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To plan or not to plan: Does planning for production remove facilitation from associative priming?

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ABSTRACT

Theories of conversation propose that in order to have smooth transitions from one turn to the next, speakers already plan their response while listening to their interlocutor. Moreover, it has been argued that speakers align their linguistic representations (i.e. prime each other), thereby reducing the processing costs associated with concurrent listening and speaking. In two experiments, we assessed how identity and associative priming from spoken words onto picture naming were affected by a concurrent speech planning task. In a baseline (no name) condition, participants heard prime words that were identical, associatively related, or unrelated to target pictures presented two seconds after prime onset. Each prime was accompanied by a non-target picture and followed by its recorded name. The participant did not name the non-target picture. In the plan condition, the participants first named the non-target picture, instead of listening to the recording, and then the target. In Experiment 1, where the plan- and no-plan conditions were tested between participants, priming effects of equal strength were found in the plan and no-plan condition. In Experiment 2, where the two conditions were tested within participants, the identity priming effect was maintained, but the associative priming effect was only seen in the no-plan but not in the plan condition. In this experiment, participant had to decide at the onset of each trial whether or not to name the non-target picture, rendering the task more complex than in Experiment 1. These decision processes may have interfered with the processing of the primes. Thus, associative priming can take place during speech planning, but only if the cognitive load is not too high.

1. Introduction

When we speak, we most often do this in conversation, in alternation with someone else. Unless we are presenting at a conference or teaching a class, we expect that the people we are talking to will reply. A conversation implies that two or more people are actively contributing to the discussion. A conversation also implies that each individual not only speaks, but also listens. In other words, the processes of language production and language comprehension must be combined when one takes part in a conversation. Yet, language production and language comprehension have been investigated largely separately. Surprisingly little is known about what happens to these two fundamental components of language in coordination with one another, even though this is the natural way these two processes occur in our daily lives.

Results of corpus studies suggest that production and comprehension can be readily combined with each other. A consistent finding across many languages is that gaps between speakers' turns are often as short as 200 ms (Heldner & Edlund, 2010; Stivers et al., 2009). In other words, after listening to someone else's speech, one's own response is already initiated within 1/5 of a second. This is surprising because studies that have investigated language production in isolation have shown that speakers need on average around 600 ms to plan a single object name (Indefrey & Levelt, 2004) and at least a second to produce a description of an action picture in a phrase such as “The dog chases the mailman” (Konopka & Meyer, 2014). Though substantial parts of these planning times may be taken up by the visual processing of the pictures, and no precise estimates are available about the time speakers need to transform their own thoughts into utterances, these studies strongly suggest that speakers usually need > 200 ms to plan a turn. The short gaps between turns therefore indicate that utterance planning already starts while one is still listening to the preceding speaker. Levinson and Torreira (2015) proposed that speakers begin to plan their utterances as soon as they have enough information to decide what to say. Specifically, they claimed that words are fully planned all the way to the stage prior to articulation, that this information may be held in working memory until the end of turn is predicted, and that articulation is launched just prior to the end of turn.

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Recent experimental evidence is consistent with this early planning hypothesis. Bögels, Magyari, and Levinson (2015) designed a quiz EEG study where the answer could either be deduced early in the question or only at the very end (e.g., "Which character, also called 007, appears in the famous movies?" versus "Which character from the famous movies is also called 007?"). Participants were 310 ms faster to answer in the early than in the late condition. Moreover, in the EEG signal a late positivity starting around 500 ms after the onset of the critical information was observed for both the early and the late condition. This positivity was reduced in a control condition where participants did not have to answer but only to remember the questions. The authors suggested that the late positivity reflected response planning. These results reveal that participants started planning their answer as soon as they had enough information to do so. Barthel, Sauppe, Levinson, and Meyer (2016) obtained similar evidence using a list-completion paradigm where a participant and a confederate both saw sets of objects on their screens. The confederate named her items first, and the participant then named any additional items they saw on their screen. Importantly, the confederate's description either ended in a noun or a verb form (e.g. "Ich habe eine Puppe und einen Schuh (besorgt) - I have a doll and a shoe (obtained)"). The participants' speech onset latencies were shorter in the verb-final than in the noun-final condition. This indicates that they began to plan their utterances as soon as they had heard the final noun and knew which objects they had to name. These studies show that the processes of comprehension and production can co-occur in time. An important task for theories of language processing is to explain how they are coordinated.

Both language comprehension and production have been shown to be capacity demanding. For instance, Rodd, Johnsrude, and Davis (2010) showed that participants were slower to decide whether visually presented letters were printed in upper or lower case when sentences they heard simultaneously required semantic disambiguation compared to unambiguous sentences. This indicates that meaning selection during comprehension interfered with response selection for the visual task. Similarly, Ferreira and Pashler (2002) showed that increasing the difficulty in a word production task delayed responses in an unrelated concurrent non-linguistic task, indicating that both tasks drew from the same pool of attentional resources (see also Cook & Meyer, 2008). Individual differences research points in the same direction, for instance by showing that individuals with better working memory abilities perform better in language comprehension (Huettig & Janse, 2016) and language production tasks (Shao, Roelofs, & Meyer, 2012) than individuals with weaker memory abilities.

In essence, listening to another person while planning one's own utterance is a dual-task situation and one would expect the two tasks to interfere with each other. This expectation has been confirmed in numerous picture-word interference (PWI) experiments, where participants name pictures while listening to stimuli they should ignore. These experiments have shown that participants are slower to name the pictures in the presence of words than noise or pseudowords (Dhooge & Hartsuiker, 2012; Schriefers, Meyer, & Levelt, 1990). Relatedly, Fargier and Laganaro (2016) showed that naming latencies increased when pictures were paired with auditorily presented linguistic stimuli (syllables) than with non-linguistic stimuli (tones) on which participants performed a categorization task. Their findings are consistent with the results of numerous dual-task studies showing that similar tasks interfere more with each other than more dissimilar ones (Navon & Miller, 1987; Wickens, 2008).

In sum, all of these studies demonstrate that speech planning is hindered by concurrent processing of words. However, the degree of hindrance depends to some extent on the relationship between the perceived and planned words: Compared to unrelated words, categorically related ones yield additional interference in picture-word interference paradigms, whereas associatively related words often yield facilitation (Abdel Rahman & Melinger, 2007). This pattern is consistent with effects found for priming of picture naming (Alario, Segui, & Ferrand, 2000; Perea & Gotor, 1997). Primes that are identical to the picture yield strongest facilitation (Ferrand, Grainger, & Segui, 1994; Wheeldon & Monsell, 1992). These findings are important in the current context because successive utterances in conversation are often related, and such relationships may either alleviate or increase the interference that should arise when speech planning and listening co-occur. In fact, Garrod & Pickering, 2004 have argued that speakers prime each other, thereby making dialogue an easier task than speaking in a monologue. Indeed, conversation partners tend to use the same word to describe an object as their interlocutor even if alternate labels are available (Brennan & Clark, 1996; Garrod & Anderson, 1987).

2. The present study

Picture-word interference studies and the study by Fargier and Laganaro (2016) investigated how picture naming was affected by concurrent processing of nonverbal and verbal stimuli. By contrast, the present study explored how the processing of spoken words was affected by the presence or absence of a concurrent word planning task. Thus, while it has already been established that speech planning is affected by listening, we investigated how listening is affected by speech planning. If it is both true that speakers prime each other and that speech planning overlaps with listening, it is of theoretical interest to demonstrate that mutual priming can indeed occur during concurrent speech planning. To test this, we used a novel priming paradigm. Participants saw a stream of pictures and named them as quickly as possible. The pictures were preceded, with an SOA of 2 s, by spoken prime words. The primes were identical to the target names, associatively related, or unrelated. We are not aware of picture priming studies using such a long SOA, but given the results of existing picture naming studies (Alario et al., 2000; Ferrand et al., 1994; Perea & Gotor, 1997) and word processing studies using associative and identity priming (Gomez, Perea, & Ratcliff, 2013; Moss & Marslen-Wilson, 1993; Shelton & Martin, 1992), we expected strong facilitation from both types of related primes. Most likely, these effects are a mixture of automatic processes (Collins & Loftus, 1975) and strategic processes coming into play with longer SOAs (Bodner & Masson, 2001; de Groot, 1984).

Our main question was how these priming effects would be affected by a concurrent speech planning task. To assess this issue, we combined each prime with a non-target picture as illustrated in Fig. 1. One group of participants (the no-plan group) did not react overtly to these pictures but heard a recording of the corresponding name 600 ms after picture onset. Thus, the participants simultaneously saw a non-target picture and heard a prime, then heard a recording of the name of the non-target picture, and finally named the target picture. Note that the name of the non-target picture intervened between the prime and the target picture. However, given the anticipated strength of the priming effects and their largely strategic basis, we expected these effects to be present in spite of the intervening name of the non-target picture.

A second group of participants saw the same pictures and heard the same prime words but had to name the non-target pictures as well as the target pictures. Thus, these participants planned the names of the non-target pictures while hearing the primes. We assessed whether the strength of the priming effects differed between the two groups. One possibility is that speakers can easily process spoken words and use them strategically (i.e. as primes) while preparing their own utterances. If that is the case, similar patterns of results should be seen in the two groups. This pattern would be in line with the proposal in the literature on conversational turn-taking that this kind of dual-tasking is facilitated by mutual priming and as such no costs are associated with speech planning with concurrent listening (Garrod & Pickering, 2004; Pickering & Garrod, 2004). Alternatively, in line with literature on dual-task experiments (Navon & Miller, 1987; Wickens, 2008), speakers may not be able to process spoken words as efficiently when they are planning utterances as when they are just listening to the words. In that case, the priming effects should be absent or much reduced in the plan compared to the no-plan group.