DOMATO PRIMES PAPIRKA: MISMATCHING PSEUDOWORDS ACTIVATE
SEMANTIC AND PHONOLOGICAL REPRESENTATIONS

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ABSTRACT
We report four cross-modal priming experiments with pseudoword (PW) primes phonologically related to the
participant or phonologically related to a semantic associate of the
target. Task is either lexical decision (LDT) or naming.
The pattern of results suggested the use of a neutral baseline
which is realised in Experiment 4 along with a reduction
of the relatedness proportion from 50% to 30%.
Semantic priming effects are obtained regardless of baseline
type for words and minimally deviating PWs with
LDT, but only for words with naming. The results of the
naming experiment in Experiment 4 suggest that cross-
modal semantic priming effects by PWs are contaminated
by processes not occurring with word primes. We obtain
phonological priming effects for word and PW primes.
Phonological word priming effects reflect prelexical and
lexical processing. The pattern of phonological activation
is not copied to the semantic level.

1. INTRODUCTION
Psycholinguistic theories of lexical access have to define the
properties of sublexical and lexical representations and
specify the mapping from the speech signal information
onto higher processing levels. They set limits to the degree
that a lexical representation may deviate from the signal.
Put differently, how far may a target representation deviate
from the input to still be counted as matching rather than
mismatching the input?

These issues are often addressed by using the cross-
modal priming paradigm. Primes are usually pseudowords
(PW) deviating minimally (one phonological feature, e.g.
voice or place) or maximally (more than one phonological
feature) from a word. The target is either a word realising
a phonological relation between prime and target (Bölte
[11]) or a semantic associate of the word functions as target
(Connine, Blasko, & Titone [2]; Marslen-Wilson [3]).
Recently, van der Lught [4] used the word spotting paradigm
for a similar investigation. We tried to determine the
potential influence of alexical processes in semantic and
phonological cross-modal priming situations by manipulating
lexical status of the target, the task, and the related-
ness proportion.

2. METHODS

2.1. Participants
There were 60 participants in each experiment but Experiment
4 in which we tested 72 participants. They were either
paid or received course-credit.

2.2. Material
We used the same targets in all experiments but Experiment
4. Primes differed between experiments to realise the
intended prime target relation (see Table 1 for examples).
There were 75 word targets. PW targets were created and
combined with primes in the same manner as word primes.
Prime target pairs were distributed across five lists, using
a Latin-square. Each target was presented only once to each
subject, but in a different condition on each list. There were
50% related and 50% unrelated prime-target pairs in all but
the last experiment. Filler items were added such that each
prime target combination had the same probability of
occurrence. We added a neutral condition, *blanco or
*blanko in Experiment 4 and reduced the number of related
pairs to 33%. Because of the neutral condition, items were
distributed across six lists. There were 72 word and 72 PW
targets. Thirty warm-up trials preceded the experimental
trials.

2.3. Procedure
Participants were tested individually for the naming
experiment, with groups up to four for the LDT experi-
ment. The typical naming or LDT instruction was admin-
istered. An asterisk, visible for 240 ms, started a trial. The
auditory prime was presented via headphones 250 ms later.
Visual targets appeared at prime offset for 360 ms. Reaction
time (RT) was measured for 1500 ms from target
onset. There was a short break in the middle of each experiment.

3. RESULTS

We excluded items or participants with more than 15% errors. The α-level of all planned comparisons were
Bonferroni corrected (p < .017). Tests concerning one
independent variable, e.g. relatedness or degree of similar-

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<th>unrelated PW</th>
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<td>*sorato</td>
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ity, belonged to one family of tests. At first, we evaluated priming effects only amongst conditions in which the primes had the same lexical status. Figure 1 displays the results of all experiments but Experiment 4.

3.1. Results Experiment 1: Phonological priming with lexical decision

Five participants and seven items were excluded before inferential analyses. The average error rate was 4.2%. RTs of each related condition were faster than RTs of the corresponding unrelated condition (t(1)(54) = 14.4, p < .0001; t(2)(66) = 15.2, p < .0001 for words; t(1)(54) = 6.1, p < .0001; t(2)(66) = 4.4, p < .0001 for minimal PW; t(1)(54) = 5.7, p < .0001; t(2)(66) = 4.7, p < .0001 for maximal PW). Word primes facilitated more than minimal and maximal PW primes (t(1)(54) = 8.4, p < .0001; t(2)(66) = 5.8, p < .0001; t(1)(55) = 8.1, p < .0001; t(2)(66) = 7.1, p < .0001; respectively). Minimal and maximal PWs did not differ significantly from each other (all t < 1). There was priming in all conditions. Unexpectedly, RTs in the unrelated word condition were slower than RTs in the unrelated PW condition (t(1)(54) = 2.1, p = .021; t(2)(66) = 2.2, p = .015).

It was only in this experiment that lexical decisions to PW targets were accelerated relative to a baseline (M = 704, SD = 118): identical prime-target pairs (M = 636, SD = 94) (t(1)(55) = 7.3, p < .001, t(2)(62) = 6.7, p < .001) minimal PWs (M = 675, SD = 105) (t(1)(55) = 4.4, p < .001, t(1)(66) = 2.8, p = .004), maximal PWs (M = 682, SD = 109) (t(1)(55) = 2.5, p = .075, t(2)(66) = 2.5, p = .008). RTs to identical pairs were faster than to minimal (t(1)(55) = 5.6, p < .001, t(2)(66) = 3.2, p = .001) or maximal PWs (t(1)(55) = 7.1, p < .001; t(2)(66) = 3.9, p < .001) while the RTs of the minimal and maximal PW condition did not differ from each other (t < 1).

3.2. Results Experiment 2: Semantic priming with lexical decision

Four subjects and five items were excluded from further inferential analyses. There were 3.5% errors on average. Related words and minimal PWs accelerated lexical decisions to word targets (t(1)(55) = 6.8, p < .0001; t(2)(69) = 7.4, p < .0001; t(1)(55) = 3.9, p < .0001; t(2)(69) = 4.5, p < .0001; respectively). The difference of maximal PW - unrelated PW was not significant after α-correction (t(1)(55) = 1.9, p = .032; t(2)(69) = 2.0, p = .024). It differed from the related word and the minimal condition (t(1)(55) = 2.2, p = .017; t(2)(69) = 1.9, p = .03; t(1)(55) = 2.2, p = .015; t(2)(69) = 2.0, p = .024; respectively). As in the phonological priming experiment, RTs of the unrelated word condition were slower than those of the unrelated PW condition (t(1)(55) = 2.6, p = .065; t(2)(69) = 3.1, p = .002).

3.3. Results Experiment 3: Semantic priming with naming

Participants saw words and PWs in this naming experiment and were asked to name both. We did not exclude PW targets in order to keep the experiments as comparable as possible. There were 3% wrong word answers and 6.8% wrong PW answers. A significant difference was observed between the related word condition and its control (t(1)(54) = 2.64, p = .005; t(2)(73) = 1.78, p = .040). All other differences were not significant after α-correction.

3.4. Results Experiment 4: Semantic priming with lexical decision. Neutral and unrelated control conditions

The unexpected difference between the control conditions in Experiment 1 and 2 led us to run an experiment with an neutral condition. We wanted to evaluate whether there were any “processing costs” in the unrelated conditions to determine the most appropriate control condition. Five participants and five items were discarded from further analyses because of high error rates. There were 3.1% errors in total. The unrelated word and the unrelated PW condition did not differ from each other (t(1)(66) = 1.5, p = .064; t(2)(66) = 1.9, p = .027). RTs in the neutral condition were faster than in the unrelated word condition (t(1)(66) = 2.8, p = .004; t(2)(66) = 2.6, p = .005) but did not differ significantly from the unrelated PW condition (t(1)(66) = 1.5, p = .065; t(2) < 1) (see Figure 2). Thus, we evaluated the
priming effects against the neutral condition. RTs of the related word condition were faster than those of the neutral condition (t1(66) = 4.3, p < .0001; t2(66) = 4.5, p < .0001). The minimal pseudoword condition just failed to reach the adjusted α-level (t1(66) = 1.9, p = .031, t2(66) = 1.8, p = .034). Maximal PW primes did not facilitate RTs relative to the neutral condition (all t < 1). All priming effects observed in the previous LDT-experiments remain significant, if we use the unrelated PW condition as a baseline. The semantic priming effect for words in the naming experiment, however, is only marginally significant (t1(54) = 1.6, p = .055; t2(73) = 1.2, p = .13).

4. SUMMARY AND DISCUSSION

First, we briefly summarize the results by describing the pattern of effects evident in nearly all experiments. Next, we summarize the pattern of results of minimal and maximal PWs. The variation in the pattern of results caused by the different prime target relationships, experimental tasks, or relatedness proportion follows.

We observe semantic priming effects for words across all experiments which ensures that we used sensitive paradigms. Latencies of the unrelated word condition were slower than those of the unrelated PW condition in Experiment 1 and 2. Minimal PWs primed only lexical decisions but did not prime naming responses. Maximal PWs never primed in any semantic priming experiment. Maximal PW primes were only of effect in the phonological priming experiment. They facilitated LDT as much as minimal PW primes but less effective than related word primes. Bölte [1] obtained a similar pattern of results for word targets (cross-modal priming 1). PW decisions were accelerated relative to the baseline only in this experiment but they were always less accelerated than word decisions.

It is possible that word and PW decisions share the following processing features. The prime tomato is identical with the target TOMATO, sharing all prelexical and lexical processing units. These three features in combination elicit the largest priming effect. The comparable PW pair, *domato-*DOMATO, is less effective in priming because no lexical units contribute to the priming effect. Only the prime-target identity and the shared prelexical units contribute to the priming effect. This is not to say, that deviating PWs are not able to activate lexical representations (Connine et al. [2] or experiment 2 and 4). But the lexical activation does not help in the generation of a PW decision. It rather slows down the decision relative to a word decision. Non-identical, related prime and target pairs employ the same units/processes. That is, the decision to *domato-TOMATO is facilitated because the prime is able to activate prelexical and lexical units that it shares with the target. The decision to *somato-DOMATO is facilitated least because prime and target share only prelexical units. We conclude that minimal and maximal PWs are able to activate lexical form representations.

The results of naming experiment suggest that PWs are not able to activate semantic representation. Only words showed a semantic priming effect. The effect is small in ms, its effect size is moderate (d’ = .52). We might have reduced lexical processing by requiring to name also PW targets. The lexical and the non-lexical route, e.g. grapheme to phoneme conversion, might have raced for delivering the naming response. The non-lexical route was predominantly used, reducing the priming effects for words and eliminating any PW priming effect.

Semantic priming effects were observed for words and minimal PWs with lexical decision. Maximal PWs did not prime lexical decisions in Experiment 2. This is different from the phonological priming experiment in which priming occurred in all related conditions. It is also different from the naming experiment in which only related words showed facilitation. The significant difference between the unrelated conditions suggests the involvement of an additional process in the unrelated word condition (Posner & Synder [5]).

We introduced a neutral baseline in Experiment 4 to investigate this issue. Word and minimal PW primes facilitated the reaction as before. But this time, word primes were more effective than minimal PW primes.
Again, the maximal PW condition did not differ from its control condition. Most importantly, the unrelated word condition was slower than the neutral baseline. This is usually taken as an indication of an additional process (de Groot [6]; Posner & Synder [5]). The priming effect for the related word pairs did not vary greatly with the number of proportion of related pairs across the experiments (d’ = .71 in Experiment 2 and d’ = .75 in Experiment 4). The relevant process for related word pairs is apparently not under strategic control (Seidenberg, Waters, Sanders, & Langer [7]). The priming effect for minimal PWs decreased, however (Experiment 2, d’ = .72; Experiment 4, d’ = .47). Thus, a part or all of the PW priming effect may have been under strategic control in Experiment 2. The strategic control facilitated the processing such that minimal and word primes brought about comparable amounts of priming. The reduction of the relatedness proportion may have weakened the influence of this process in Experiment 4 to a yet unidentified degree.

Research has uncovered that lexical decision and naming are influenced by different processes or mechanisms. These include backward priming and postlexical checking processes. Backward priming influences lexical decision and to a smaller degree naming (Peterson & Simpson [8]). There is evidence that postlexical checking mechanisms influence lexical decision more than naming (for a review see Neely [9]). Thus, it could be that the semantic priming effects in the LDT are an outcome of backward priming and/or postlexical checking processes. There is some sensitivity to relatedness proportion manipulation, but no unequivocal evidence for semantic matching which has been suggested as a postlexical checking mechanism (Neely [9]). An inhibition-domination pattern, typical for semantic-matching, was not observed here (d’ = .75 for related and d’ = .48 for unrelated word trials), for instance.

The data reveal an intricate relationship between activation of form and semantic representation. It is by no means the case that form information is mapped onto semantic information in a one-to-one basis. Thus, conclusions about the activation of word forms based on cross-modal semantic priming experiments can be incorrect. Prominent auditory word recognition models must specify how form information is mapped on to semantic information. The potential involvement of backward priming or postlexical checking processes requires thoroughly control of the causing factors. We showed that an unrelated word baseline and a relatedness proportion of 50% may overestimate the PW priming effect. There is now ample evidence that maximal deviating PWs do not activate semantic representations sufficiently enough to allow for measurable activation of related entries (Connine et al. [2]; Marslen-Wilson [3]; Marslen-Wilson & Zwitserlood [10]). Nonetheless, they activate form representations. Minimal PWs are able to activate form and semantic representations. But it is unclear whether they activate semantic representations in a comparable fashion as words do. Activation of semantic information does not always depend on activation of form information (Heinrich, [11]).

5. ACKNOWLEDGMENTS

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6. REFERENCES