutria [nutria]
Dackel [dachshund]	Hund [dog]	Humpen [beaker]	Sporn [spur]
Pudel [poodle]	Hund [dog]	Humpen [beaker]	Sporn [spur]
Barbie [barbie]	Puppe [doll]	Pumpe [pump]	Hobel [plane]
Matroschka [matryoshka]	Puppe [doll]	Pumpe [pump]	Hobel [plane]
Füller [fountain pen]	Stift [pen]	Stirn [forehead]	Pumpe [pump]
Kuli [ballpoint pen]	Stift [pen]	Stirn [forehead]	Pumpe [pump]
Ente [duck]	Vogel [bird]	Foto [photograph]	Bude [shack]

Storch [stork]	Vogel [bird]	Foto [photograph]	Bude [shack]
Toast [toast]	Brot [bread]	Brom [bromine]	Auge [eye]
Sandwich [sandwich]	Brot [bread]	Brom [bromine]	Auge [eye]
Atlas [atlas]	Buch [book]	Bude [shack]	Stirn [forehead]
Duden [dictionary]	Buch [book]	Bude [shack]	Stirn [forehead]
Boxer [boxer]	Sportler [athlete]	Sporn [spur]	Humpen [beaker]
Golfer [golfer]	Sportler [athlete]	Sporn [spur]	Humpen [beaker]
Ass [ace]	Karte [card]	Karren [barrow]	Bluse [blouse]
Joker [joker]	Karte [card]	Karren [barrow]	Bluse [blouse]
Flipflop [flipflop]	Schuh [shoe]	Schule [school]	Käfig [cage]
Sandale [sandal]	Schuh [shoe]	Schule [school]	Käfig [cage]
Trabi [Trabant]	Auto [car]	Auge [eye]	Brom [bromine]
Smart [Smart]	Auto [car]	Auge [eye]	Brom [bromine]
Mozzarella [mozzarella]	Käse [cheese]	Käfig [cage]	Schule [school]
Parmesan [parmesan]	Käse [cheese]	Käfig [cage]	Schule [school]
Spaghetti [spaghetti]	Nudeln [noodles]	Nutria [nutria]	Filter [filter]
Tortellini [tortellini]	Nudeln [noodles]	Nutria [nutria]	Filter [filter]