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Task choice and semantic interference in picture naming

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ABSTRACT

Evidence from dual-task performance indicates that speakers prefer not to select simultaneous responses in picture naming and another unrelated task, suggesting a response selection bottleneck in naming. In particular, when participants respond to tones with a manual response and name pictures with superimposed semantically related or unrelated distractor words, semantic interference in naming tends to be constant across stimulus onset asynchronies (SOAs) between the tone stimulus and the picture–word stimulus. In the present study, we examine whether semantic interference in picture naming depends on SOA in case of a task choice (naming the picture vs reading the word of a picture–word stimulus) based on tones. This situation requires concurrent processing of the tone stimulus and the picture–word stimulus, but not a manual response to the tones. On each trial, participants either named a picture or read aloud a word depending on the pitch of a tone, which was presented simultaneously with picture–word onset or 350 ms or 1000 ms before picture–word onset. Semantic interference was present with tone pre-exposure, but absent when tone and picture-word stimulus were presented simultaneously. Against the background of the available studies, these results support an account according to which speakers tend to avoid concurrent response selection, but can engage in other types of concurrent processing, such as task choices.

1. Introduction

Speaking is a highly exercised psychomotor skill and accessing words in memory forms an essential part of this skill (Levelt, 1989). Being such a well-practised activity, it feels as if speaking happens automatically. Yet, evidence has accumulated that certain linguistic processes required for speaking, such as lexical selection, cannot occur simultaneously with certain nonlinguistic processes (see for review Roelofs & Piai, 2011). Which types of nonlinguistic processes can or cannot happen in parallel with lexical selection in speaking are addressed in the present study. Below, we first introduce a paradigm often used to investigate lexical selection and outline our current understanding of how lexical response selection precludes other concurrent nonlinguistic processes. Next, we discuss evidence suggesting that speakers tend to avoid concurrent response selection but can engage in other types of concurrent processing, such as task choices. We then present two experiments explicitly testing whether lexical selection can occur simultaneously with making task choices.

1.1. Picture naming and dual-task procedures

An experimental paradigm particularly fruitful for investigating lexical access in word production is picture–word interference (e.g., Abdel Rahman & Melinger, 2009; Glaser, 1992; Roelofs, 2007, for reviews): Speakers name pictured objects while trying to ignore written distractor words superimposed onto the pictures. A central finding obtained with picture–word interference (PWI) is that response time (RT) is longer for picture naming when the word is from the same semantic category as the picture name (related condition, picture: goat, word: *horse*) relative to unrelated words (word: *pen*), called the semantic interference effect.

In the past few years, researchers have used the PWI paradigm in combination with a dual-task procedure, called the psychological refractory period (PRP) paradigm (Pashler, 1994), to investigate at which stage during word production the semantic interference effect arises (Dell'Acqua, Job, Peressotti, & Pascali, 2007; Kleinman, 2013; Piai, Roelofs, & Schriefers, 2014; Schnur & Martin, 2012). In a PRP experiment, participants respond quickly and accurately to two stimuli (S1 and S2) in the correct order (i.e., first to S1, then to S2) while the stimulus onset asynchrony (SOA) between S1 and S2 is varied to determine whether processes are delayed due to concurrent processing. To investigate the locus of semantic interference, researchers have employed a combination of a manual tone discrimination task (Task 1) and the PWI task (Task 2).

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A prominent view in the literature maintains that, when tasks are performed concurrently, response selection constitutes a processing bottleneck. The response selection bottleneck implies that only one response can be selected at a time. The bottleneck is assumed to be structural (Pashler, 1994) or strategically imposed (Meyer & Kieras, 1997). The view of a response selection bottleneck holds that in a PRP experiment, a response for Task 2 (e.g., picture naming) can only be selected after the response for Task 1 (e.g., tone discrimination) has been selected and this waiting for response selection for Task 1 creates *cognitive slack* (Pashler, 1994). With a long SOA between S1 and S2 (e.g., S1 preceding S2 by 1000 ms), the response–selection stages of Tasks 1 and 2 do not overlap. Under these conditions, Task 2 manipulations yield similar effects as in a situation with only Task 2 (e.g., manipulating distractor type in PWI yields the semantic interference effect in picture naming). With a short SOA (e.g., 0 or 100 ms) between S1 and S2, however, effects can be present of absent, providing evidence about the locus of the effect of Task 2 manipulations. According to the slack logic, the presence of an effect at short SOAs provides evidence that the effect emerges at response–selection or at post-selection stages. This is illustrated in Fig. 1, which assumes a response–selection locus of semantic interference. By contrast, the absence of such an effect is taken as evidence that the effect emerges prior to response selection and is absorbed into slack.

In previous PRP studies examining the locus of the semantic interference effect in picture naming over a wide range of SOAs, two main patterns have been observed (for an overview, see Piai, Roelofs, & Schriefers, 2014). Some studies reported that the semantic interference effect is absent (or clearly reduced) at short SOAs, but present at long SOAs (Ayora et al., 2011; Dell'Acqua et al., 2007; Kleinman, 2013; Van Maanen, van Rijn, & Taatgen, 2012). The underadditive effect of SOA and distractor type suggests a pre-selection locus of the semantic interference effect (Ayora et al., 2011; Dell'Acqua et al., 2007), or can be interpreted as evidence that response selection processes of Tasks 1 and 2 may overlap (Roelofs & Piai, 2011). Most commonly, however, it has been observed that the semantic interference effect is of similar magnitude at short and long SOAs, that is, additive effects of SOA and distractor type are obtained (Kleinman, 2013; Piai & Roelofs, 2013; Piai, Roelofs, & Roete, 2014; Piai, Roelofs, & Schriefers, 2014; Schnur & Martin, 2012; Van Maanen et al., 2012). The additivity suggests that the semantic interference effect emerges during lexical response–selection or later stages, as shown in Fig. 1. Thus, in the remainder of this article, we adopt the assumption that the locus of the semantic interference effect is at selection or post-selection stages (see for extensive discussion Piai, Roelofs, & Schriefers, 2014). Note that the aim of the present study is not to test this assumption, but rather to investigate whether the additivity of the semantic interference effect depends on the nature of the concurrent processes.

Piai, Roelofs, and Schriefers (2014) systematically manipulated various dimensions on which earlier PRP studies differed, including tasks, materials, stimulus types, and SOAs. Still, in all experiments, additive effects of SOA and distractor type on naming RTs were obtained. Piai et al. therefore concluded that "participants strongly prefer imposing a response–selection bottleneck (yielding the pervasive additive effects) rather than a post-selection bottleneck (yielding the less-pervasive underadditive effects)" (pp. 161–162).

Essential to the response–selection bottleneck account of additive effects in dual-task performance is that only one response can be selected at a time. Consequently, effects arising in response selection for Task 2, such as semantic interference in picture naming, will not be absorbed into slack created by response selection in Task 1. This account entails that when Task 1 creates slack but does not involve response selection, semantic interference in Task 2 may be absorbed into slack. Under these circumstances, underadditive effects of distractor type and SOA may be obtained. Elsewhere (Piai, Roelofs, & Schriefers, 2011), we argued that such a situation may occur when Task 1 involves a task choice without response selection, as illustrated in Fig. 2.

1.2. Picture naming and a task-choice procedure

Following Janssen, Schirm, Mahon, and Caramazza (2008), Piai et al. (2011) used a task-choice paradigm (Besner & Care, 2003), requiring a choice between picture naming and word reading on each trial. The print colour of the word indicated whether participants had to name the picture or read the word aloud. Using another group of participants, Piai et al. (2011) also examined picture naming without a task choice. The same PWI stimuli were presented, but now the picture had to be named on all trials. We observed that the semantic interference effect was present in picture naming without a task choice but absent with a task choice. Mädebach, Oppermann, Hantsch, Curda, and Jescheniak (2011) observed exactly the same. Piai et al. (2011) accounted for these findings by assuming that in the task-choice condition, the response to the picture is selected concurrently with the processing of the cue (the colour of the written word) for the task choice. The task choice creates cognitive slack in that a response to the picture cannot be given before the task choice has been made. The cognitive slack may absorb the semantic interference, as illustrated in Fig. 2. However, different from Mädebach et al. (2011) and Piai et al. (2011), Janssen et al. (2008) did observe semantic interference with a task choice, suggesting that the slack created by a task choice may not always be sufficient to fully absorb semantic interference, or that participants may sometimes prefer not to fully overlap task choice and response selection processes.

Furthermore, Piai et al. (2011) assumed that picture and word processes initially run in parallel and are then suspended until the task-decision process is finished. Word-form encoding (indicated as the post-selection stage in the figure) in both picture naming and reading aloud requires central processing resources (Reynolds & Besner, 2006; Roelofs, 2008), and so does the task-decision process (Paulitzki, Risko,

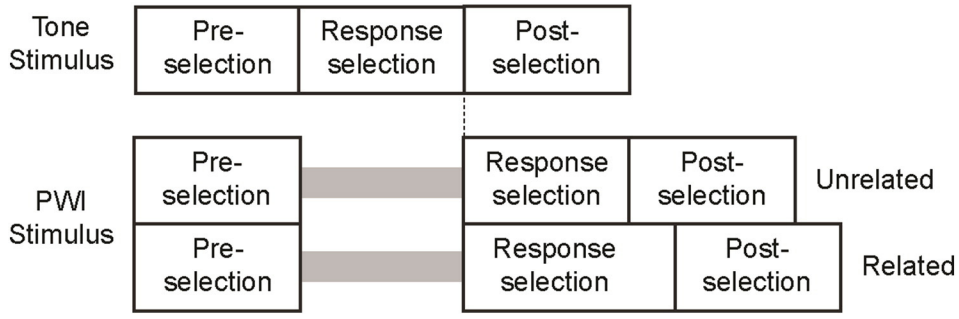

Fig. 1. Schematic illustration of the slack logic for the psychological refractory period (PRP) procedure at SOA = 0 ms applied to semantic interference in picture naming. Pre-selection refers to the stages of perceptual and conceptual encoding. Post-selection for the tone stimulus refers to the stages of response programming and execution and for the picture stimulus to the stages of word-form encoding and articulation. The distractor types are given to the right of the figure. The shaded areas indicate slack. The figure illustrates the assumption that semantic interference arises in response selection and is reflected in the response times, as assumed by Piai, Roelofs, and Schriefers (2014).