

Response-Retrieval and Negative Priming

Encoding- and Retrieval-Specific Effects

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Abstract. In a recent debate concerning the origin of the negative priming (NP) effect, evidence for the involvement of retrieval processes during the prime episode has accumulated. Rothermund, Wentura, and De Houwer (2005) explain the effect as a product of a conflict between retrieved and current response. Since specific properties of the involved encoding and retrieval mechanisms were not investigated so far, we extend the response-retrieval framework by asking if encoding during prime processing and retrieval-specific processes during probe processing have a modulating influence on the priming effects. In an overlapping-picture task experiment with an explicit variation of the role of the objects in prime and probe, we reproduce the response-retrieval-specific Response-retrieval \times Priming interaction but find a modulation caused by the role of the repeated object in the probe trial. This modulation manifests in a vanishing interaction when the repeated object is a distractor in the probe. We interpret these findings in support of the response-retrieval theory of NP and conclude that the retrieval mechanism is more flexible than previously believed since it is sensitive to relevance of the repeated object regarding the experimental task.

Keywords: negative priming, selective attention, response retrieval, episodic retrieval

Negative priming (NP) is generally considered an appropriate tool to investigate how attentional processes select and ignore important and irrelevant information, respectively. The negative priming effect describes an increase in the duration between stimulus and response and a higher probability of an erroneous response, when the prime distractor is repeated as probe target (Tipper, 1985). Traditionally, NP is studied in contrast to the positive priming (PP) effect which implies a response facilitation when a target reoccurs. These findings are quite stable and have been found in variety of tasks using very different stimuli (for reviews, see Fox, 1995; Mayr & Buchner, 2007). In spite of this seeming robustness, many factors have been identified that can modulate, cancel, or even reverse (negative) priming effects. This complexity of the phenomenon is responsible for the many different theoretical accounts that have been formulated over the years (e.g., May, Kane, & Hasher, 1995; Milliken, Joordens, Merikle, & Seiffert, 1998; Neill, 1977; Neill, Valdes, Terry, & Gorfein, 1992; Park & Kanwisher, 1994; Rothermund, Wentura, & De Houwer, 2005; Schrobsdorff et al., 2007; Tipper, 1985).

A reason why no consensus has been reached in this debate is the apparently faulty assumption that one and the same mechanism is responsible for all NP effects, an assertion that has long dominated research in that domain.

More recently, evidence has accumulated that different mechanisms might produce the NP effect depending on the experimental setup (e.g., Neill, 2007; Tipper, 2001). These integrative accounts agree that there are at least two more or less independent mechanisms that are responsible for NP, persisting inhibition (e.g., Houghton & Tipper, 1994; Tipper, 1985), and memory retrieval (e.g., Neill, 1997; Neill et al., 1992). Which of these components is dominant depends on many factors, among others task, level of representation, and behavioral strategies. It is therefore crucial for any experimental study to carefully place itself within the wealth of empirical findings on NP.

In the large field of identity NP, there is a growing consensus that NP is primarily a memory phenomenon, that is, it is caused by retrieval rather than inhibition. This idea builds on the instance theory of automation (Logan, 1988) which postulates strong automation and optimization tendencies during the processing of successive trials. This optimization leads to a memory retrieval of the previous episode in case of a repetition of a stimulus and increases performance, while a slower, algorithmic processing is carried out when no similarity between prime and probe is detected. In the classical formulation of the episodic retrieval theory (Neill, 1997; Neill et al., 1992), a *do-not-respond* tag is attached to the distractor object while encoding the prime

episode. During probe processing, the greater perceptual similarity of prime and probe in PP and NP conditions triggers the retrieval of the prime episode including this tag. Because the tag is congruent in the PP case and incongruent in the NP condition, a speedup and delay can be observed, respectively.

As more data conflicting with this argument became available, the initial theory was modified several times. More recent retrieval accounts stress the point that prime retrieval reinstates processing operations that have been carried out during the prime episode (Neill, 2007; Neill & Mathis, 1998). In their response-retrieval account, Rothermund et al. (2005) focus on a particular operation, the response. These authors state that it is sufficient to assume a conflict of previous and current responses. This idea is particularly attractive in the light of Logan's (2002) instance theory of attention and memory which makes predictions about which aspects of the prime episode will be encoded and retrieved. The theory models attention, encoding, and retrieval in terms of Broadbent's (1971) stimulus-set (the object identification) and response-set (the categorization of the object). A basic assumption of the theory is that response-set categorizations are represented more strongly in working memory and are hence encoded prominently at prime processing. This implies that any retrieval that accesses the encoded memory trace from the prime retrieves primarily the response-set which, in NP tasks, is equivalent to the prime response.

An interesting consequence of the response-retrieval assumption is that predictions about how priming effects should be moderated by response-repetition or -switch can be derived from the theory: Whenever parts of the prime-episode are repeated in the probe (i.e., both target- and distractor-repetitions), an incidental retrieval of the prime response should occur because of the similarity between prime and probe. Furthermore, whenever the retrieved response is coherent with the probe response, a facilitative effect should be observed, while performance should be impeded when the responses are incoherent. This explanation accounts for NP as the result of a confounding present in most classical NP paradigms: Given a naming task (e.g., Tipper, 1985), the target is always switched in NP trials but repeated in PP trials, suggesting that the response is switched or repeated as well. This is a crucial confound in the light of the response-retrieval theory since it introduces an ambiguous distinction between NP and PP which, in fact, is due only to the response-repetition or -switch. It follows that classical NP and PP conditions can both delay or accelerate reactions. Therefore, in the following, we draw on the terminology from Christie and Klein (2001): The condition is given as a two-letter combination indicating the role of the repeated object in prime and probe, respectively. Negative priming is therefore referred to as DT (i.e., distractor-to-target) while positive priming is tagged TT (i.e., target-to-target).

In their study, Rothermund et al. (2005, Experiment 4) tested the response-retrieval theory using a DT and a

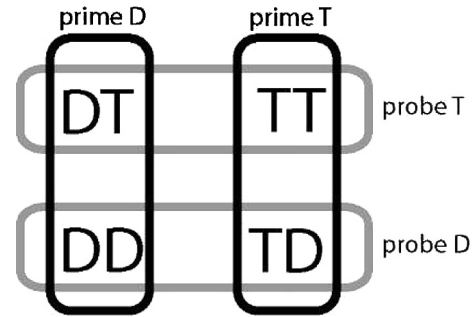


Figure 1. The priming conditions can be grouped according to the role of the repeated object in the prime (black) or in the probe (gray), yielding the “encoding-” (DT, DD vs. TD, TT) and “retrieval-specificity” (DT, TT vs. DD, TD) factor.

distractor-repetition (DD) condition. That is, they used only conditions in which the prime distractor was repeated (either as target or distractor). This makes sense since their idea was to look for response-retrieval caused by incidental (i.e., distractor) information. However, it is crucial for the validity of the theory that its predictions extend to conditions that repeat the prime target since there is no reason to suspect that the prime response should exclusively be linked to the prime distractor. Consequently, we derive predictions for two additional priming conditions, a target-repetition (TT) and a target-to-distractor (TD) condition. Both conditions should produce delaying effects whenever responses are switched between prime and probe. Accordingly they should facilitate processing when the response is repeated. Using all four conditions (DT, TT, TD, DD) provides a complete scheme where both distractor- and target-repetitions can be studied since no confound of prime-probe similarity is present (consider, e.g., DT and DD as used by Rothermund et al., 2005); while both conditions produce the expected Response-repetition \times Priming interaction, they differ in prime-probe similarity because the repeated object changes color in DT but not in DD trials).

The four conditions can be grouped according to the role of the repeated object in prime (Figure 1, black) and probe (Figure 1, gray), respectively. In the former case, the memory trace encoded during prime processing is identical within the groups (hence, we refer to this grouping as “encoding specific”¹) while in the latter case, the retrieval is based on the same perceptual input in the probe (“retrieval specific”). Therefore, studying the four conditions from Figure 1 provides a method to disentangle the impact of encoding- and retrieval-specific effects that can modulate the magnitude of the priming effects. It also provides a facility to better understand the underlying retrieval mechanisms by investigating whether encoding of the prime episode and/or selective retrieval processes are relevant for the observed priming effects.

¹ Note that this nomenclature is not in one-to-one correspondence with the encoding-specificity principle described by Tulving and Thomson (1973). These authors refer to a fit between retrieval cues and memory trace while we use the term to refer to a match between prime episodes with similar stimuli.

Evidence that different stimulus constellations in NP settings can produce priming effects of varying magnitude has been reported in previous studies (e.g., Schrobsdorff et al., 2007) where DT was compared to a reversed repetition (distractor became target and vice versa) and TT was compared to a complete repetition (both target and distractor were repeated). In these cases, the stronger (dis-)similarity for the reversed and complete repetitions led to stronger priming effects. However, whether these modulations were caused by encoding- or retrieval-specific effects remains unclear.

Support for the proposition that encoding during the prime episode may modulate priming effects comes from research on selective NP effects (Frings & Wentura, 2006; Tipper, Weaver, & Houghton, 1994). In these studies, NP was investigated both for irrelevant and relevant dimensions by letting the targets vary on three dimensions rather than two. A consistent finding is that the NP effect is stronger when the prime distractor becomes the probe target on the relevant compared to the irrelevant dimension. Explaining the effect in terms of differences in strength of encoding, the prime memory-traces contain weaker information about the irrelevant dimension than about the response-relevant dimension. Therefore, the retrieved activation does not conflict with the currently computed one as strongly, thereby producing the selective NP effect.

This suggests that memory traces created during DD and DT trials may be qualitatively different from those in TT and TD trials. Arguing from a classical episodic retrieval perspective, the target is encoded more strongly than the distractor and DD/DT trials should thus show a less pronounced effect than TD/TT trials. However, the response-retrieval theory states explicitly that only the response gets retrieved from the prime episode. The cognitive representation of the response is likely to be strongly encoded in all cases because of its direct relevance for behavior. For retrieval it would suffice that the distractor is encoded strongly enough to be matched with the repeated object in the probe. The conflict resulting from the retrieved and the actual response should not be modulated by encoding strength of the distractor. Thus, no modulating effect of encoding-specificity on the priming effects is predicted by response-retrieval.

An alternative view is based on retrieval rather than encoding processes: The DT and the TT condition share the common feature that the *behaviorally relevant* stimulus (i.e., the target) triggers the retrieval, while this is not the case for TD and DD. According to Logan's (2002) *instance theory of attention and memory*, object recognition, and classification occur in parallel and are, in fact, one and the same. This means that the cognitive representation of the object is activated along with its role as target or distractor. In terms of efficiency, it can be assumed that the cognitive system should seek for memory traces relevant for behavior (i.e., to use the target as cue). In the light of these arguments, there is an alternative interpretation of the findings from the study of the selective NP effect stated above: Since the weaker dimension is irrelevant both in prime and probe, it might be less efficient in retrieving the prime episode thus producing less NP than the relevant dimension. From this point of view, one should expect the retrieval to be stronger

for a repeating probe target (DT, TT) than for a probe distractor (TD, DD).

Implementing the priming-condition scheme discussed above (Figure 1), the respective roles that encoding- and retrieval-specific effects play to modulate priming effects in NP settings can be investigated. In spite of its potential in illuminating the mechanisms underlying the generation of the negative priming effect, the main prediction of the response-retrieval theory, the Response-repetition \times Priming interaction, has not yet been replicated in other paradigms in which NP effects have traditionally been found (even though the idea of prime-response-retrieval has been tested in other studies, e.g., Mayr & Buchner, 2006). One important goal of this study is therefore to replicate Rothermund et al.'s (2005) findings in a classical NP paradigm. A second issue is to investigate whether predictions from the response-retrieval theory extend to trial conditions where the repeated object is the target in the prime (i.e., TD and TT conditions). Thirdly, because all four priming conditions (Figure 1) are realized in a single experiment, it is possible to address the issue of encoding- and retrieval-specific effects: It can be tested whether object relevance (i.e., object appears as target or distractor) during encoding or retrieval has an influence on the observed reaction time. According to classical episodic retrieval, weaker encoding of the prime-distractor should modulate priming, while no modulation is expected from a response-retrieval perspective. Both theories acknowledge the possibility of retrieval-specific effects.

Method

An overlapping-pictures paradigm similar to the one used by Tipper and Cranston (1985) was applied. This paradigm has the advantage that it is associated with comparatively strong reaction-time effects, which is not a trivial result as NP effects are often quite subtle (Fox, 1995). Implementing a semantic object-word comparison task, we achieve the orthogonal variation of priming and response relation that is necessary to study the response-retrieval hypothesis (see Figure 2): A word is displayed along with two overlapping pictures representing target and distractor, respectively. Asking the subjects to compare word and target object produces conditions where the same stimulus constellation requires a response-repetition or -switch.

Participants

Sixteen (6 male, 10 female) participants, recruited from the University of Göttingen, took part in the study. Their age ranged from 20 to 34 years ($M = 24.8$ years, $SD = 3.2$ years). Participants were compensated for their efforts either by course credits or they were paid (10 € \approx 14 USD). All participants had normal or corrected-to-normal vision, had normal color-discrimination ability, and were right-handed. All subjects were naive to the purpose of the experiment.

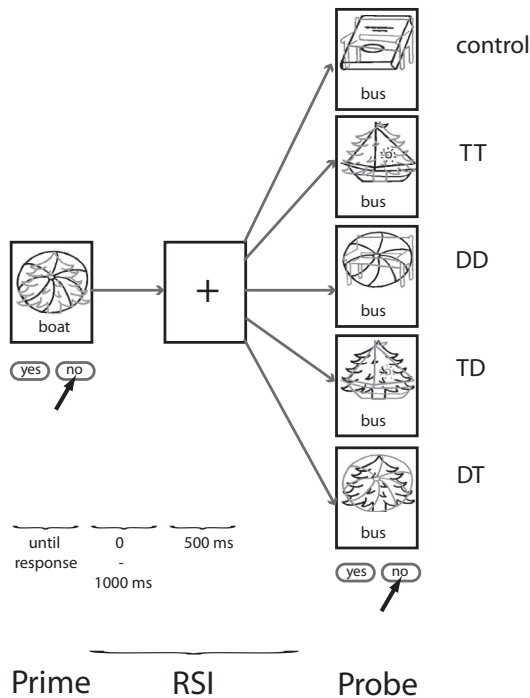


Figure 2. Experimental setup and priming conditions implemented in the experiment. Subjects compared the word to the green (light-gray) target-object and pressed “yes” if they matched and “no” otherwise.

Stimuli and Apparatus

Six characteristic line drawings of everyday objects were used as stimuli. These drawings represented the objects “bus,” “ball,” “tree,” “book,” “bed,” and “bench.” The objects have been successfully applied in previous NP studies (Titz, Behrendt, Menge, & Hasselhorn, 2008). The area covered by the objects was approximately equal and the drawings were prepared in a way to achieve constant visual complexity (validated in pilot studies). The words corresponding to the used pictograms appear frequently in everyday language and should thus be equally available to the participants. In the experiment, the target and the distractor object appeared superimposed such that large portions of the drawings overlapped. Nonetheless, both objects were clearly discernible at all times. The distractor always appeared in pure red ($RGB = \{255, 0, 0\}$), the target in pure green ($RGB = \{0, 255, 0\}$). Below this overlapping target/distractor compound, a word corresponding to one of the six objects (either the target or one of the objects not shown) was presented.

Subjects were seated at a distance of 1 m from the monitor. The target-distractor compound along with the word used for comparison was presented on a 19 in. SVGA monitor and subtended a horizontal angle of 5.0 visual degree

and a vertical angle of 4.3 visual degree. Presentation of stimuli and acquisition of the subject’s response were controlled by a program implemented using Presentation® software (version 9.20, www.neurobs.com).

Design

The design of the study comprised two within-subject factors: response-relation (repetition vs. switch) and priming. Five different priming conditions were realized: control, target repetition (TT), negative priming (DT), distractor-repetition (DD), and a target-to-distractor condition (TD). The two factors were varied independently of each other and trials were presented in a pseudo-randomized fashion. Each of the pictograms appeared an equal number of times (both as target and distractor) and the number of trials was counterbalanced across the priming conditions (including control) and response-relation.² For comparing encoding and retrieval effects, we used two meta-factors (Figure 1): The encoding factor consisted of priming conditions DD and DT versus TT and TD while the retrieval factor comprised DT and TT versus TD and DD.

Procedure

Participants were tested individually in sessions that lasted no longer than 60 min. Initially, the participants were introduced to the stimuli and their associated label. They were instructed to compare the green target object to the word as quickly and correctly as possible while ignoring the red distractor object. After 30 trials practice, the experiment consisted of 840 trials which were divided into 10 blocks allowing for short breaks in between.

Each trial consisted of: (a) a fixation cross for 500 ms; (b) a display containing two superimposed objects and a word (until the subject responded, but no longer than 2 s); (c) a blank screen providing a randomized response-to-stimulus interval (RSI) between 500 and 1,500 ms (blank screen plus fixation cross). This approach yielded strong NP effects in previous experiments (Titz et al., 2008).

Outlier Correction

For inclusion in the analysis, responses to both prime and probe display had to be correct. Furthermore, reaction times below 250 ms and above 3,000 ms were excluded from the analysis, as well as those with a difference to the mean in the same experimental condition exceeding two times the standard deviation. Finally, because the applied inferential statistics assume a normal distribution of the data, Kolmogorov-Smirnov tests (Conover, 1980) were conducted for individual reaction times. The reaction times with

² This approach implies an overrepresentation of trials with repeated objects since four out of five trials were priming trials. The design was chosen (1) to ensure comparability to previous studies (e.g., Rothermund et al., 2005) and (2) to promote retrieval-based processing which is triggered when many object repetitions are presented (Kane, May, Hasher, Rahhal, & Stoltzfus, 1997).

Table 1. Summary of reaction times (RT) and error rates (ER)

	Mean reaction time/error rates ^{a,b}			
	Same response		Different response	
	RT	ER	RT	ER
Control	838.4 (154.4)	4.10 (3.3)	821.2 (139.7)	3.65 (3.6)
DT (NP)	829.5 (139.9)	3.82 (3.5)	842.0 (156.3)	3.32 (2.7)
TT (PP)	816.7 (120.5)	2.17 (1.9)	835.8 (136.8)	5.15 (4.4)
TD	840.7 (144.4)	5.71 (5.4)	814.9 (149.4)	3.33 (3.4)
DD	824.4 (158.0)	5.20 (4.2)	817.6 (146.8)	3.26 (2.4)
	Priming effects			
DT (NP)	8.9	0.28	-20.8	0.33
TT (PP)	21.7	1.92	-14.5	-1.50
TD	-2.3	-1.61	6.3	0.32
DD	14.0	-1.10	3.6	0.39

^aPercentage of wrong responses per condition.

^bStandard deviation in parentheses.

^cDifference of control and priming condition.

lowest probability given the normal distribution model were removed until the test yielded insignificant results.³ Overall, not more than 10% of the trials for each participant were excluded from the analysis.

Results

Priming and Response-Repetition Effects

A descriptive summary of the reaction-time data is presented in Table 1. The global 2 (Response-repetition: repeated vs. switched) \times 5 (Priming: CO, DT, TT, DD, TD) repeated measures analysis of variance (ANOVA) yielded no main effect of priming, $F(4, 60) = 1.39, p = .24$ or response-repetition, $F(4, 60) = 0.89, p = .36$. However, the interaction of Priming \times Response-repetition reached significance, $F(4, 60) = 4.56, p < .01$. We applied separate 2 (Priming: control vs. priming) \times 2 (Response-repetition) ANOVAs per priming condition using Holm's (1979) method for adjusting the p values to account for the family-wise error rate. We found that the global pattern was caused by significant interaction effects in the TT and DT conditions, (TT: $F(1, 15) = 7.20, p < .01$, DT: $F(1, 15) = 9.30, p < .01$) where the main effects did not reach significance. With regard to the DT condition, responding was significantly slowed down by 20.8 ms, $t(15) = -3.16, p < .01$ when the response had to be changed, while the acceleration by 8.9 ms for response changes was not significant, $t(15) = 1.05, p = .16$. In the TT condition, both the slow-down by 14.5 ms, $t(15) = -1.77, p < .05$ for response-switches and the acceleration (21.7 ms, $t(15) = 1.92, p < .05$) for response-repetitions were significant.

In contrast, interaction effects for DD and TD were not significant (DD: $F(1, 15) = 0.55, p = .47$, TD: $F(1, 15) = 0.98, p = .34$). However, there was a tendency for a main effect for priming in the DD condition, $F(1, 15) = 3.70, p < .07$ and a main effect for response-repetition for TD, $F(1, 15) = 9.98, p < .01$.

The corresponding analysis for the error rates yielded similar results in the global ANOVA, where the interaction effect reached significance, $F(4, 60) = 6.99, p < .01$, while the main effects did not. The separate analyses per priming condition found a significant interaction in the TT condition, $F(1, 15) = 14.18, p < .001$ but not in the other conditions. In the TT condition, behavioral errors were more likely than in the control condition when the response had to be switched, $t(15) = -1.91, p < .05$. In contrast, responding was more likely to be correct as compared to control trials, when the response was repeated, $t(15) = 2.72, p < .01$. All other effects failed to reach significance. Inspection of the data (Table 1) shows that the tendencies of the effects are mostly congruent with the RT data.

Encoding- versus Retrieval-Specificity Effects

In order to investigate whether the observed Response \times Priming interaction effect depended on the role of the repeated object during prime and probe, we conducted a 2 (Response-repetition: repeated vs. switched) \times 2 (Encoding-specificity: D vs. T in prime) \times 2 (Retrieval-specificity: D vs. T in probe) repeated measures ANOVA treating the priming effects (control RT – priming RT) as dependent variable. This analysis complements the separate comparisons of individual conditions with the control condition (see last section) by simultaneously using the whole design. We found a

³ This outlier correction guaranteed that the normal-distribution requirement was fulfilled. Log-transforming the data gave similar results but was not successful in all 16 (subjects) \times 5 \times 2 = 160 distributions.

tendency for a main effect of response-repetition, $F(1, 15) = 4.00, p = .06$ which was expected given the significant interaction effects in the previous analyses. The encoding versus retrieval-specificity effects appear as encoding and Retrieval \times Response-relation interactions in this analysis. The Encoding-specificity \times Response-relation interaction failed to reach significance, $F(1, 15) = 0.50, p = .49$ while the corresponding interaction for retrieval-specificity was significant, $F(1, 15) = 13.03, p < .01$. In response-repetition trials a repetition as probe-distractor caused a smaller effect than repetition as probe-target, $t(31) = 2.96, p < .005$ and there was a tendency for the reversed effect for trials where the response had to be switched, $t(31) = -1.38, p = .08$. There were no other significant main effects or interactions.

Discussion

Including all possibilities of single-object repetition in our experimental design, we were able to address the question whether encoding- or retrieval-specific processes modulate the priming effects. We found a significant Response \times Priming interaction predicted by the response-retrieval theory (Rothermund et al., 2005), which was moderated by retrieval-specific characteristics of the probe. No evidence for an encoding-specific effect could be found.

The general pattern of results supports the response-retrieval theory of NP. Because reaction times in the priming conditions were accelerated relative to control for response repetitions but decelerated for response-switches, we found support for the hypothesis that the response is retrieved when some aspect of the prime is repeated in the probe. Our results were obtained using a conceptual comparison task, that is, target object and word had to be compared on a semantic rather than a perceptual level. Rothermund et al. (2005) used a purely perceptual task and our findings thus extend the validity of the theory to a higher level of cognitive representation, supporting the idea expressed by Neill (2007) that episodic retrieval is the main determinant of NP in case of priming operating on perceptual and conceptual representations.

As already argued in Rothermund et al. (2005), the Response \times Priming interaction is problematic for theoretical accounts that do not take the retrieval of processing operations into account. The very general retrieval-based transfer-inappropriate processing (TIPTAP) theory (Neill, 2007; Neill & Mathis, 1998) does include response-related processing operations and is thus able to predict the interaction pattern. Dictated by Occam's razor, given two models of differing complexity it is feasible to prefer the simpler one provided that it explains the data just as well. This is the main reason why we interpret our data in favor of response-retrieval rather than transfer-inappropriate processing. Classical episodic retrieval on the other hand fails to predict the interaction pattern because it predicts the interference to occur between prime distractor and probe target.

Similar considerations apply to the inhibition theory which predicts NP effects for the DT and TD conditions independent of response-relation while only PP effects for

TT and DD should be measured. While a tendency for a facilitative effect in the DD condition is present, we fail to find such an effect for TT. We therefore argue that the main effect in the DD condition is not due to persisting inhibition but to a different mechanism. In fact, the effect has already been reported by Rothermund et al. (2005, Experiment 4). Similar to these authors who explained this finding as a consequence of the letter-matching task they used, we argue that the effect in our experiment is due to facilitated figure-ground separation: When the distractor is repeated in the same color, it is interpreted as background such that the remaining percept is better discernible, resulting in the observable speedup independent of response relation.

We observed that the magnitude of the response-repetition moderated priming effects is influenced by the role of the repeated object during probe processing, that is, retrieval-specific processing. Whenever the repeated object was the target during retrieval, the priming effect was stronger than when the repeated object was the distractor. In fact, in fine-grained analyses the interaction effect failed to reach significance for repetitions as probe-distractors (i.e., for TD and DD). These findings are in contrast to data by Frings, Rothermund, and Wentura (2007) who found facilitative and delaying effects for response-repetition and -switches, respectively, also in the DD condition. A possible explanation for these divergent results is based on the specificities of our paradigm: The distractor in our experiment was very salient (it was displayed in red) while Frings, Rothermund, and Wentura (2007) used a flanker-task with letters where distractor and target saliency did not differ as much as in our design. Because of its stronger saliency in our setup, the distractor was easily recognizable as irrelevant and did not act as a retrieval cue. Previously, it has been shown that the negative priming effect (DT) increases with distractor saliency in DT conditions, an effect coined "reactive inhibition" (e.g., Grison & Strayer, 2001). We observe here that a strong distractor can cause priming to vanish when the object is repeated as a distractor in the probe. These considerations open an interesting avenue for further research: By explicitly manipulating distractor saliency across the priming conditions, it is possible to investigate the role of the representational strength of objects in memory on the reactive inhibition effect and to further test the hypothesis of a retrieval-specific modulation of the magnitude of priming effects.

Another important result was our failure to find any modulatory effect on priming caused by encoding-specificity during prime processing. This is a rather strong argument for the validity of the response-retrieval theory in contrast to classical episodic retrieval. According to classical episodic retrieval, a clear dependency of the priming effect on the strength of the encoding of the distractor should be found, because the complete episode is retrieved and the resulting conflict between actual and retrieved episode should be correlated with its strength. However, in the response-retrieval framework the interference/facilitation caused by the retrieval of the prime response should not depend on the strength of the encoding of the prime episode. This prediction derives from the assumption that, given that the distractor is encoded sufficiently strong in the prime episode to be found, the response is encoded similarly in all conditions. This

assumption is a necessary and plausible one, since negative priming relies on the similarity between prime distractor and probe target. The lack of encoding-specific influences therefore lends further empirical support to response-retrieval as compared to classical episodic retrieval.

This argument rests on the assumption that the process of searching for matching episodes in memory is not influenced by the strength of the representation of the object. It is also conceivable that the less prominent distractor is not found as easily as the stronger target and that a delay could occur because of this more difficult search process. In this case, response-retrieval would also predict an impact of encoding-specificity. However, it is more likely that the former argument holds, because a significant modulation of speed of the memory search would imply a delay both for response-repetitions and -switches. The data however reveal an interaction with response-relation which can only occur after the retrieval has already occurred.

Empirical evidence for the lack of encoding-specific effects in NP comes also from neuropsychological research. In an experiment implementing a picture-naming task, Behrendt et al. (2010) investigated DT and TT conditions in an EEG-experiment. A main finding of their study was that the two priming conditions did not differ in early time-windows (P300) but only began to diverge later (PSW). Since DT and TT differ in the encoding of the repeated object, this indicates that stimulus-specific encoding during the prime has no influence on the priming effect as the retrieval is presumed to operate on a relatively early stage of trial processing.

The interaction in the target-to-distractor (TD) condition failed to reach significance. Previous investigations of the TD condition in the NP task (Neumann & DeSchepper, 1991) and in a visual search context (Kristjánsson & Driver, 2008) found longer reaction times compared to control trials. Note however that in these experiments there was a confound of response-repetition, as responses had to be switched in TD trials (because the target changes identity). Our failure to find these effects might be attributed to differences in distractor saliency between our and Neumann and DeSchepper's (1991) study: Because of its strong saliency in our paradigm, the distractor was easily recognizable as irrelevant and did not act as a retrieval cue thus suppressing the negative priming effect. This is also in accordance with the findings in the DD condition discussed above where no NP was found for response-switches.

In summary, using a classical NP paradigm, we found evidence for the involvement of selective response-retrieval processes: The retrieval process is apparently influenced by a flexible mechanism that is sensitive to the relevance of the repeated object with respect to the experimental task. Future work should proceed to deepen the understanding of the nature of this process. In the light of the reported results and data from Frings et al. (2007), a promising approach is the investigation of distractor saliency in combination with the priming-condition scheme used here. Given that the retrieval is sensitive to task-relevance of the stimuli, the modulating impact of the retrieval-specific processes should disappear as probe target and distractor become more difficult to distinguish. This is because the task-relevance of target

and distractor is more difficult to assess the more perceptually similar they are, causing the retrieval mechanism to use traces from episodic memory based on both target and distractor information.

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