Having a task partner affects lexical retrieval:

Spoken word production in shared task settings

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Abstract

Acting jointly with a partner is different from acting alone. In this study we investigate whether speaking with a partner is different from speaking alone. Drawing upon a well-established effect in language production we investigate the degree of cumulative semantic interference experienced when naming a sequence of pictures together with a partner. Pictures of semantically related objects were named either by participants only, or by taking turns with their partner. Naming latencies increased with each additional category member, confirming cumulative semantic interference. Crucially, naming latencies increased more sharply when in previous trials within-category pictures were named by the partner (vs. presented only visually but named by no one). This effect is not simply due to hearing additional pictures being named (Experiment 1). Even when participants merely believe their remotely located partner is naming the picture (Experiment 2), and when participants cannot hear their co-present partner naming the picture (Experiment 3), lexical processes appear to be triggered that subsequently interfere with participants' own lexical retrieval. Our results speak for a profound and lasting effect of having a partner on the language production system.

Keywords: Language production, lexical retrieval, semantic interference, joint action

Having a task partner affects lexical retrieval:

Spoken word production in shared task settings

Many pragmatic phenomena are fundamentally embedded in social interaction (Levinson, 1983). Yet, comparatively little is known about how language is processed within a social interaction and how this may differ from language processing isolated from social context (e.g., Rohr & Abdel Rahman, 2015; Schindler, Wegrzyn, Steppacher, & Kissler, 2014). One characteristic of language use in conversational settings it that conversational partners alternate, often in quick succession, between speaking and listening (Clark, 1996; Pickering & Garrod, 2004, 2013). While one speaks, the other anticipates what is likely to be said and formulates the own response (Bögels, Magyari, & Levinson, 2015; Pickering & Garrod, 2007). The two processes, attending to the partner's speech, and preparing one's own speech, are coordinated and are likely to influence each other.

In this study we investigate how a simple language production task, picture naming, may be influenced by the language production of another individual. Studies investigating the cognitive processes underlying cooperation and social interaction more generally have shown that the task of one partner can influence the task of the other partner (for overview see e.g., Knoblich, Butterfill, & Sebanz, 2011). For instance, when two partners perform complementary tasks in a shared setting, individual actors experience interference from the other person's task requirements (e.g., Sebanz, Knoblich, & Prinz, 2003). One explanation for this has been that the partner's task (e.g., Sebanz, Knoblich, & Prinz, 2005), or the partner's turn (e.g., Philipp & Prinz, 2010), is co-represented

This may also apply to speaking: A recent study by Gambi and colleagues shows that picture naming latencies are delayed when participants believe their partner is about to speak (Gambi, Van de Cavey, & Pickering, 2015). In a study by Baus and colleagues (Baus et al., 2014), two participants took turns naming objects of high or low word frequency. Electroencephalographic recordings (EEG) during those trials in which the partner (but not the participant) had to name the object showed distinct signatures of electrophysiological activity in response to word frequency (that were less pronounced when nobody named the object). This suggests that participants engage in lexical processes not only when naming the object themselves, but also when the partner is naming the object.

These findings provoke the question whether simulation of the partner's language production affects the own language production system. To address this question we investigate cumulative semantic interference, a well-documented effect in single subject settings (e.g., Belke, 2013; Costa, Strijkers, Martin, & Thierry, 2009; Howard, Nickels, Coltheart, & Cole-Virtue, 2006; Navarrete, Mahon, & Caramazza, 2010). In this paradigm, subjects are asked to name a seemingly random sequence of pictures. Embedded in this sequence are pictures that are semantically related to each other, most often by being members of the same semantic category (e.g., types of birds; but see Rose & Abdel Rahman, 2016 for similar findings with semantic associations). The typical finding is that naming latencies increase linearly with each newly named member of a given semantic category, resulting in cumulative semantic interference. Because of its progressive development over time this effect is particularly suited for investigating how simulating a partner's language production may subsequently influence the own language production. Indeed, a recent study investigated continuous picture naming in a two person setting and demonstrated that hearing a partner name pictures can elicit interference with own speech production (Hoedemaker, Ernst, Meyer, & Belke, 2017), as discussed in more detail later.

Different explanations have been put forward to explain cumulative sematic interference. One common account assumes increased competition on the level of semantically related lexical entries: When naming a picture the depicted object elicits the activation of its concept (e.g., raven), and in turn the activation of the corresponding lexical entry (the lemma; e.g., *raven*). At the same time, activation spreads to semantically related concepts (e.g., dove, eagle, swan) and their lexical representations. Thus, the target lexical entry needs to be selected among several co-activated, semantically related competing entries (e.g., Dell, 1986; Levelt, Roelofs, & Meyer, 1999; Abdel Rahman & Melinger, 2009b; Roelofs, 1992).

Once the target lexical entry has been selected the connection between the entry and its concept is strengthened. When subsequently a new, semantically related object is named, the prior named concept is co-activated along with an enhanced activation level of its lexical entry. The resulting increased competition causes the new target lexical entry to be selected later. As the number of strongly active competitors steadily increases with each additional category member named, interference between semantically related items also increases (Howard et al., 2006). A variant of this competitive account assumes the origin of competition at the conceptual level elicited by a strengthened connection between concepts and their semantic features, which in turn impedes selection at the level of lexical entries (Belke, 2013). A different explanation for cumulative semantic interference argues that lexical access must not be competitive in order to account for the effect (Oppenheim, Dell, & Schwartz, 2010; Navarrete et al., 2010). A word is selected once its activation level exceeds a certain threshold. This selection not only reinforces the connection between a concept and its lexical entry, but additionally weakens the connection of co-activated non-target lexical entries. When later a picture with a weakened connection needs to be named, the target lexical entry has a lower activation level and hence takes longer to be selected.

In a shared task setting in which two partners take turns naming pictures, we predict that cumulative semantic interference can be elicited not only by naming pictures oneself, but also by pictures that are named by a partner. This would be in line with previous work (Baus et al., 2014) suggesting that a partner's naming of pictures is simulated and thereby elicits lexical processes comparable to the ones elicited when naming the picture oneself. Going beyond previous work, we furthermore expect that simulating a partner's lexical access will induce lexical competition or inhibitory mechanisms as described above. Specifically, simulated lexical retrieval (like real lexical retrieval) may impede subsequent lexical retrieval by creating highly active competitors through strengthened connections between concepts and their lexical entries (Howard et al., 2006), or between concepts and their semantic features (Belke, 2013), or, alternatively, by weakening non-target lexical entries (Oppenheim et al., 2010). In either case, partner-elicited semantic interference would provide evidence that the language production requirements of a task partner are not only co-represented but also exert a lasting influence on one's own language production.

Present Experiments

In three experiments participants successively named pictures, some of which were semantically related (e.g., several types of birds), in turns together with a partner. Within some semantic categories, half of the exemplars were named by the partner (Joint Naming condition); within other semantic categories half of the exemplars were named by neither partner nor participant (Single Naming condition). Thus, in both conditions participants named in close succession an equal number of semantically related pictures; what differed was whether, interspersed, additional pictures of the same category were named by the partner, or whether they were presented visually but were not named by anyone. This manipulation was imposed in a within-subject design. In Experiment 1 participants named pictures sitting immediately next to their task partner; in Experiment 2 participants merely believed they were naming pictures together with a physically remote partner; in Experiment 3 participants sat next to their partner but wore headphones that prevented them from hearing their partner name the pictures.

We hypothesize that having a partner will lead participants to co-represent their partner's task, hence activating the lexical representation of the object named by the partner in a fashion similar to naming it oneself. We therefore expect a steeper increase in naming latencies for those categories co-named with a partner compared to those categories named by the participant only.

Experiment 1

In Experiment 1 we tested the strength of cumulative semantic inhibition experienced when previous semantically related pictures are named by a co-present task partner compared to when they are presented only visually. Participants and their task partner (an experimental confederate) sat next to each other. Hence, participants directly witnessed their partner naming pictures.

Methods

Participants. Twenty-four native speakers of German (6 male, 18 female) between the ages 19-34 (mean 26.5) were included in the data analyses. Two participants had to be excluded and replaced due to technical failure. Participants gave informed consent and were compensated with €8 per hour or received credit towards their curriculum requirements. The experiment (as well as Experiment 2 and 3) was approved by the local ethics committee of the Psychology Department of the Humboldt

University of Berlin and complies with the Declaration of Helsinki on ethical principles for research involving human subjects (Version 2013).

Materials. Three hundred and twenty colored pictures (photographs) of man-made or natural objects were collected. The objects mapped onto 32 different semantic categories (e.g., birds, beverages, flowers; please see Appendix for complete list of objects). Most of the categories were taken from previous work (Belke, 2013; Howard et al., 2006; Rose & Abdel Rahman, 2016). Each category held 10 exemplars. Hundred and twenty additional objects served as filler items, which were unrelated to the categories underlying the target items. All pictures were scaled to 3.5 cm x 3.5 cm and had a homogenous grey background.

Experimental design. Pictures were collated in a stimulus list, which was created for each participant individually with the following constraints: The order in which exemplars of one category occurred was randomly selected (by the program "Mix", van Casteren & Davis, 2006), and they were separated randomly by a minimum of two and a maximum of six unrelated items (separating items could be filler items or items belonging to different categories). To avoid a conceptual merging of two or more related categories (e.g., categories fish and birds merging to the superordinate category animal) these never overlapped within a list (for comparable procedure see Rose & Abdel Rahman, 2016).

Half of the exemplars of a given category were assigned to "Participant Go" trials (participant names object). Under the Joint Naming condition, the other half of exemplars was assigned to "Partner Go" trials (partner names object); under the Single Naming condition, the other half was assigned to "Joint No Go" trials (nobody names object). The assignment of trial type was random with the following two exceptions: Participant Go trials were separated by maximally three Joint No Go or Partner Go trials. The first and the last presented exemplar of a category were always assigned to Participant Go trials. All filler items were Participant Go trials.

The assignment of categories to naming condition (Joint vs. Single Naming) was balanced across participants.

Procedure. Prior to the experiment, all pictures (unsorted) and their target object names were presented to participants on paper. Participants had approximately 5min to study the pictures and their corresponding name.

In the main experimental session, participants and their partner sat next to each other in front of the computer screen. One picture was presented at a time. A colored frame around the picture indicated who was to name the object: the participant, the partner, or nobody. Participants and partner were instructed to name as fast and accurately as possible those objects coded in their assigned color. In all other trials they were told to do nothing. The corresponding color codes were assigned randomly at the beginning of each experiment.

Trials began with a fixation cross of 0.5s. The picture was then presented until a response was initiated or for a maximum of 2s. A blank screen of 1.5s followed each picture presentation and then the next trial followed. Naming latency (reaction time) was recorded with the help of a voice-key from the onset of the picture presentation. During the experiment, the experimenter coded any failure of the voice-key (onset too early) as well as erroneous trials (object named wrongly or by the wrong person).

Data analyses. Naming latency was analyzed for target trials in which participants named the picture (Participant Go). Data obtained from filler trials were excluded. Furthermore excluded were trials in which pictures were named incorrectly or disfluently, or the voice-key was triggered erroneously (4.77%). Participants failed to name pictures in the assigned time 7.24% of all target trials. From the remaining valid trials 5.47% were excluded based on a naming latency that deviated two standard deviations from the individual's overall mean value. In total 82.53% of all target trials were analyzed.

Linear mixed effects models (LMM; Baayen, Davidson, & Bates, 2008) as implemented in the *lmer* function of the *lme4* package (Bates, Maechler, Bolker, & Walker, 2015) for R (R Development Core Team, 2012) with random intercepts for participants and semantic categories were applied to the log-transformed naming latencies. Naming latencies were modeled as a function of the predictors naming condition (Joint Naming vs. Single Naming) and naming order (five ordinal naming positions). The predictor naming condition was contrast coded using the sliding difference contrast, which compares average latencies between neighboring ordinal positions. The second predictor, naming order, was centered and entered as continuous variable.

Models were initially run with a maximum random effects structure (cf. Barr, Levy, Scheepers, & Tily, 2013). Using singular value decomposition, the initial full random effect structure was simplified, if necessary, by successively removing those random effects for which estimated variance was indistinguishable from zero until the maximal informative model was identified.

For fixed effects, we report fixed effect estimates, standard errors (SE), and t values, as well as the estimates of variance and the square root (standard deviations) of the random effect structure, and goodness-of-fit statistics. Fixed effects were considered significant if $|t| \geq 1.96$ (cf. Baayen, Davidson, & Bates, 2008).

Results

Replicating the typical cumulative semantic interference effect, naming latencies increased steadily with each ordinal position within a semantically related category, on average by 19ms. Crucially, naming latencies increased more steeply in the Joint Naming condition (25ms) than in the Single Naming condition (12ms), see *Figure 1*. The LMM analyses confirmed these effects as follows, for summary see *Table 1.*

The maximal informative model specified a random structure with random slopes for the factor naming condition for participants and a random intercept for semantic categories. With the random effects thus specified, the model showed a significant main effect for the predictor naming order, confirming cumulative semantic interference. Importantly, the interaction between naming order and naming condition was significant, confirming the influence of having a task partner who co-names pictures within the same semantic category. Dropping this interaction led to a significant decrease in goodness of fit, logLik $\Delta\ \chi^2(1) = 6.07$, $p = .014$.

Discussion

Experiment 1 demonstrates that the degree of interference experienced when naming in close succession semantically related pictures is amplified when speakers witness their task partner naming additional category members. Crucially, cumulative semantic inhibition is less pronounced when the same number of additional category members is presented visually, but named by neither participant nor task partner. This pattern of results suggests that participants simulate their partner's lexical retrieval, which subsequently causes interference with their own lexical retrieval.

But is this effect indeed based on participants representing their partner's behavior as contribution to a socially shared task? Experiment 1 cannot demonstrate this beyond doubt: the effect may have nothing to do with having a task partner; instead increased semantic interference may have been elicited solely by hearing the name of additional pictures. Indeed, theories proposing parity between comprehension and production (Garrod & Pickering, 2004; Levelt, 1983; Liberman & Whalen, 2000; Prinz, 1990) suggest that hearing speech may activate representations similar to producing speech. For instance, the connections between concepts and lexical entries may be strengthened not only by retrieving the name from the concept during (simulated) production but also by accessing the concept upon hearing the object name, resulting in enhanced power of a concept in activating its lexical representation. To test this possibility directly, Experiment 2 investigates the development of semantic interference under conditions in which participants only *believe* their partner names semantically related pictures, but receive no auditory evidence.

Experiment 2

In Experiment 2 participants performed the joint picture naming task spatially separated and without auditory feedback from their task partner. Thus, our manipulation relied on participants' mere belief that their task partner was naming certain pictures. Based on the assumption that performing a task together with a partner leads to co-representing the partner's task (Atmaca et al., 2011; Sebanz et al., 2005) we expect that cumulative interference will be observed even without receiving direct feedback from the partner's behavior. If participants simulate their partner's naming task independent of auditory input, a similar modulation of cumulative semantic interference as in Experiment 1 is expected.

Methods

Participants. Twenty-four native speakers of German (2 male, 22 female) between the ages 18-36 (mean 22.7) were included in the analyses of Experiment 2. Six participants were excluded and replaced because they indicated at the debriefing that they did not believe they had actually been working together with the second participant located in the other room. All participants gave informed consent and were compensated with €8 per hour or received credit towards their curriculum requirements. None of the participants had taken part in Experiment 1.

Materials, Experimental Design and Data Analyses. Materials, experimental design, and data analyses were kept identical to Experiment 1. Applying the same criteria as for Experiment 1, 6.33% of all target trials had to be excluded due to false naming, speech disfluencies, or voice-key error. Participants failed to name the pictures within the assigned time in 6.54% of all target trials. An additional 3.88% were excluded as reaction time outliers, leaving a total of 83.26% of all target trials in the analyses.

To create the impression that the remote partner's naming response terminated the presentation of the pictures, stimulus presentation time for trials in which presumably the partner named the pictures (80 Partner Go trials) were modeled after naming latencies recorded during Experiment 1. For each stimulus picture the average naming latency was calculated. From this pool, 75 latencies were randomly selected (M = 983.35ms; SD = 163.74). Five additional trials with 2000ms presentation time were added, reflecting the average percentage of trials in which participants failed to name the picture. In trials in which nobody named the picture (No Go trials), pictures disappeared after a fixed interval of 2000ms.

Procedure. Two volunteer participants were invited to the lab at one time. They were introduced to each other as task partners. After receiving the general task instructions analog to Experiment 1, participants were told they would be performing the task of jointly naming pictures spatially isolated from each other ("similar to a virtual computer game"). They were then seated in two separate cabins where they underwent procedures identical to Experiment 1, with the exception that their task partner was not physically present.

Hence, during those trials in which the partner was required to name the object, participants did not receive any auditory feedback from their partner's performance. Instead, the computer simulated the partner's naming response, which could be inferred by how quickly the picture disappeared from the screen (see procedures described above). Thus, the two participants performed the task completely independent from each other. Only their belief of performing the task together with their remote partner defined the shared task setting.

During a break, the two participants reunited outside their experimental cabins. After the picture-naming task, participants were separately interviewed on their beliefs about the experiment, in particular, whether they believed they had truly been working together with their partner on the same task.

Results

As in Experiment 1, the data of Experiment 2 demonstrate an increase of naming latencies with the number of within-category pictures named for both experimental conditions, on average 17ms. Importantly, naming latencies increased more steeply in the Joint Naming condition (27ms) than in the Single Naming condition (8ms), see *Figure 2*. These effects were corroborated by the LMM analyses on the log-transformed naming latencies, as follows (see also *Table 2*).

The model optimized for the data of Experiment 2 included a random structure with random intercept for participants and random slopes for the factor naming order for semantic categories. The increase of reaction times over ordinal position (cumulative semantic interference) was confirmed by a main effect for the predictor naming order. The steeper increase in the Joint Naming compared to the Single Naming condition was accounted for by an interaction between naming order and naming condition. Omitting this interaction from the model led to a significant decrease in fit, logLik $\Delta\chi^2(1)$ =3.29, p = .014.

Comparison of Experiment 1 and 2. We directly related findings of Experiment 1 and Experiment 2 to each other in a combined LMM analysis with the two experiments entered as an additional predictor ("experiment"), specified by a sliding difference contrast. The optimal random structure supported by the data contained varying slopes for naming order for both participants and semantic categories. Overall, participants showed longer naming latencies with a physically co-present partner (grand mean Experiment 1: 988.38ms) than with a remote partner (grand mean Experiment 2: 906.61ms), resulting in a significant main effect for the predictor experiment, b = -0.10, SE = 0.01, t = *-15.73*. We discuss this effect together with results from Experiment 3 in our General Discussion. There was no evidence for further differences between the two experiments: The predictor experiment did not interact with any of the other predictors. A simplified model permitting only the hypothesized interaction between naming order and naming condition (omitting any interactions with experiment) explained the data equally well, logLik $\Delta\chi^2(1)$ =0.07, p = .99.

Over both experiments our data showed increased naming latencies with ordinal position in both naming conditions, resulting in a main effect of the predictor naming order, b = .02, SE = 0.00, t = 5.29. The naming condition itself (Single vs. Joint) did not significantly affect naming latencies, b = -.01, SE = 0.01, t = -1.9. Crucially, in both experiments naming latencies increased steeper in the Joint Naming condition, resulting in the hypothesized interaction, b = -.015, SE = 0.00, t = -3.39.

Discussion

Experiment 2 demonstrates that the mere belief a partner is naming a picture can increase the degree of interference experienced when subsequently naming semantically related pictures. The pattern of results is in line with our interpretation from Experiment 1, in shared task settings the language production of one task partner affects the language production of the other task partner. Moreover, Experiment 2 speaks against the possibility that perceived auditory input alone is the driving factor behind the increase of semantic inhibition experienced. Instead, (presumed) knowledge about the action of the partner seems to be the main driving factor.As indicated by the combined analysis of Experiment 1 and 2, the pattern of results of the two experiments closely resembled each other. However, in both experiments the experimental conditions differed not only in their social nature, but also in the duration of the stimulus presentation: When pictures were (supposedly) named by the task partner, a variable interval simulated the partner's naming latency; when pictures were named by neither participant nor partner, pictures disappeared after a fixed interval. To exclude a possible contribution of this factor to our effects, Experiment 3 kept the stimulus presentation interval comparable between the two conditions.

Experiment 3

In Experiment 3 the two task partners sat next to each other (as in Experiment 1), while auditory input from the partner's naming response was shielded from participants through noise-canceling headphones (analog to the auditory isolation achieved through spatial separation in Experiment 2). All trials in Experiment

3 presented the stimulus pictures for a variable time range that reflected typical naming latencies. We opted for keeping presentation times variable (instead of setting all trials to a fixed interval) in order to replicate the data pattern of Experiment 2 using the identical simulated presentation times but this time inserted into the opposite experimental condition (No Go instead of Partner Go). As in the previous two experiments we expected naming latencies to increase more steadily with ordinal position for those semantic categories co-named with the partner.

Methods

Participants. Seventy-two participants were recruited for this experiment. Half of the participants served as task partner. The other half, 36 participants between the ages 18-36 (mean 25.14), were included in the analyses (9 male, 27 female). Task partners were naïve participants (compare use of confederates in Experiment 1) to maximize the impression of having an authentic and engaged task partner. Only main participants' behavior was analyzed as they named a higher number of pictures compared to task partners. The overall larger sample size compared to the previous experiments (N=36 vs. N=24) compensated for a greater loss of single trials, presumably caused by the higher strain placed on participants through the noise-canceling environment (for more details see below). One participant was replaced because the number of trials in which he failed to name the picture on time exceeded by more than two standard deviations the average number of missed trials by other participants of Experiment 3. Seven additional participants were replaced because they indicated at the debriefing that they heard their partner name pictures. All participants gave informed consent and were compensated with €8 per hour or received credit towards their curriculum requirements. Participants had taken part in neither of the two previous experiments.

Materials, Experimental Design and Data Analyses. Materials, experimental design, and data analyses were identical to the previous experiments. Applying the same criteria as before, 8.02% of all target trials were excluded due to false naming, speech disfluencies, or voice-key error. In 17.34% of all target trials participants failed to name the picture within the assigned time. An additional 3.65% was excluded as reaction time outliers, leaving a total of 70.99% of all target trials in the analyses.

Procedure. Two volunteer participants were invited to the lab at the same time. They were introduced to each other as task partners and received the same task instructions as participants of the previous experiments. Without their knowledge, the experimenter randomly assigned one participant to the role "task partner", the other to "main participant".

Participants were seated next to each other facing the monitor displaying the pictures. Both participants wore noise-canceling headphones (Bose QuietComfort 25) playing continuously Pink noise. The effectiveness of the noise canceling was tested prior to experiment for each participant individually. First one participant read a list of seven words to their partner wearing the headphones. Then the partner was asked to report whether the list had contained an animal and if so, which one. If the partner could answer one of these questions, the test was repeated with increased volume of Pink noise. If necessary, participants were instructed to lower their voice.

The experimental task proceeded as in the previous experiments. The frame around the picture indicated to participants whose turn it was to name the pictures (self, partner or nobody). Pictures were presented for the duration it took for the cued participant to initiate naming. In trials in which nobody named the picture (No Go trials) the pictures disappeared at a variable interval, reflecting average reaction times recorded for Experiment 1. Note that these are the same presentation times used for simulating the remote partner's Go trials in Experiment 2.

After the experiment both participants were asked whether they had heard the partner name pictures. Participants who indicated to have understood words the partner had produced were excluded from the analyses.

Results

Duration of stimulus presentation. The duration of the picture presentation, which terminated as a function of naming latency, was comparable in Partner Go and No Go trials: The average picture naming latencies in Partner Go trials (M = 1054.44ms, SD = 301.39ms) did not differ significantly from our simulated latencies in No Go trials (M = 1046.44, SD = 290.46ms), neither for subjects, $t_1(35) = .61$, $p = .55$, nor for semantic categories, $t_2(31) = .67$, $p = .51$.

Naming latencies. Our results replicated the overall data pattern of the previous two experiments: Naming latencies increased on average 20ms with each ordinal position, demonstrating the cumulative semantic interference effect over both experimental conditions. Yet in the Joint Naming condition naming latencies increased more steeply (27ms) compared to the Single Naming condition (14ms), see *Figure 3*, demonstrating for a third time interference by naming a semantic category together with a task partner. These results were supported by the LMM analyses on the log-transformed naming latencies, see *Table 3*.

The maximal informative model contained random intercept for participants and random slopes for the factor naming order for semantic categories. The model showed a significant main effect for the predictor naming order, confirming the overall increase in response latencies as participants named additional within-category pictures. Importantly, the interaction between naming order and naming condition was significant, confirming the steeper increase when naming pictures with a task partner. Without this interaction the goodness of fit was significantly reduced, logLik $\Delta \chi^2(1) = 2.64$, $p = .02$.

Comparison of Experiment 1 and 3. To directly compare the results of Experiment 1 to Experiment 3 (both with physically co-present partners), we combined the data from both experiments and added the predictor "experiment" in a joint LMM analysis. As expected, over both experiments participants showed significant cumulative semantic interference, yielding in a significant contribution of the predictor naming order, $b = 0.02$, $SE = 0.00$, $t = 8.61$. Participants in the Joint Naming condition showed overall slower naming latencies (grand mean: 997.27ms) than participants in the Single Naming condition (grand mean: 986.62ms), as demonstrated by a significant contribution of the predictor naming condition, $b = -0.01$, $SE = 0.01$, $t = -2.24$. Note that this is the only time naming condition shows a main effect; possibly indicating a tendency towards even low ordinal positions being affected by the task partner. Consistent with the pattern found in all three experiments, naming pictures together with a partner led to a steeper increase of naming latencies than without a partner, testified by the expected significant interaction between naming order and naming condition, $b = -0.01$, $SE = 0.00$, $t = -3.25$. Adding the predictor experiment to the model did not yield any additional effects, nor did it increase significantly the model's goodness of fit, logLik $\Delta \chi^2(1) = 0.61$, $p = .87$.

Discussion

Experiment 3 corroborates our conclusion from Experiment 2 that *hearing* the partner name pictures is not the driving factor behind the interference experienced in partner trials. Even when wearing noise-canceling headphones, which prevented participants from hearing their task partner, naming latencies increased more steeply when pictures within the same semantic category were co-named with a partner compared to when they were named alone. Furthermore, Experiment 3 demonstrates that the effect of the partner's (presumed) naming is not simply due to low-level markers such as picture presentation times, as Experiment 3 keeps these comparable across experimental conditions. Indeed, the numerically identical presentation times elicited different results when plugged into the Joint Naming condition in Experiment 2 versus the Single Naming condition in Experiment 3.

Compared to Experiment 2, in which task partners were spatially separated from each other and worked together only under pretense, Experiment 3's manipulation of having an actual, physical co-present task partner was arguably stronger (in Experiment 2 a number of participants was in doubt whether they actually had a partner). Yet Experiment 3's setting also came with a trade-off: The task of naming pictures under noise-deprived conditions appeared to be more demanding for participants, resulting in a greater loss of trials. Future experiments will have to wisely weigh the trade-offs of maximizing experimental control and having realistic (e.g., physically co-present) task partners (cf. Kuhlen & Brennan, 2013).

General Discussion

When naming pictures on their own, speakers show increased naming latencies with each additional picture within the same semantic category they name in a sequence of pictures, the cumulative semantic interference effect (e.g., Belke, 2013; Costa et al., 2009; Howard et al., 2006; Navarrete et al., 2010). In this study we show that naming latency not only increases in response to participants' own prior naming of within-category pictures, but also in response to their task partner naming the pictures: In three experiments, naming latencies increased more steeply for those categories in which a partner named half of the category members compared to those categories in which additional members were presented visually (but named by neither partner nor participant). Note that in both conditions speakers themselves named an equal number of within-category pictures. The steeper increase in categories co-named with a partner therefore must be triggered by those pictures named by the partner. This small, but very robust effect suggests that pictures named by the partner elicit in participants lexical processes comparable to naming the picture themselves. Our interpretation is consistent with previous work showing that participants simulate lexicalization processes when task partners name pictures (Baus et al., 2014).

Going beyond previous work, our study shows that the partner's picture naming is not only simulated, but that this simulation has lasting effects on the participants' own language production. Specifically, we propose that participants' subsequent lexical retrieval is hampered by a simulation of lexical retrieval on behalf of the partner. Our account can accommodate different assumptions about the nature of the processes being simulated: According to one theoretical perspective, naming a picture strengthens the link between concept and lexical entry, or between concepts and their semantic features, and hence lexical competition increases when naming additional semantically related pictures (Belke, 2013; Howard et al., 2006). Following this proposal, our experiments suggest that the link between a concept and its lexical entry (or semantic features) is also strengthened when pictures are named by a task partner. In other words, pictures named by a task partner add to the number and strength of semantically-related lexical entries co-activated when selecting the correct lexical entry for a given target picture. Thus, the degree of lexical competition experienced by a speaker is increased by another person's prior lexical choices. According to an alternative understanding of the effect, simulated lexical retrieval may weaken the connections between concepts and lexical entries for non-target semantically related objects (Oppenheim et al., 2010). Both accounts provide viable explanations for how simulating a partner's lexical choices can lead to experiencing increased semantic inhibition.

Interestingly, speakers were influenced by their partner even when the partner's actions could not be observed directly. This suggests that speakers' performance is shaped by their understanding of the social context of the task. This is in line with previous work on shared task settings that show the mere belief of interacting with a partner affects one's own behavior (Atmaca et al., 2011; Elekes, Bródy, Halász, & Király, 2016; Sebanz et al., 2005). In terms of lexical processing, our results demonstrate that auditory input is not a necessary condition for partner-elicited semantic interference. Instead, the belief that a speaker is naming a picture appears to trigger in speakers simulated lexicalization processes.

When simulating lexical access, participants may be engaging in processes similar to inner speech and merely performing their own task of naming pictures when it is their partner's turn. Alternatively, participants may be simulating more specifically the nature of the task the partner needs to perform. A study by Gambi and colleagues addresses a related question (Gambi et al., 2015). In this study participants' picture naming slowed down when they believed their task partner was concurrently preparing to name a picture as well, compared to when they believed the partner was preparing to categorize the picture or not responding at all. Interestingly, in this study participants were not affected by *what* the partner was preparing to say (i.e., concurrently naming the same or a different picture), favoring the assumption that interference stems not from representing the exact nature of the partner's task, but instead from representing more generally that it is the partner's turn to act. In contrast, the effect of our study builds upon interference through successively accessing semantically related lexical entries. Thus, in order to experience interference from the partner, participants in our study must have represented what their partners were saying (i.e., that their partner was naming a picture semantically related to pictures they have named). The precise nature of this representation is an interesting question to address by future research.

Simulating the partner's anticipated lexical processes may not be the only mechanism supporting an increase of semantic interference. A recent study by Hoedemaker and colleagues also investigates cumulative semantic interference in a setting in which two participants take turns naming pictures (Hoedemaker et al., 2017). This study manipulated how many preceding semantically related pictures participants, versus their partner, had named, and whether participants could see the picture the partner was about to name. Naming latencies slowed as a function of the number of semantically related pictures previously named by the partner. Crucially, this effect emerged even when the partner's pictures were not accessible to participants, making simulation as driving mechanism unlikely. Instead, the authors argue that interference stems from processes of speech comprehension (i.e., hearing the partner name a semantically related picture) eliciting processes comparable to one's own speech production (cf. Garrod & Pickering, 2004; Levelt, 1983; Liberman & Whalen, 2000; Prinz, 1990). Yet our Experiment 2 and 3 explicitly exclude speech comprehension as sole mechanism behind partner-elicited semantic interference as we deprive participants of auditory evidence of the partner's speech. Taken together, the two studies suggest that lexicalization processes may be triggered both by simulating the partner's anticipated speech and by processing the partner's perceived speech.

An increase of naming latencies was observed in the Joint Naming as well as in the Single Naming condition, testifying the robustness of cumulative semantic interference. In a single-speaker setting the typically observed increase for each additional within-category picture is 20 to 30ms (Belke, 2013; Howard et al., 2006; Oppenheim, et al., 2010; Alario, del Prado, & Martin, 2010; Navarrete et al., 2010; Rose & Abdel Rahman, 2016). The average increase found in our Joint Naming condition (over all three Experiments: 26.28ms) is comparable, suggesting that the partner's naming has an equally strong effect as naming the picture oneself (but compare to Hoedemaker et al., who report a weaker effect for partner-elicited semantic interference). In contrast, the average increase in our Single Naming condition was on the lower end of what is typically observed (11.32ms). This adds to our conclusion that semantic interference was less severe in the Single Naming condition[1].

Moreover, in all three experiments the differences in naming latencies between the two naming conditions appear most pronounced in the final ordinal positions. Indeed, the increase in reaction time slowed down, or even reversed its trend, in the final two ordinal positions of the Single Naming condition. This suggests that in this condition semantic interference may dissipate over time. Such a fading may be explained by the fact that the lag elapsing since the preceding naming of a semantically related picture was at times quite large: up to 18 semantically unrelated or unnamed pictures could intervene. Note that previous studies commonly implemented a lag of maximally eight intervening items (e.g., Belke, 2013; Howard et al., 2006). These studies report an increase in naming latencies independent of the size

[1] We also compared directly the increase in naming latency in the Joint Naming and the Single Naming condition by entering the average gain in naming latency from one ordinal position to the next into a 2(naming condition) x 4 (average gain between ordinal positions) repeated measures analysis of variance (ANOVA) with participants (F_1) and categories (F_2) as random variables. These analyses supported the results of the LMM analyses and showed a significant main effect of naming condition on the incline of naming latencies (Experiment 1: $F_1(1, 23) = 5.67$, p = .03, η^2= .2; $F_2(1, 31) = 7.28$, p = .01, η^2 = .19; Experiment 2: $F_1(1, 23) = 10.98$, p = .00, η^2= .32; $F_2(1, 31) = 7.74$, p = .01, η^2 = .2; Experiment 3: $F_1(1, 35) = 7.25$, p = .01, η^2= .17; $F_2(1, 31) = 9.91$, p = .00, η^2 = .24). No further effects were found significant.

of the lag. Yet a study with lags of up to 38 intervening items reports a complete decay of inhibitory effects (Wheeldon & Monsell, 1994). Under the assumption that pictures that are named by neither partner nor participant (Single Naming condition) do not elicit full-fledged lexicalization processes in a speaker the number of strong competitors active by previously named pictures may disperse over time. In contrast, in the Joint Naming condition lexical competitors remain activated due to the partner's naming of additional category members. As a consequence, semantic inhibition would dissipate over time under the Single Naming, but increase under the Joint Naming condition.

It is a well-known finding in social psychology that the physical presence of others affect one's own actions (e.g., Baron, 1986; Zajonc, 1965). However, less well understood is when individual performance benefits, and when performance suffers, from having a task partner (ibid.). In our study, participants were overall slower to name pictures when their partner was sitting next to them (Experiment 1 & 3) compared to when their partner was not physically co-present (Experiment 2). Previous studies investigating joint task performance requiring motor actions have reported *faster* reaction times with physically co-present partners (Sebanz et al., 2003, 2005). These studies assume that the perception of the partner's action triggers motor simulation, which in turn benefits own performance when partner's motor actions overlap with one's own, and hinders own performance when they don't. Participants who are deprived of auditory or visual feedback from their task partner may experience weaker simulation (Sebanz et al., 2005; but see Elekes et al., 2016). In our study, the partner's actions were expected to interfere with own task performance. Following the above rationale, we speculate that this interference may have spread to the overall task and becomes amplified with a physically co-present partner.

Our study demonstrates how social context can shape individual cognitive processes of language production. When language is used in the context of a social interaction (e.g., in conversation), interacting partners typically take turns talking. Accordingly, it has been proposed that the cognitive processes underlying the production of language and the comprehension of language become coordinated and influence each other (e.g., Pickering & Garrod, 2004, 2013). Yet, commonly this is assumed to facilitate an individual's processing cost (Garrod & Pickering, 2004). In contrast, our experiments show inhibitory effects of speaking in a collaborative setting. This need not be a contradiction as our experimental setting differs from conversational encounters in important ways:

In conversation, lexical choices are highly determined by the speaker's own communicative intention. Demands on lexical access evolve not necessarily around objects of close categorical relations, but instead around associated concepts, which can elicit semantic facilitation (e.g., Abdel Rahman & Melinger, 2007; Alario, Segui, & Ferrand, 2000; Aristei, Melinger, & Abdel Rahman, 2011; Costa, Alario, & Caramazza, 2005; La Heij, Dirkx, & Kramer, 1990) as well as interference (e.g., Abdel Rahman & Melinger, 2007; Rose & Abdel Rahman, 2016). In contrast, our paradigm imposes on speakers specific lexical choices (the pictures presented to them on the computer screen). A build-up of semantic context (possibly creating a facilitating context found in conversation) may be furthermore impeded because semantically related items are spread out and separated by several unrelated items.

A second important factor determining lexical choices in a conversational setting is the history shared with the conversational partner. Conversational partners tend to re-use and converge on their choice of lexical expressions, a process commonly referred to as lexical entrainment (Brennan & Clark, 1996; Garrod & Anderson, 1987).

Yet in our experimental setting, speakers could not develop together with their partner a shared repertoire of lexical expressions. Instead, they were prompted to seek lexical entries explicitly for concepts that had not been named previously by their partner. In this special case of collaborative language use, it is therefore not surprising to observe inhibitory effects. In our view, the most important finding of the present study is that the presence of a task partner can affect a speaker's language production. Whether this yields inhibitory or facilitative effects may be the result of the specific task demands and conversational goals (see also Abdel Rahman & Melinger, 2009a, 2009b, 2011).

Our results are in line with proposals that listeners simulate speakers' utterances by relying on their own language production system (Pickering & Garrod, 2013). But what purpose may it have to covertly simulate lexicalization processes on behalf of another person? In fact, it may seem surprising that a partner's action is simulated given that this is neither necessary nor beneficial for the participant's own performance. One explanation for the propensity to include another person's actions or perspective lies in the benefits of being able to predict the other person's behavior (Baus et al., 2014; Knoblich, Butterfill, & Sebanz, 2011; Sebanz et al., 2005). From this perspective, co-representing a partner's action may be a default mode serving the purpose to facilitate social interactions. In the context of language use, simulation may enable individuals to anticipate what their partner will say next, allowing them to prepare their response (Bögels et al., 2015). In this sense, simulated lexical access may serve as a building block for smooth coordination between conversational partners during interactive language use.

Together our three experiments show that acting together with a partner can change profoundly how participants respond to a task. Even within a minimal social context, in which collaboration is not required, speaking together with another person is different from speaking alone. Having a partner, and even the mere belief of having a partner, leads to co-representing the partner's task. When such a representation involves simulating lexical retrieval, speaking jointly with a partner can have lasting effects on one's own language production processes. With our study we contribute to the growing body of literature showing how the social setting can influence individual cognitive processes.

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Table 1. Fixed-effect estimates, standard errors, and t- values for the selected model of Experiment 1; estimates of the variance and square root (standard deviations) of the random effect structure and goodness-of-fit statistics.

Fixed effects	Estimate	Standard Error	t value
Intercept	6.87	0.03	267.17
Naming Order	0.02	0.00	6.83
Naming Condition	-0.01	0.01	-1.23
Naming Order x Naming Condition	-0.01	0.01	-2.47
Random effects	Variance	Standard Deviation	
Participants			
Intercept	0.01	0.10	
Naming Condition	0.00	0.02	
Semantic categories			
Intercept	0.01	0.08	
Residual	0.05	0.22	
Goodness of fit			
Log likelihood	250.7		
REML deviance	-501.4		

Table 2. Fixed-effect estimates, standard errors, and t- values for the selected model of Experiment 2; estimates of the variance and square root (standard deviations) of the random effect structure and goodness-of-fit statistics.

Fixed effects	Estimate	Standard Error	t value
Intercept	6.78	0.03	230.79
Naming Order	0.02	0.00	4.81
Naming Condition	-0.01	0.01	-1.64
Naming Order x Naming Condition	-0.02	0.01	-2.57
Random effects	Variance	Standard Deviation	
Participants			
Intercept	0.01	0.11	
Semantic categories			
Intercept	0.01	0.10	
Naming order	0.00	0.02	
Residual	0.06	0.24	
Goodness of fit			
Log likelihood	-127.3		
REML deviance	254.6		

Table 3. Fixed-effect estimates, standard errors, and t- values for the selected model of Experiment 3; estimates of the variance and square root (standard deviations) of the random effect structure and goodness-of-fit statistics.

Fixed effects	Estimate	Standard Error	t value
Intercept	6.88	0.03	273.44
Naming Order	0.02	0.00	7.71
Naming Condition	-0.01	0.01	-1.76
Naming Order x Naming Condition	-0.01	0.00	-2.30
Random effects	Variance	Standard Deviation	
Participants			
Intercept	0.01	0.12	
Semantic categories			
Intercept	0.01	0.08	
Naming order	0.00	0.01	
Residual	0.04	0.21	
Goodness of fit			
Log likelihood	512.8		
REML deviance	-1025.7		

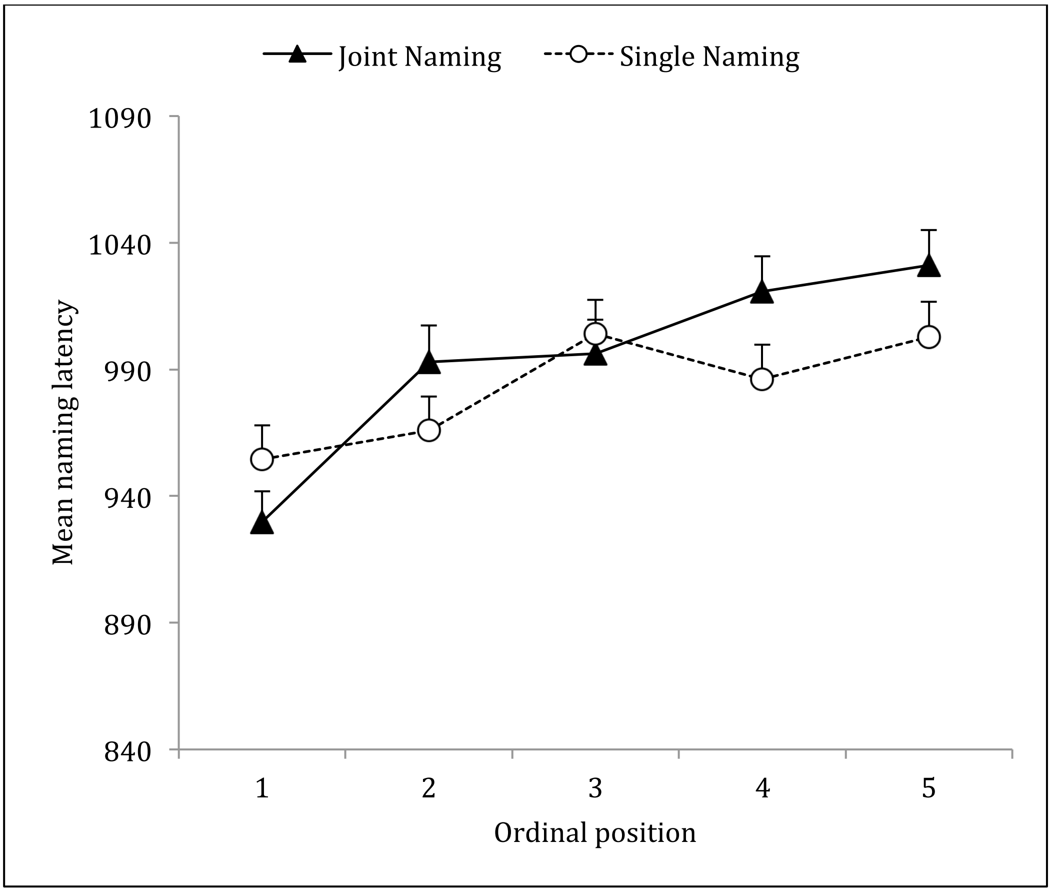

Figure 1. Mean naming latency and standard error (in milliseconds) observed in Experiment 1 broken down by ordinal position and naming condition. A linear trend visualizes the cumulative increase in naming latencies.

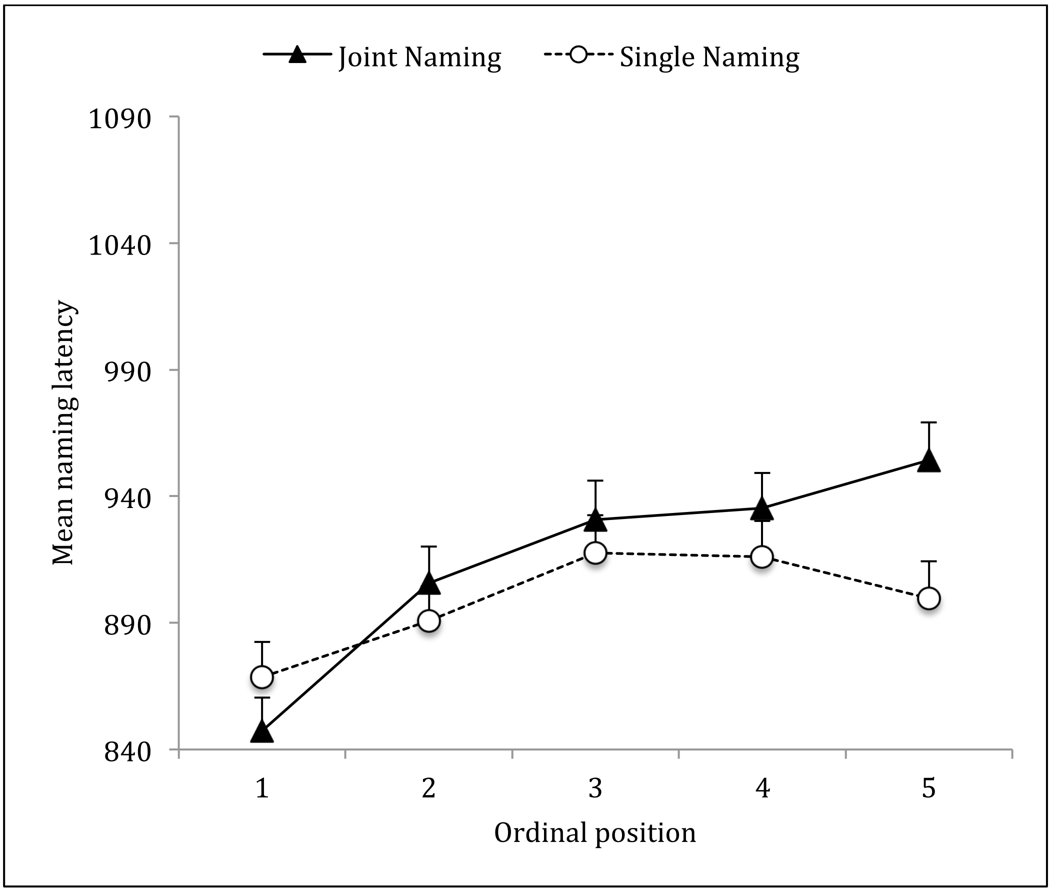

Figure 2. Mean naming latency and standard error (in milliseconds) observed in Experiment 2 broken down by ordinal position and naming condition. A linear trend visualizes the cumulative increase in naming latencies.

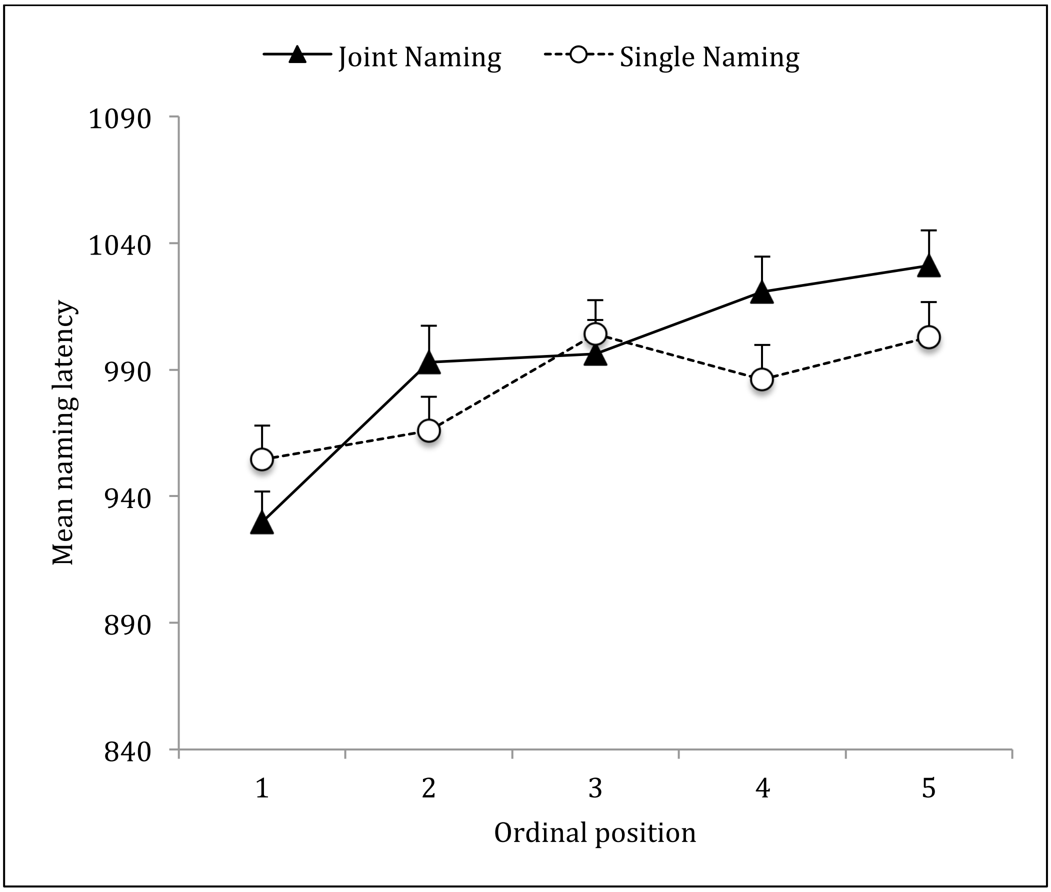

Figure 3. Mean naming latency and standard error (in milliseconds) observed in Experiment 3 broken down by ordinal position and naming condition. A linear trend visualizes the cumulative increase in naming latencies.

Appendix

List of target stimuli used in Experiment 1 & 2

Aircraft	Drachenflieger (hang glider)
	Drohne (drone)
	Fallschirm (parachute)
	Flugzeug (airplane)
	Heissluftballon (hot air ballon)
	Hubschrauber (helicopter)
	Rakete (spaceship)
	Segelflugzeug (glider)
	Seilbahn (cable car)
	Zeppelin (zeppelin)
Bags	Aktenkoffer (briefcase)
	Beutel (jute bag)
	Brustbeutel (neck pouch)
	Fahrradtasche (pannier)
	Handtasche (purse)
	Koffer (suitcase)
	Korb (woven basket)
	Plastiktuete (plastic bag)
	Rucksack (backpack)
	Schulranzen (satchel)
Furniture for reclining	Bett (bed)
	Diwan (divan)
	Futon (futon)
	Haengematte (hammock)
	Liege (lounger)
	Luftmatratze (air mattress)
	Pritsche (pallet)
	Schlafsofa (sofa bed)
	Stockbett (bunk bed)
	Wiege (cradle)
Beverages	Bier (beer)
	Cocktail (cocktail)
	Heisse Schokolade (hot chocolate)
	Kaffee (coffee)
	Milch (milk)
	Orangensaft (orange juice)
	Schnaps (liquor)
	Sprudelwasser (sparkling water)
	Tee (tea)
	Wein (wine)
Birds	Adler (eagle)

	Ente (duck)
	Eule (owl)
	Kolibri (humming bird)
	Papagei (parrot)
	Pinguin (penguin)
	Rabe (raven)
	Schwan (swan)
	Strauss (ostrich)
	Taube (dove)
Body parts	Arm (arm)
	Auge (eye)
	Bauch (tummy)
	Bein (leg)
	Finger (finger)
	Fuss (foot)
	Hand (hand)
	Mund (mouth)
	Nase (nose)
	Ohr (ear)
Buildings	Burg (castle)
	Fachwerkhaus (timbered house)
	Garage (garage)
	Hochhaus (high-rise)
	Kirche (church)
	Leuchtturm (lighthouse)
	Schloss (palace)
	Stadion (stadion)
	Tempel (temple)
	Windmuehle (windmill)
Celestial phenomena	Blitz (lightning)
	Komet (shooting star)
	Polarlicht (northern lights)
	Regenbogen (rainbow)
	Sichelmond (crescent moon)
	Sonnenuntergang (sun set)
	Sterne (stars)
	Vollmond (full moon)
	Windhose (tornado)
	Wolken (clouds)
Construction vehicles	Abrissbirne (wrecking ball)
	Abschleppwagen (tow truck)
	Bagger (excavator)
	Betonmischer (cement mixer)
	Gabelstapler (forklift truck)
	Kehrmaschine (road sweeper)
	Kran (crane)
	Planierraupe (bulldozer)

	Traktor (tractor)
	Walze (compactor)
Cooking equipment	Dosenoeffner (can opener)
	Flaschenoeffner (bottle opener)
	Gabel (fork)
	Kelle (ladle)
	Korkenzieher (cork skrew)
	Loeffel (spoon)
	Messer (knife)
	Nudelholz (rolling pin)
	Puerierstab (liquidizer)
	Schneebesen (egg beater)
Farming tools	Axt (axt)
	Besen (broom)
	Heugabel (hay fork)
	Pflug (plough)
	Rasenmaeher (lawn mower)
	Rechen (rake)
	Saege (saw)
	Schaufel (shovel)
	Schubkarre (wheelbarrow)
	Sense (scythe)
Fish	Aal (eel)
	Delfin (dolphin)
	Forrelle (trout)
	Goldfisch (goldfish)
	Hai (shark)
	Karpfen (carp)
	Kugelfisch (globefish)
	Rochen (ray)
	Schwertfisch (swordfish)
	Wal (whale)
Flowers	Gaensebluemchen (daisy)
	Lilie (lily)
	Loewenzahn (dandelion)
	Mohn (poppy)
	Orchidee (orchid)
	Rose (rose)
	Schneegloeckchen (snowdrop)
	Seerose (water lily)
	Sonnenblume (sunflower)
	Tulpe (tulip)
Fruits	Ananas (pineapple)
	Apfel (apple)
	Banane (banana)
	Birne (pear)
	Erdbeere (strawberry)

	Kirsche (cherry)
	Kiwi (kiwi)
	Mandarine (mandarine)
	Trauben (grapes)
	Wassermelone (water melon)
Furniture for sitting	Bank (bench)
	Barhocker (bar stool)
	Couch (couch)
	Hocker (stool)
	Hollywood-Schaukel (swing)
	Kinderhochsitz (high chair)
	Sessel (armchair)
	Sitzsack (beanbag)
	Stuhl (chair)
	Thron (throne)
Headgear	Badekappe (bathing cap)
	Cappy (baseball cap)
	Cowboyhut (cowboy hat)
	Fahrradhelm (bicycle helmet)
	Kochmuetze (chef's hat)
	Kopftuch (bandana)
	Pudelmuetze (bobble hat)
	Sombrero (sombrero)
	Turban (turban)
	Zylinder (top hat)
Hoofed mammals	Elch (elk)
	Esel (donkey)
	Kamel (camel)
	Kuh (cow)
	Lama (lama)
	Pferd (horse)
	Reh (deer)
	Schaf (sheep)
	Zebra (zebra)
	Ziege (goat)
Insects	Ameise (ant)
	Biene (bee)
	Fliege (fly)
	Grashuepfer (gras hopper)
	Libelle (dragon fly)
	Marienkaefer (lady bug)
	Muecke (mosquito)
	Schmetterling (butterfly)
	Skorpion (scorpion)
	Spinne (spider)
Instruments	Akkordeon (accordion)
	Blockfloete (recorder)

	Geige (violin)
	Gitarre (guitar)
	Harfe (harpe)
	Klavier (piano)
	Saxophon (saxophone)
	Schlagzeug (drum set)
	Trommel (drums)
	Trompete (trumpet)
Jewelry	Armband (bracelet)
	Brosche (brooch)
	Diadem (diadem)
	Fusskettchen (anklet)
	Haarreif (hair band)
	Kette (necklace)
	Manschettenknopf (cufflinks)
	Ohrring (earring)
	Piercing (piercing)
	Ring (ring)
Kitchen furniture	Backofen (oven)
	Dunstabzugshaube (exhaust hood)
	Geschirrspueler (dish washer)
	Herd (stove)
	Kaffeemaschine (coffee machine)
	Kuehlschrank (fridge)
	Mikrowelle (microwave)
	Mixer (mixer)
	Spuelbecken (sink)
	Toaster (toaster)
Landscapes	Acker (field)
	Berg (mountain)
	Fluss (river)
	Meer (ocean)
	See (lake)
	Vulkan (vulcano)
	Wald (forest)
	Wasserfall (water fall)
	Wiese (meadows)
	Wueste (desert)
Office wear	Anspitzer (pencil sharpener)
	Bleistift (pencil)
	Edding (marker)
	Klammer (paper clip)
	Lineal (ruler)
	Locher (hole puncher)
	Radiergummi (eraser)
	Schere (scissors)

	Tacker (stapler)
	Tesafilm (tape)
Plants	Aloe Vera (aloe vera)
	Bambus (bamboo)
	Brennnessel (nettle)
	Efeu (ivy)
	Farn (fern)
	Gras (gras)
	Hanf (hemp)
	Kaktus (cactus)
	Kleeblatt (clover)
	Schilf (reed)
Sewing equipment	Buegeleisen (pressing iron)
	Fingerhut (thimble)
	Garn (thread)
	Knopf (button)
	Massband (measuring tape)
	Nadelkissen (pincushion)
	Naehmaschine (sewing machine)
	Sicherheitsnadel (safety pin)
	Stricknadel (knitting needle)
	Wollknaeuel (wool)
Shoes	Crocs (crocs)
	Flip-Flop (flip-flops)
	Flossen (fins)
	Gummistiefel (rubber boots)
	Highheels (highheels)
	Pantoffel (slippers)
	Reitstiefel (riding boots)
	Sandale (sandals)
	Turnschuh (sneakers)
	Wanderschuhe (hiking boots)
Sports	Boxen (boxing)
	Fussball (soccer)
	Golfen (golf)
	Handball (handball)
	Hockey (hockey)
	Radfahren (cycling)
	Schwimmen (swimming)
	Tennis (tennis)
	Tischtennis (table tennis)
	Volleyball (volleyball)
Storage	Kleiderschrank (closet)
	Kommode (dresser)
	Regal (shelf)
	Safe (safe)
	Schachtel (box)

	Schmuckkaestchen (jewel case)
	Schublade (drawers)
	Schuhschrank (shoe rack)
	Truhe (chest)
	Vitrine (cabinet)
Street vehicles	Auto (car)
	Bus (bus)
	Cabriolet (convertible)
	Jeep (jeep)
	Limousine (stretch limousine)
	LKW (truck)
	Motorrad (motorcycle)
	Rennwagen (racing car)
	Taxi (taxi)
	Wohnmobil (trailer)
Sweets	Bonbon (hard candy)
	Eis (ice cream)
	Gummibaerchen (gummi bears)
	Kekse (cookies)
	Kuchen (cake)
	Lakritz (licorice)
	Lollipop (lollipop)
	Muffin (muffin)
	Schokolade (chocolate)
	Zuckerwatte (cotton candy)
Vegetables	Blumenkohl (cauliflower)
	Brokkoli (brokoli)
	Erbse (peas)
	Gurke (cucumber)
	Karotte (carot)
	Kartoffel (potato)
	Paprika (pepper)
	Radieschen (radish)
	Spargel (asparagus)
	Tomate (tomato)
Water vehicles	Dampfer (Steamboat)
	Faehre (ferry)
	Floss (raft)
	Gondel (gondola)
	Jacht (yacht)
	Kanu (canoe)
	Segelschiff (sailing boat)
	Surfbrett (surf board)
	Tretboot (paddleboat)
	U-Boot (submarine)