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A Joint Interference Effect in Picture Naming

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Abstract

In two experiments we provided evidence for a joint interference effect in picture naming. Participants took longer to name pictures when they believed that their partner concurrently named pictures than when they believed their partner was silent (Experiment 1) or concurrently categorized the pictures as being from the same or from different semantic categories (Experiment 2). However, picture naming latencies were not affected by beliefs about what one's partner said. These findings are consistent with the idea that speakers represent *whether* another speaker is preparing to speak, but not *what* they are preparing to say.

Keywords: joint task; co-representation; agent-conflict; language production; picture naming.

In this paper we report results from two experiments that, for the first time, combined a highly constrained language task (picture naming), with a manipulation of the context in which the task is performed (i.e., whether the participant speaks concurrently with her partner or on her own). A similar rationale has been used by researchers who compared solo and joint SR compatibility effects (see Knoblich, Butterfill, & Sebanz, 2011 for a review), but it has never been applied to picture naming.

A well-known SR compatibility effect is the Simon effect. People are faster responding to "right" stimuli with their right hand and to "left" stimuli with their left hand (congruent trials) than they are responding to "right" stimuli with their left hand and to "left" stimuli with their right hand (incongruent trials). For example, people respond more quickly to the color of a stimulus when the stimulus (e.g., the photograph of a hand) is pointing towards the response hand than when the stimulus is pointing away from the response hand (Sebanz, Knoblich, & Prinz, 2003).

A similar effect occurs when participants respond only with one hand, but they take turns with another participant who is seated next to them (i.e., they are slower when the pictured hand points towards the other participant than when it points towards themselves). This *joint interference effect* is interesting because the Simon effect is not observed (or is reduced) if participants respond with one hand and they perform the task on their own.

The joint Simon effect has been interpreted as evidence that participants represent their partner's potential response and that this representation interferes with their own response on incongruent trials (because the two responses are incompatible, in the same way as a response with one's right hand is incompatible with a response given with one's left hand). We refer to this as the *co-representation* account of joint interference effects. Interestingly, joint compatibility effects were found when participants sat alone but were led to believe another person performed the task with them. This occurred even when no feedback was available (Atmaca, Sebanz, & Knoblich, 2011).

The co-representation account has been challenged. Here we are particularly interested in an alternative account put forward by Wenke et al. (2011), the *agent-conflict* account. According to this account, representing that one's partner is (potentially) about to respond on the current trial interferes with one's own response. However, this occurs because there is a conflict regarding whose turn it is to respond, rather than because of incompatibility between one's own and one's partner's response. In fact, congruent responses should lead to similar amounts of interference as incongruent responses.

Joint interference effects have been almost exclusively investigated in manual tasks (e.g., Simon task, Flanker task, SNARC task), with only two studies using verbal responses (Philipp & Prinz, 2010; Pickering & MacLean, 2013) and none looking at picture-naming responses. Importantly, picture-naming responses are subject to varying degrees of congruency. For example, if one participant names the picture of an apple, her partner could either concurrently produce the same word (i.e., *apple*), or they could concurrently produce an unrelated word (e.g., *blouse*), or a related word (e.g., *banana*).

These different degrees of congruency do matter in solo tasks, as shown by several picture-word interference studies. Speakers who name pictures while ignoring distractor words are fastest when the distractor word is the picture's name.

They are slower when the distractor is a different word and slowest when it is a different but semantically related word. The difference in naming latencies between trials with unrelated distractors and trials with related distractors is due to interference between co-activated lexical representations (Levelt, Roelofs, & Meyer, 1999).

In our study, participants saw pairs of pictures rather than picture-word pairs. When distractor words are replaced by distractor pictures, semantic interference effects generally disappear (Damian & Bowers, 2003), possibly because distractor picture names are not routinely retrieved or their activation is too weak to out-weight facilitatory effects at the conceptual level. We therefore asked participants to name both pictures in a pair, a task that is subject to semantic interference effects (Aristei, Zwitserlood, & Abdel Rahman, 2012).We asked whether the time they took to respond might be affected by a representation of their partner's concurrent response.

Experiment 1

In Experiment 1, a red and a blue picture were simultaneously displayed to two participants seated in different rooms. Before the pictures appeared, an instruction screen showed the names of the two participants accompanied by the words *red*, *blue*, or *no*. *Red* and *blue* corresponded to "go" trials: the participant was instructed to name the picture presented in the given color first, and then also name the other picture. *No* corresponded to "no-go" trials: The participant was instructed to give no response.

We varied the order in which the other participant (the partner) was concurrently naming the pictures (Partner's task), as follows. On trials on which the two participants were assigned the same color, they named the pictures in the same order, therefore producing the same verbal response (SAME condition). On trials on which the two participants were assigned different colors, they named the pictures in reversed order, therefore producing different verbal responses (DIFF condition). Finally, when either of the participants was assigned a "no-go" cue, one participant named the pictures while their partner produced no response (NO condition). See Figure 1 (top) for examples (with apple in blue, blouse in red).

In addition, we introduced a second manipulation, orthogonal to Partner's task. Participants saw either two semantically related (e.g., *apple – banana*) or two unrelated pictures (e.g., *apple – blouse*). This served two purposes. The first was to provide a manipulation check. When two semantically related lexical items are activated concurrently (e.g., when speakers are asked to say "apple" and "banana" in close proximity), they interfere with one another (Aristei, et al., 2012). We therefore expected longer latencies when participants named two related than when they named two unrelated pictures (a main effect of semantic relatedness).

Most importantly, we expected Partner's task to affect naming latencies. Specifically, if the co-representation account can be extended to naming responses, it could be taken to predict that speakers represent the content of their partner's response and activate the corresponding lexical representations.

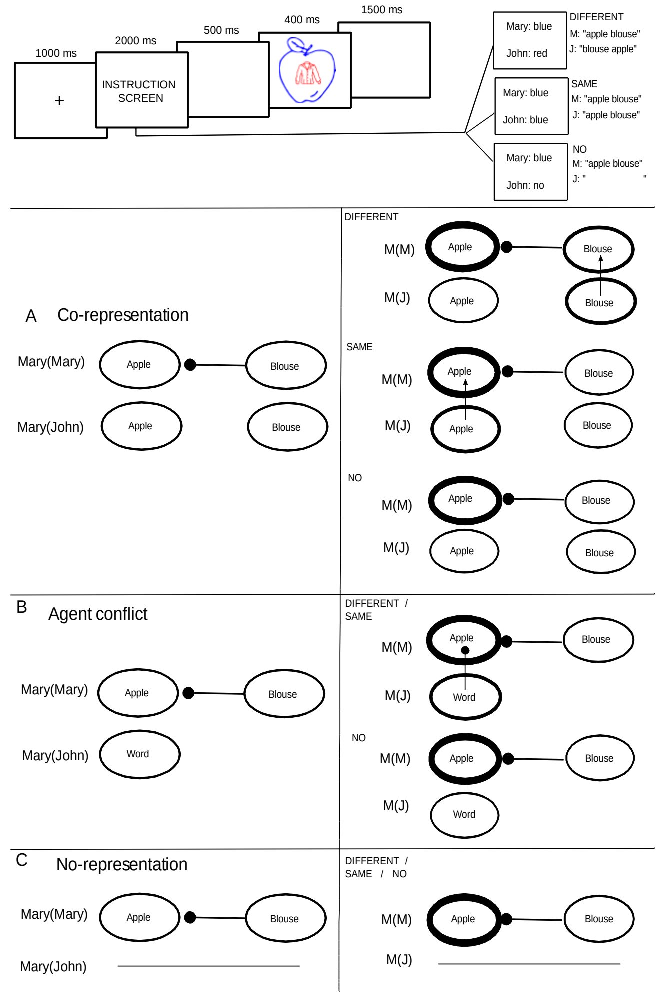

Figure 1: Sample trial (top) and hypothesized effects according to the three accounts.

Note that, because the speakers always named both pictures, their utterances always contained the same lexical items. However, when the order differed, the picture that the speaker named second was the picture that their partner named first.

Therefore, in the DIFF condition the representation of the partner's response might enhance the activation of the second picture's name. This would in turn result in greater competition between the two pictures' names. Instead, when the order is the same, the first picture's name was the word that one's partner also named first. Therefore, its activation level might be raised and competition with the second picture's name could be reduced. Overall, we should find longer naming latencies in the DIFF condition than in the SAME condition.

This scenario is presented in Figure 1 (panel A). The nodes represent lemmas in Mary's mental lexicon. On the right is a snapshot of the activation level of the nodes *apple* and *blouse* just before the onset of the word "apple" when Mary is preparing to utter "apple blouse" (unrelated case), under the different conditions. The degree of activation is indicated by the thickness of the circles. Pointed arrows are excitatory connections, rounded arrows are inhibitory connections.

In addition, the degree of relatedness might also matter (and this was the second purpose of the relatedness manipulation). Specifically, if other-representations are content-specific, the semantic interference effect could be enhanced in the DIFF compared to the SAME condition.

Alternatively, speakers might not represent the content of their partner's response, but they might represent whether their partner responds on the current trial or not (agent-conflict account). If so, the relationship between self- and other-representations would not affect processing, and hence naming latencies would be comparable in the SAME and DIFF conditions. For the same reason, there should be no interaction between Relatedness and Partner's task. However, naming latencies should be longer in the SAME and DIFF conditions than in the NO condition. This scenario is presented in Figure 1 (panel B).

Finally, people might not represent other people's responses. Note that our participants could not interact: They named pictures alongside each other, but could not hear each other. Whereas several studies have shown that non-interacting participants display joint interference effects (see above), they all used manual responses. We do not know whether the same would be true for verbal responses, particularly because language is perhaps more tightly linked to communicative situations compared to manual actions. If the Partner's task manipulation has no effect (i.e., no difference between the SAME, DIFF, and NO conditions), we would conclude that another person's utterances are not represented under the conditions tested in our experiment. This scenario is presented in Figure 1 (panel C) as the *no-representation* account.

Method

Participants Twelve pairs of previously unacquainted participants were recruited from the University of Edinburgh student community. All reported to be native English speakers and had no speaking or reading difficulties. They were paid £6 in return for participation.

Materials Fifty line drawings of everyday objects and animals were paired twice to yield 50 picture-picture pairs (25 semantically related, 25 semantically unrelated).

Design and Procedure Partner's task (henceforth, Partner; SAME vs. DIFF vs. NO) and Relatedness (unrelated vs. related) were manipulated within participants and within items. An item was defined in terms of the first named picture (so *apple-blouse* and *blouse-apple* counted as different items). Partner varied on a trial-by-trial basis.

Each participant named a given item once per condition. Pictures were presented into 4 different blocks of 100 trials each. Each block comprised an equal number of trials in each condition for both participants. The order of presentation was pseudo-randomized, separately for each pair and for each block, with the constraint that the same picture never appeared on two consecutive trials. (The order of blocks was counterbalanced across pairs). In addition, we counterbalanced within each block and for each participant the color of the first named picture (blue or red) and the position of the cue (top or bottom half of the screen).

Participants were tested in adjacent soundproof booths. They were seated in front of computer monitors connected to the same machine in the control room (so stimulus presentation was simultaneous). There was a window between the two rooms, but participants could perceive each other only peripherally when facing the monitors.

Upon entering the lab, participants were introduced to one another and taken into the booths. After learning the picture names individually, they were told that they would "work together"; instructions were delivered to both participants at the same time in the control room. Participants then returned to the booths and, after performing 20 practice trials, began the experimental phase. A sample trial is shown in Figure 1 (top). A session lasted about 1 hour.

Recording and Data Analysis An inaudible beep marked stimulus presentation and was recorded together with the participants' responses (on three separate channels), using a multi-channel M-Audio FireWire 1814 device (inMusic, Cumberland, RI, www.m-audio.com) and Adobe Audition (Version 4.0; sampling rate: 48000 Hz). Beep onsets were automatically tagged using Audacity (Version 1.2.5). Recordings were pre-processed to reduce background noise. Speech onsets were tagged using the Silence finder algorithm in Audacity and manually checked (for lip smacks, etc.). Naming latencies were defined as the time from beep onset to the onset of the participant's response.

The data were analyzed using Generalized Linear mixed-effects models (Bayeen, Davidson, & Bates, 2008) in R (Version 2.7.2) with a logistic link function for categorical data (Jaeger, 2008). All predictors were contrast-coded. For Partner, we defined two planned contrasts: *naming vs. no* compared the DIFF and SAME conditions against the NO condition; *same vs. different* compared the SAME against the DIFF condition.

Fixed and random effects were selected using backward selection. If the model with full random structure did not converge we simplified it by removing higher order terms (first by subjects, then by items). The alpha-level for likelihood-ratio tests was set to .05 for fixed effects, to .1 for random effects[1].

Latencies were analyzed only if both pictures were named correctly. Incorrect responses included: naming errors (the wrong name was used), disfluencies, order errors (the name of the second picture was uttered first and *vice versa*), missing responses. Latencies longer than 3000 or shorter than 300 ms were considered outliers and excluded. Latencies more than 3 standard deviations from the by-participant mean (1.5%) were replaced with the cut-off value.

Results

Accuracy Speakers produced (marginally) fewer incorrect responses when naming related than unrelated pictures ($\chi^2(1) = 3.54$, p= .06).

Table 1: % incorrect in Exp. 1.

	DIFF	SAME	NO
Unrelated	7.9%	6.8%	6.3%
Related	8.1%	5.3%	4.9%

Table 2: Best fit for accuracy data in Exp. 1.

Predictor	Estimate	SE	Z
Intercept	-3.10	.18	-16.97
naming vs. no	.24	.11	2.23
same vs. different	-.23	.08	-2.75
related vs. unrelated	-.31	.15	-2.05
Random effect	Explained variance estimate		
Subjects: intercept	.48		
Items: intercept	.48		
Items: Relatedness	.56		

Interestingly, the likelihood of producing an incorrect response was affected by Partner ($\chi^2(2) = 13.10$, p<.01): They produced more incorrect response when their partner was naming than when their partner was silent and also fewer incorrect responses in the SAME than in the DIFF condition (see Table 1 and 2).

Naming latencies Participants took longer to name semantically related than unrelated pictures ($\chi^2(1) = 11.32$, p<.001). Crucially, Partner affected naming latencies ($\chi^2(2) = 7.80$, p<.05): Latencies were longer when the partner was naming than when he was silent. However, the DIFF and SAME conditions did not differ. Finally, Relatedness and Partner did not interact (see Table 3 and 4).

[1] Analyses that included random slopes for the factor of interest (Partner), for both items and subjects, yielded the same pattern of results as the ones reported here.

Table 3: Mean latencies in Exp. 1.

	DIFF	SAME	NO	Tot
Unrelated	869	869	855	864
Related	881	886	872	880
Tot	875	877	864	
Semantic interference	-12	-17	-17	-16

Table 4: Model for naming latencies in Exp. 1.

Predictor	Estimate	SE	t
Intercept	874	24	36.72
naming vs. no	14	5	2.79
same vs. different	1	4	.17
related vs. unrelated	16	5	3.36
Random effect	Explained variance estimate		
Subjects: intercept	11980		
Items: intercept	3150		

Discussion

Experiment 1 showed that beliefs about another's task can affect the latency of picture-naming responses, and are thus not consistent with the no-representation account. We take this as evidence that speakers represented that their partner was about to speak. More precisely, our results do not support the co-representation account. Though participants made more errors when their partner prepared an incongruent (DIFF) than a congruent (SAME) response, this pattern was not confirmed by latency data. In addition, while there was a clear semantic interference effect, which replicated previous findings (Aristei, et al., 2012), the effect was no greater in the DIFF (12 ms) than in the SAME condition (17 ms). These results are consistent with the agent-conflict account, as participants took longer to respond when they believed their partner also prepared to respond.

However, we must consider alternative explanations. Note that the slowest conditions (SAME and DIFF) are the ones in which two "go" instructions are displayed on the screen. Participants might be distracted by their partner's instruction more if it is a "go" instruction than if it is a "no-go" instruction, perhaps because "go" instructions are more similar to each other than they are to "no-go" instructions. This might cause interference between memory representations for one's own and the partner's instructions. Participants rarely performed their partner's task by mistake, which seems to suggest that they had little trouble remembering instructions. However, this occurred more often in the DIFF (on 2.3% of trials speakers named the pictures in their partner's order) than in the NO condition (on 1.2% of trials speakers gave no response). But more importantly, this explanation cannot account for the fact that latencies were equally long in the SAME as in the DIFF condition (as in SAME instructions were identical). We return to this issue after Experiment 2.

We conclude that participants experienced interference whenever their partner responded concurrently, because they represented whether it was their partner's turn to respond. But what sort of mechanism could be responsible for this interference effect? The process of "imagining" that one's partner is about to respond might draw away attentional resources from the picture-naming task. If this is the case, "imagining" one's partner performing *any* task should slow down latencies to the same extent as "imagining" them *naming*.

However, it is also possible that interference arises because the same mechanisms (i.e., language production mechanisms) are used to represent one's partner naming response and to prepare one's own naming response. If this is the case, we predict less interference when one's partner is preparing a different (non-naming) task than when one's partner is preparing a naming response. Experiment 2 was designed to decide between these alternative explanations.

Experiment 2

In Experiment 2 we replaced "no-go" trials with a semantic categorization (CAT) task. The SAME and DIFF conditions were exactly the same as in Experiment 1. In the CAT condition, partners were instructed to judge whether the two pictures belonged to the same semantic category or to different semantic categories. They responded by saying "yes" or "no" into the microphone.

Thus, all trials required a response from both participants. If imagining one's partner performing *any* task was driving the effect we observed in Experiment 1, we should now find no difference between the SAME, DIFF and CAT conditions. Note that both the CAT task and the naming task involve visual processing of the pictures and retrieval of the concepts associated with the depicted entities from memory. In addition, both tasks require articulation of an overt verbal response.

Crucially, however, only the naming task engages language production mechanisms (and specifically the retrieval of the picture's name). Therefore, if the interference effect in Experiment 1 is due to a representation that one's partner is preparing a *naming* task, we should replicate it in Experiment 2.

Method

Sixteen new participants from the University of Edinburgh student community were recruited. Materials, design and procedure were as in Experiment 1, except that the CAT condition replaced the NO condition. For the semantic categorization task, participants were told that when they saw the word *question* (which replaced the word *no*) next to their name, they were to respond to the following question: "Are the two pictures from the same category?" Data were analyzed as in Experiment 1; latencies exceeding the 3SD-threshold amounted to 1.7% of the data.

Results and Discussion

Categorization Task Participants responded correctly on 94.7% of the unrelated trials and on 93.6% of the related trials (a non-significant difference).

Accuracy Speakers produced (marginally) more incorrect naming responses to related than unrelated pictures ($\chi^2(1)$ = 2.98, p=.08). More importantly, Partner did not affect the likelihood of producing an incorrect response (see Table 5).

Table 5: % incorrect in Exp. 2.

	DIFF	SAME	CAT
Unrelated	5.6%	6.3%	6.0%
Related	7.2%	7.1%	5.8%

Naming latencies Participants took longer to name semantically related than unrelated pictures ($\chi2(1)$ = 11.04, p<.001). As in Experiment 1, Partner affected latencies ($\chi2(2)$ = 6.54, p<.05): They were longer when participants believed their partner named pictures than when they believed their partner categorized the pictures. However, the DIFF and SAME conditions did not differ and Relatedness and Partner did not interact (see Table 6 and 7).

Table 6: Mean latencies in Exp. 2.

	DIFF	SAME	NO	Tot
Unrelated	881	879	874	878
Related	898	907	885	897
Tot	889	893	880	
Semantic interference	-17	-28	-11	-19

Note that in Experiment 2 two "go" instructions were displayed on every trial, including in the CAT condition; therefore, interference could not have been due to greater interference between memory representations for more similar instructions.

The results of Experiment 2 are not consistent with the co-representation account. As in Experiment 1, naming latencies were very similar in the DIFF and SAME condition. In addition, and unlike in Experiment 1, the likelihood of incorrect responses was very similar in the two conditions (and did not differ significantly from the CAT condition, either). Finally, the semantic interference effect was not larger in the DIFF than in the SAME condition.

Table 7: Model for naming latencies in Exp. 2

Predictor	Estimate	SE	t
Intercept	884	24	36.77
naming vs. no	12	5	2.47
same vs. different	3	4	.70
related vs. unrelated	19	5	3.48
Random effect	Explained variance estimate		
Subjects: intercept	16490		
Subjects: Size[2]	13080		
Items: intercept	46670		
Items: Relatedness	4380		

Most importantly, we found that naming latencies are longer when speakers believe that their partner is also naming a picture than when they believe their partner is performing a semantic categorization task. Given that the two tasks share all processing stages except lexical retrieval, we conclude that the process of naming pictures is inhibited by the belief that another speaker is concurrently retrieving the pictures' names.

Conclusion

We showed that people represent their partner's task in a joint picture-naming task. The evidence is not consistent with the co-representation account of joint task effects. Participants did not form content-specific representations of their partner's response. It is possible that this finding is limited to the conditions tested in this study. Interlocutors might form content-specific representations when engaged in a conversation (when they rarely speak at the same time). In addition, the amount of practice and repetition that characterizes picture naming experiments could have masked content-specific effects (perhaps because activation was already at ceiling). Future studies should consider these limitations.

However, our results are consistent with a version of the agent-conflict account, in which interference in naming responses is due (at least partly) to the belief that one's partner is preparing a naming response (as opposed to any response). This is consistent with the idea that people represent others' utterances using some of the mechanisms they use in preparing their own utterances (i.e., language production mechanisms; Pickering & Garrod, in press).

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[2] Size refers to the Size of the first named picture. Pictures were either relatively big (e.g., apple in Figure 1) or small (e.g., blouse in Figure 1). Size did not interact with any other factors in the analyses reported in this paper.

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