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Brief article

Being fast or slow at naming depends on recency of experience

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ABSTRACT

The speed with which we produce words (e.g., dog) changes depending on whether a word named in the past is from the same semantic category (e.g., cat) or not (e.g., vase). Strikingly, whereas earlier studies find that producing semantically related words speeds up subsequent naming, recent studies report that it slows down future naming. It is unclear why the same experience results in opposite effects and whether both effects originate within the language system. Using the same picture naming paradigm and materials, we manipulated the interval between two naming events, while reducing the influence of expectation. We observed facilitation when semantically related pictures were presented adjacently. By contrast, when semantically related pictures were separated by two unrelated pictures, interference was observed. The results suggest that both facilitation and interference effects emerge within the language system where changes are critically based on the interval between naming, rather than solely due to peripheral processes associated with task demands.

1. Introduction

What we experience in the past positively and negatively affects how we process information in the future when recognizing words (e.g., Neely, 1991), retrieving memories (e.g., Anderson, Bjork, & Bjork, 1994), and attending to events (Hunter & Ames, 1988; Posner & Cohen, 1984). For example, the same previously viewed stimuli change an infant's preference for future stimuli depending on how long they were viewed (e.g., Hunter & Ames, 1988). Remembering previous words impairs future attempts to remember related words (Anderson et al., 1994). Seeing a semantically related word (e.g., "cat") facilitates subsequent word reading (e.g., "dog"), compared to an unrelated word (e.g., "vase"; e.g., Neely, 1991), whereas naming a picture (e.g., dog) is hampered by previously naming semantically related words (e.g., "cat") (e.g., Brown, 1981). In this study, we examined whether similar to other cognitive domains, the same past experience produces different effects during speech production. By reconciling previous findings, we demonstrate how experience shapes the language system. We consider how these phenomena in the language system reflect the way other cognitive domains use the same experience to positively and negatively influence future action.

The speed with which we name a picture (e.g., dog) changes depending on whether a picture named in the past is from the same semantic category (e.g., cat) or not (e.g., vase). It has been well demonstrated that future speech production is hampered by semantically related naming experience (e.g., Belke, 2013; Brown, 1981; Damian, Vigliocco, & Levelt, 2001; Howard, Nickels, Coltheart, & Cole-Virtue, 2006; Schnur, Schwartz, Brecher, & Hodgson, 2006; Vitkovitch, Cooper-Pye, & Leadbetter, 2006; Vitkovitch, Rutter, & Read, 2001; Wheeldon & Monsell, 1994). This phenomenon, termed semantic interference, inspired several computational models of speech production (e.g., Howard et al., 2006; Oppenheim, Dell, & Schwartz, 2010; Roelofs, 2018). However, early studies report that speech production is *facilitated* by naming semantically related pictures in the past (i.e., semantic facilitation; e.g., Biggs & Marmurek, 1990; Huttenlocher & Kubicek, 1983; Lupker, 1988; Sperber, McCauley, Ragain, & Weil, 1979) as similarly observed in other language-related tasks, e.g., during reading (e.g., Meyer, Schvaneveldt, & Ruddy, 1975) and semantic classification (Belke, 2013; Riley, McMahon, & de Zubicaray, 2015). However, computational models of speech production have not addressed semantic facilitation during naming (Dell, 1986; Roelofs, 1992; Howard et al., 2006; Oppenheim et al., 2010; Roelofs, 2018). This was in part because it is unclear whether facilitation reflects changes within the language system (e.g., Navarrete, Del Prato, & Mahon, 2012) or outside the language system because of peripheral processes associated with task demands (e.g., working memory, Belke, 2008; or participants' strategy, Belke, Shao, & Meyer, 2017; Oppenheim et al., 2010; Roelofs, 2018). The theoretical question we posed was whether the same naming experience induces opposite effects on subsequent naming as a result of changes within the language system as opposed to processes

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which occur outside of the language system.

We hypothesized that the polarity of the naming effect depends on the interval between two naming events because facilitation is short-lived and interference is long-lasting (e.g., Damian & Als, 2005; Wheeldon & Monsell, 1994). Consistent with this hypothesis, the time interval between prime and target onsets is shorter in studies demonstrating facilitation ($<$ 2 sec., Biggs & Marmurek, 1990; Huttenlocher & Kubicek, 1983; Lupker, 1988; Sperber et al., 1979) compared to those demonstrating interference ($>$ 4 sec., Vitkovitch et al., 2001, 2006; Wheeldon & Monsell, 1994). However, to allow for this conclusion, another explanation needs to be ruled out. Semantic interference also occurs when all the pictures (prime and target) are presented at a consistent rate (2006; Vitkovitch et al., 2001; Wheeldon & Monsell, 1994), while semantic facilitation occurs when the response-stimulus interval (RSI) between the prime and target is much shorter ($<$ 1 sec.) than the RSI between the target and next prime (3–10 sec.) (Biggs & Marmurek, 1990; Huttenlocher & Kubicek, 1983; Lupker, 1988; Sperber et al., 1979). Compared with the first case, in the second case participants may be more likely to notice the prime-target pairs and thus rely on the semantic relationship to predict the target response, resulting in facilitation. Indeed, Huttenlocher and Kubicek (1983) manipulated the probability of related pairs (87.5% vs. 12.5%) and found a larger facilitation effect (175 ms vs. 59 ms) in the high vs. low expectancy condition. Thus, the expectation of a relationship between trial pairs impacts the degree of facilitation in naming.

To uncover how speech production is affected by past naming experience, we conducted two sets of experiments testing whether facilitation and interference effects in naming are caused by different time courses while reducing the influence of expectation.

2. Experiment 1

We performed the following manipulations to assess whether semantic facilitation and interference occur within the language system due to the same naming experience. First, to detect short-lived facilitation in naming, we presented the prime and target adjacently and the time interval between onset of prime and target was fixed to 2 sec. (lag0). Second, to directly test whether opposite effects caused by semantically related naming experience depend on different intervals between naming trials, we included a lag2 condition, where the prime and target were separated by two unrelated intervening pictures (i.e., fillers). In this lag2 condition, the time interval between the onset of the prime and target was 6 sec., similar to previous studies reporting semantic interference (e.g., Wheeldon & Monsell, 1994). Third, to make the prime-target pairs less obvious to participants, we followed Wheeldon and Monsell (1994) and Vitkovitch et al. (2001, 2006), presenting pictures at a consistent rate (2 sec.).

If opposite effects of naming experience on speech production occur within the language system due to different intervals between naming occurrences, we predicted a facilitation effect when the prime and target are presented adjacently to each other with a short time interval (2 sec., lag0) and an interference effect when the prime and target are separated by two intervening trials with a longer time interval (6 sec., lag2). Alternatively, if facilitation is the result of processes peripheral to the language system because of the obvious grouping of primes and targets, the consistent presentation rate in the current study predicts no facilitation in either the lag0 or lag2 condition.

2.1. Method

2.1.1. Participants

Ninety-Six Rice University undergraduates participated in Experiment 1 for course credit, 40 of whom participated in rating the materials (see Materials). All participants were native English speakers who provided written informed consent in accordance with the Institutional Review Board at Rice University.

2.1.2. Materials and design

The stimuli were 320 color photographs (80 targets, 80 primes, and 160 fillers) from the Bank of Standardized Stimuli (Brodeur, Guérard, & Bouras, 2014) scaled to 300 x 300 pixels. We chose the target pictures from several semantic categories and paired each target with a semantically related prime from the same category to form the related prime-target pairs (the related condition). Unrelated prime-target pairs were created by re-pairing the semantically related prime and target pictures into unrelated pairs (see Supplemental Materials). Using a 5-point scale, another group of 40 participants rated the degree of semantic similarity between the prime and target in the related and unrelated pairs. The related pairs (mean: 4.52; range: 3.55–5.00) were rated more similar than the unrelated pairs (mean: 1.13, range: 1.00–1.40; $t_1(39) = 58.35$, $p < .001$; $t_2(79) = 56.79$, $p < .001$).

To control for possible diminution of effects due to repetition, participants named the same pictures once during the experiment. To this end, we performed the following manipulations. First, we divided the 80 related prime-target picture pairs into two lists of 40 pairs each (lists A and B) and created the unrelated prime-target pairs within a list. Half of the participants saw targets in list A with related primes and list B with unrelated primes, while the other participants saw the reverse. Second, we manipulated the condition of lag between-subject but within-item. Specifically, we paired each target picture with an additional two pictures (unrelated to the target and the target's paired semantically related and unrelated primes) to serve as fillers. The two unrelated fillers were interleaved between the prime and target (i.e., prime, filler, filler, target) in the lag2 condition. In the lag0 condition, we presented the two unrelated fillers before the prime-target pair (i.e., filler, filler, prime, target) to reduce the possibility of participants detecting the occasional semantic relationship between two sequential pictures. Fifty-six participants were equally assigned between the lag0 and lag2 conditions.

2.1.3. Apparatus

DMDX software (Forster & Forster, 2003) was used to run the experiment and record verbal responses. A microphone headset triggered a voice key to collect naming response times (RTs) to the nearest millisecond (ms).

2.1.4. Procedure

First, participants were familiarized with all picture stimuli used in this experiment. The experimenter corrected participants when a wrong name or no response was provided. Immediately after the familiarization phase, the experiment began with ten practice items presented in the same way as experimental items. Each item began with a cross (+) in the center of the screen for 500 ms, followed by a single picture. Participants named pictures as quickly and accurately as possible. Pictures remained on the screen for 1000 ms followed by a 500 ms blank screen. The experiment lasted ~20 min.

3. Results

Five participants were excluded due to equipment/experimenter errors. Incorrect responses and omissions were coded as analyzable errors (2.5%) in the error analyses. Trials with analyzable errors, voice key/microphone errors and RTs beyond 2.5 standard deviations from the mean were removed from the RT analyses (7.8%). Fig. 1 (left) shows Experiment 1a mean naming latencies in different conditions with 95% confidence intervals (CI). To test how naming was affected by semantic relatedness, the following analyses were conducted in the R software environment (Version 3.4.4) using lme4 (Version 1.1–15; Bates, Maechler, Bolker, & Walker, 2015) and lmerTest (Version 2.0–36; Kuznetsova, Brockhoff, & Christensen, 2017). Specifically, we modeled the logRTs/errors using Relatedness (Related vs. Unrelated), Lag (Lag0 vs. 2) and the interaction as fixed-effect variables. The random-effect variables were determined by choosing the maximal