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The effect of similarity on evaluative priming: Higher similarity predicts stronger congruency effects

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For Gören Burghardt

A fructibus eorum cognoscetis eos. (Matthew 7:16)

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Summary

The evaluative priming paradigm aims to uncover the processes underlying evaluations. For this purpose, this paradigm presents a sequence of two or more stimuli varying on the valence dimension to which participants must provide a response. The “standard” evaluative priming effect is a relative facilitation of the required responses in congruent trials compared to incongruent trials. The following thesis argues that this evaluative priming effect depends on prime-target similarity, with higher similarity between prime and target leading to larger priming effects. Part one of this thesis presents a meta-analysis of existing data, which tests evidence for the impact of similarity on evaluative priming effects. This reanalysis is based on the assumption that positive information is overall more similar to other positive information than negative information is to other negative information. Thus, this analysis compares effects of positive and negative prime-target pairs. The results confirm that (similar) positive prime-target pairs elicit stronger priming effects than (dissimilar) negative prime-target pairs. This analysis involves a broad sample of stimuli and designs which supports the generalizability of this finding. However, the results are also in line with alternative interpretations attributing the valence asymmetries to other effects caused by valence (e.g., general inhibition). The following four experiments manipulate similarity either by selecting prime-target pairs based on pre-ratings or by presenting identical and non-identical prime-target pairs. All four experiments show that similar prime-target pairs create larger priming effects than dissimilar prime-target pairs. These findings have implications for our understanding of the evaluative priming paradigm, the use of evaluative priming as a measure of attitudes, and the conceptualization of the evaluative system. These implications will be discussed.

Introduction and Theoretical Background

Every day each one of us is surrounded by hundreds of things and dozens of people. In spite of the amount of encounters, it is usually easy to tell, whether we like or dislike each of these things or persons. Evaluations (good vs. bad) come to our mind fast and effortless and can have a direct effect on behavior. Positive evaluations are linked to approach, whereas negative evaluations are linked to avoidance (Lewin, 1939; Neumann, Förster, & Strack, 2003). We approach people we like and distance ourselves from people we fear. Therefore, understanding evaluative processes is a fundamental requirement for understanding and predicting behavior.

One of the central questions regarding evaluations is whether they are made in an “automatic” fashion or “deliberately” (Fazio, Sanbonmatsu, Powell, & Kardes, 1986). This involves the questions whether evaluations require an intention or a goal to occur or whether they form in the absence of a goal. Fazio et al. (1986) argued that some (i.e., repeatedly evaluated) attitude objects, including words, pictures, or objects develop the ability to activate their respective evaluation automatically, whereas other attitude objects show no automatic evaluation. To test this prediction the authors developed the so-called evaluative priming (EP) paradigm. This paradigm consists of a series of trials, each trial starts with the presentation of a first stimulus (prime), which is followed by a second stimulus (target). Target and prime are either positive or negative. Fazio et al. (1986) instructed participants to categorize targets as “good” or “bad”. They found that responses towards targets were faster, if they were preceded by a prime of the same valence compared to when preceded by a prime of the other valence. This was termed EP effect. Thus, prime information influenced target responses. Fazio et al. (1986) argued that this effect resulted from prime evaluations, which were activated unintentionally and then influenced the classification of the subsequent target stimuli. However, it is unclear whether this influence is limited to certain conditions and if it is, to which conditions (Burghardt & Unkelbach, submitted). Bargh, Chaiken, Govender, and Pratto (1992) argued that the effects of primes are unconditional in nature and not limited to specific stimuli or specific situations (i.e., tasks). Thus, any prime should influence any target. They argued that attitude objects activate their corresponding evaluations when merely encountering them. Further, researchers assumed that this activation spreads to other attitude objects of the same valence (Fazio et al., 1986; Hermans, De Houwer, & Eelen, 1994). This conceptualization implies that a single attitude object activates a plethora of other concepts. It follows that a large amount of evaluations is always active and is activating further evaluations.

In contrast, I will argue in the present work that evaluations do not influence any other subsequent evaluation but only have an effect on evaluations of similar concepts. More precisely, this thesis presents evidence that the EP effect depends on prime-target similarity. The present thesis will thereby offer new insight into the structure of the cognitive system and evaluative processes.

These insights are interesting in their own regard but in addition they are also relevant for application. The EP paradigm is widely used as unobtrusive measure of attitudes (Wittenbrink, 2007). Researchers infer attitudes towards an attitude object (taking the place of the prime) from responses towards the target. If similarity influences EP effects than design construction should consider similarity between prime and target, which is not the case at the moment (Wentura & Degner, 2010b; Wittenbrink, 2007). Hence, evidence for the impact of similarity on EP effects could be the basis for improving implicit attitude measures.

The relevance of similarity for processing is not a new assumption instead there are many examples of how the cognitive system uses similarity to guide processing (Markman & Gentner, 2005). For instance new problems are solved based on known similar problems (e.g., Reed, Ernst, & Banerji, 1974). New exemplars, objects as well as humans, are classified as belonging to a category based on similarity to a prototype, or a previously encountered exemplar (Medin & Schaffer, 1978; Nosofsky, 1986; Rosch, 1975). In stimulus identification similar distractors interfere more than dissimilar distractors (Nosofsky, 1985). Thus, there is ample evidence that similarity influences processing. In contrast to this, many researchers assume that EP effects are not influenced by relations between primes and targets (e.g., similarity; Hermans et al., 1994). Yet, as this assumption was never explicitly tested the present thesis aims to bridge this gap.

To argue about the influence of similarity on EP effects I will first define similarity and compare different types of similarity. Subsequently, I will elaborate on the mechanisms that explain EP effects and how similarity could be implemented within these mechanisms. Following this, I will present empirical evidence regarding the relevance of similarity for EP effects. This evidence incorporates data from two sources: The first part is a meta-analysis of existing EP data; the second part presents new experimental data. The meta-analysis aims to show stronger EP effects for positive in contrast to negative prime-target pairs. As positive information is on average more similar to other positive information relative to negative information (Unkelbach, 2012; Unkelbach, Fiedler, Bayer, Stegmueller, & Danner, 2008), stronger EP effects for positive prime-target pairs provide evidence for the impact of similarity on EP effects. The meta-analysis allows testing this prediction for a large sample of different stimuli and thereby allows broad generalization. However, such a valence asymmetry in evaluative priming could be mediated by differential similarity, as I suggest, or it could be a general phenomenon of the differential processing of positive and negative information (e.g., general suppression of negative information). To disentangle the effects of valence and similarity I conducted four experiments, which manipulated similarity orthogonally to valence. In the first experiment, I selected primes and targets to create similar prime-target pairs (e.g., war and gun) and dissimilar prime-target pairs (e.g., taxes and gun) for positive and negative stimuli respectively. I predict stronger EP effects for similar in contrast to dissimilar prime-target pairs irrespective of valence. A potential critique to this experiment is that a single stimulus is either similar or dissimilar and that similarity is solely varied between valences. To overcome this critique the last 3 experiments vary similarity within the same valence. Thus, the designs include relatively dissimilar positive and negative as well as highly similar positive and negative stimuli in the same experiment. Again, I predict especially pronounced EP effects for similar prime-target pairs. Based on the results from the meta-analysis and my own empirical findings, I will discuss implications for cognitive models, for the application of EP as an attitude measure, and for evaluation in general.

Similarity

Before I turn to elaborate on effects of similarity in EP I will discuss different types of similarity and argue about the conceptualization of similarity used in this report. Similarity describes the relation between two concepts. This relation is not invariant but is context-dependent (Nosofsky, 1985). The perceived similarity of two objects for instance, depends on the entities that it is compared with. For example, a tiger and an eagle are perceived dissimilar when they are compared in the context of other animals (e.g., lion, robin, and seagull). However, when they are compared in the context of non-living concepts (e.g., chair, bottle, and skyscraper) they are perceived as more similar.

Three accounts of similarity were proposed: The Spatial view of similarity, the featural approach, and the structural alignment view (Markman & Gentner, 2005). These accounts differ both in the ways concepts are represented in memory as well as in the ways these representations are compared in order to form a similarity judgment. The spatial view of similarity represents concepts as points or vectors in a semantic space. Similarity corresponds to the distance between points or vectors. The lower the distance between two concepts the higher is the perceived similarity. This approach is often empirically implemented by multidimensional scaling where participants rate for instance, the similarity of a given pair of concepts (e.g., cat and dog) without specifying the features (e.g., four-legged) or dimensions (e.g., size) on which these concepts should be compared. Based on different mathematical algorithms the similarity ratings are used to estimate the spatial configuration of representations. Thus, it is not necessary to know whether the impression that cat and dog are similar is based on their similar size, shape, color or other features. This makes this view of similarity easy to estimate.

In contrast, the featural approach assumes that similarity is inferred from the overlap of commonalities and differences. Concepts are represented by sets of features (e.g., cat is purring, four-legged, etc.). Similarity judgments (e.g., for cat and dog) are inferred by assessing the amount of commonalities (e.g., are pets, can be stroked) and differences (e.g., purrs vs. barks) between the two concepts (Tversky, 1977). Perceived similarity increases with the number of commonalities and decreases with the number of differences. To measure similarity, relevant features of two concepts must be known.

The structural alignment view also defines concepts by features but instead of comparing features only, similarity ratings are also influenced by hierarchical structure and alignment of features (i.e., relations between features). Features are in contrast to both spatial view and featural approach not assumed to be independent. For instance, the fact that cats and dogs have offspring can be seen as a commonality, however, the fact that cats have kitten and dogs have puppies can be defined as differences (Markman & Gentner, 2005).

The structure alignment view provides a good model to assess perceived similarity (Markman & Gentner, 1993; Markman & Gentner, 2005). However, it is computationally much more intensive than spatial models: Each relation needs to be checked for correspondence to ensure that all arguments of those relations match. The spatial view of similarity does not require knowledge about the specific commonalities and differences that form the basis of the similarity judgment. Thus, it is not necessary to define whether similarity of concepts is created by for instance semantic or perceptual overlap. Therefore, I will base the following work on a spatial measurement model of similarity. Especially, I will work with an operationalization of similarity used by Unkelbach et al. (2008) who measured similarity using multidimensional scaling. They estimated similarity of concepts by averaging over all dimensions of the conceptual representation generated by multidimensional scaling. For each concept they calculated the mean Euclidean distance to all other concepts across all dimensions of the specific multidimensional model to form an index termed *density index*. High density is equivalent to high similarity of concepts, thus concepts are close to each other in “space”. In contrast, low density is equivalent to low similarity.

After defining the concept of similarity, I will now turn to the concept of associations. Like similarity, associations describe relations between concepts. The distinction between the two concepts is outlined in the following.

Associative Strength

Associations form when two concepts repeatedly co-occur (e.g., chair and table; Collins & Loftus, 1975; Moss, Ostrin, Tyler, & Marslen-Wilson, 1995). The strength of these associations is measured by the percentage of people, who report a concept in response to another concept in free association norms (e.g., Moss et al., 1995). Theoretically, associative strength clearly differs from the similarity concept. Associations do not imply similar features. However, similarity if often empirically confounded with associative strength (Hutchison, 2003). Concepts with strong associations for instance chair and table are often also similar (e.g., furniture, four legged). Because of this confound it is useful to look at studies testing for effects of associations in EP to derive predictions for effects of similarity in EP. However, the concepts are theoretically distinct.

Evaluative Priming

The evaluative priming paradigm was developed to study the structure of the cognitive system (Fazio et al., 1986). As noted above, results from EP were used to argue about the nature of evaluation. For instance, whether attitude objects must be conscious to influence processing, whether evaluation is intentional, or whether it can be controlled (Spruyt, Gast, & Moors, 2011). In the course of this research different variations of the EP paradigm were developed. These variations are captured in the working definition of EP provided by Burghardt and Unkelbach (submitted):

> In its broadest sense, EP is a sequence of two or more stimuli varying on the valence dimension to which participants must provide a response. More concretely, a positive or negative stimulus is presented (i.e., the prime) which is followed by another positive or negative stimulus (i.e., the target). Participants respond to the target, usually with an evaluative classification

> (e.g., “positive” vs. “negative”). The 2 (prime valence: positive vs. negative) x 2 (target valence: positive vs. negative) structure of an EP trial creates congruent and incongruent trials. Either prime and target have the same valence (congruent trials) or prime and target differ in valence (incongruent trials). The “standard” EP effect is a relative facilitation of the required responses in congruent trials compared to incongruent trials. Responses become relatively faster and/or more accurate. (p. 6)

This will be the working definition of the EP effect in the following thesis. Note that facilitation in congruent trials is relative in nature. This implies that EP effects can be based on response inhibition in incongruent trials as well as facilitation of responses in congruent trials. The question whether EP is better understood as facilitation or inhibition can only be assessed relative to responses to unprimed target baselines. Finding a suitable baselines proved to be impractical (see Wentura, 1999, for details). Thus, faster or more accurate responses can only be interpreted as relative differences between congruent and incongruent trials (Burghardt & Unkelbach, submitted).

Though the relevance of similarity for attention and memory retrieval is well established (see above) EP effects were argued to be unaffected by similarity (e.g., Hermans et al., 1994; Wentura, 1999). Yet, this assumption was never tested. In contrast, I argue that the similarity between prime and target influences responses in the EP paradigm. More precisely, I argue that prime-target pairs are categorized faster when they are similar. For this argumentation I will first discuss existing evidence regarding the effect of similarity in EP. Subsequently, I will outline theoretical explanations of EP and their predictions regarding similarity. In the remainder, I will provide data from a meta-analysis and 4 experiments that support the impact of similarity on EP effects.

Existing Evidence about Similarity in Evaluative Priming

It was repeatedly argued that EP effects occur for any stimulus of the same valence (Hermans et al., 1994; Wentura, 1999). Thus, similarity of prime and target should be irrelevant for EP effects. No study exists that systematically tested the impact of similarity on EP effects. However, some studies imply evidence regarding similarity. The most important study is a reanalysis of existing data (Unkelbach et al. (2008). Unkelbach et al. (2008) did not systematically vary similarity. Instead, they argued about differences in processing between positive and negative information. They assumed that similarity and valence are often confounded, with positive information being overall more similar to other positive information relative to negative information (see also; Unkelbach, 2012). If positive information is more similar than negative information and higher similarity between prime and target enhances EP effects than EP effects should be stronger for positive prime-target pairs in contrast to negative prime-target pairs. To test this, the authors conducted a reanalysis of seven articles and confirmed this assumption as EP effects were stronger for positive primes-target pairs compared to negative prime-target pairs. However, this evidence was based on the assumption that positive information is more similar to other positive information compared to negative information and therefore did not directly test the influence of similarity. Further, the analysis was based on a small sample of studies and could suffer from a biased sample.

Hermans, Smeesters, De Houwer, and Eelen (2002) showed that EP effects were not based on associations. As similarity and associations are confounded, this study can thus be seen as evidence that similarity is not relevant for EP effects. In favor of the relevance of similarity for EP effects are studies by Wentura and Degner (2010a), who showed that trait words were only creating EP effects if both prime and target were either other-relevant traits (e.g., “brutal” or “just”) or possessor-relevant traits (e.g., “intelligent” or “dull”), but not when prime-target pairs mixed both trait types. Rohr, Degner, and Wentura (2012) found that EP effects were sensitive to specific emotions and not merely to a positive-negative distinction. Both findings support the notion of specific EP effects as EP effects did not occur for any stimulus combination. Another interesting finding in this regard, is that EP effects were repeatedly absent for extreme stimuli (Glaser & Banaji, 1999). Assuming that extreme stimuli are generally very distinct from most stimuli they are often dissimilar from other concepts of that same valence. These findings are in line with the assumption that EP effects are based on similarity. In conclusion, evidence regarding the relevance of similarity is sparse and inconclusive. To understand why and how similarity could affect EP effects I will now outline processes underlying EP effects.

Explanations of Evaluative Priming

The following section outlines two broad theories that are most prominent in the EP research field, namely spreading activation and response competition. Further I discuss three minor accounts to explain EP effects because of their potential relevance for the effect of similarity on EP. Each section discusses an account and what assumption it makes about the effect of similarity on EP effects.

Spreading activation. The earliest explanation of EP is based on spreading activation (Fazio et al., 1986). There are many different conceptualizations of spreading activation accounts, the major three accounts are outlined below. Albeit the difference between these accounts the basis of spreading activation is always the same: Humans represent all concepts they know in memory. The models differ regarding the organization of these memory models. The first models termed *symbolic* networks represent each concept by a single node (e.g., there is a node for the concept kitten; Bower, 1981; Collins & Loftus, 1975). The different nodes are interconnected (e.g., kitten is connected to furry, purr and cat). The connections between nodes vary in strength or weight depending on associations or semantic relations between concepts (Collins & Loftus, 1975). For instance, kitten has a strong connection to the concept dog, whereas the connection between kitten and Hawaii is weak.

The second models termed *parallel distributed* models represent concepts by patterns of activation across a collection of processing units (Masson, 1995; McClelland, Rumelhart, & the PDP research group, 1986). Concepts are identical to specific combinations of different features (e.g., kitten is purring, four-legged, etc.; Hutchison, 2003). In both cases encountering an instance of a concept (e.g., a word or a picture of a kitten) activates its representation in memory. This activation then leads to the activation of other concepts. In symbolic networks the activation spreads from one concept node (e.g., the concept kitten) to other related nodes (e.g., to the concepts dog or cat). Thereby, other concepts (e.g., dog) are co-activated with the original concept (e.g., kitten). In parallel distributed networks related concepts have overlapping patterns of activation. Thus, the concepts dog and kitten share a similar pattern (e.g., pet, four-legged, etc.), whereas the patterns of kitten and Hawaii differ a lot (e.g., pet vs. island). In sum, the activation of one concept leads to the (partial) activation of connected concepts either by strong links or similar patterns. If subsequently one of these activated concepts appears as target it is identified or processed faster than without pre-activation. That is how responses towards a target are facilitated when a connected or similar prime was presented.

Hence, the two networks models both represent similarity. Similar concepts have stronger connections or more strongly overlapping patterns (Collins & Loftus, 1975; Hutchison, 2003). It is plausible to assume that when prime and target are more similar the target is activated more strongly. However, many researchers assume that EP effects should occur for all concepts of the same valence (Hermans et al., 1994). To allow for this prediction they argued that all concepts of a specific valence are connected by a valence node (e.g., Bower, 1981). They assumed that a concept activates the evaluation associated with it (Fazio et al., 1986; Hermans et al., 1994). The activation than spreads to all concepts of the same valence (Hermans et al., 1994; Wentura, 1999). This conceptualization does not imply effects of similarity; instead all concepts of the same valence will be activated irrespective of their feature overlap or specific connections. A given prime (e.g., kitten) will thus activate the concept positive which will in turn activate similar concepts such as baby as well as dissimilar concepts such as Hawaii. As a result all positive concepts will be activated, which will then enable response facilitation. However, if the EP effect does depend on similarity another conceptualization is possible. Instead of assuming that all concepts of the same valence are activated it is also possible to assume that only similar concepts are activated. Thus, activation arises only when concepts are strongly connected or have strongly overlapping patterns. No pre-activation and no response facilitation will occur for dissimilar concepts even when they have the same valence.

Both the symbolic network and the distributed network model described above locate the EP effect at the level of specific targets. The target concept (e.g., baby) itself is activated. However, a third conceptualization of spreading activation was proposed which assumes that not target concepts but only valence categories are pre-activated (Fazio, 2001). Instead of spreading to all concepts of the same valence activation spreads solely to the valence concepts (i.e., positive or negative). This facilitates positive or negative responses as the valence concept is pre-activated. Thus, a given prime such as kitten activates the concept positive and no other concept. This implies that similarity of primes and targets is irrelevant. Primes will always activate its respective valence category as long as the prime is not ambiguous. This model was proposed in response to the inability to find EP effects in other than the evaluative decision task (Klauer & Musch, 2002; Klinger, Burton, & Pitts, 2000; Rothermund & Wentura, 1998). This was a surprising finding, as it was argued that if a specific target is pre-activated all responses towards this target should be facilitated (e.g., De Houwer, Hermans, Rothermund, & Wentura, 2002; Rothermund & Wentura, 1998). If a concept (e.g., kitten) is activated this should facilitate all responses towards this concept, for instance, pronouncing the word kitten, deciding whether kitten is a word or not, or categorizing it as an animal. Empirically, this prediction could not be confirmed. EP effects were often absent when other responses than the standard evaluative decision task (positive or negative) were required (De Houwer et al., 2002; Klauer & Musch, 2001, 2002).

In conclusion, different models of spreading activation were proposed that can but do not have to imply effects of similarity. Symbolic and parallel distributed network models are well suited to incorporate effects of similarity. However, researchers did not consider them.

Response competition. The most important alternative explanation to spreading activation is called response competition. This account was also proposed based on the finding that EP effects were repeatedly absent with other tasks than the evaluative decision task (Klauer & Musch, 2002; Klinger et al., 2000; Rothermund & Wentura, 1998). Accordingly, a specific aspect of the evaluative decision task creates EP effects without spreading activation being involved. The evaluative decision task confounds the valence dimension (i.e., the dimension of the EP effect) with the dimension on which the response towards the target is made. In congruent trials both prime and target have the same valence and require the same response. In incongruent trials primes and targets differ in valence as well as in the required response. Thus, it is unclear what causes the EP effect: The identical responses or the identical valence. To explain the EP effect it is assumed that participants generalize the task towards the target (i.e., evaluation) to the prime (Burghardt & Unkelbach, submitted). When a prime (e.g., kitten) appears it activates a response (e.g., press key labeled positive), when the target is congruent (e.g., baby) the activated response can be enacted. In case of an incongruent target (e.g., war) the response to the prime must be inhibited because it is incorrect. Therefore, responses in incongruent trials are slower and more error-prone than responses in congruent trials. The EP effect is thus explained by different responses activated in incongruent trials, no target concept is activated.

Response conflict can operate on two levels: On a motor response level or on a conceptual level. Motor response interferences stems from the movement of the response (e.g., key press) which either does (incongruent trials) or does not compete (congruent trials) with target response. Prime and target are processed independently up to response selection stage at which responses interact (Klauer, Musch, & Eder, 2005). On the conceptual level, response conflict already results at the stage of categorizing the target as either positive or negative. In congruent trials both prime and target either activate the concept positive or the concept negative. In contrast, in incongruent trials the prime activates for instance the concept positive but the target activates the concept negative.

Irrespective of the concrete conceptualization of response competition the EP effect is caused by same or different responses. This implies that similarity between prime and target cannot be relevant for EP effects as only the link between concepts and responses matter. Finding effects of similarity in the EP paradigm would therefore also challenge response competition accounts. Thus, tests of similarity provide a test of the major accounts to explain EP effects. In addition to these major accounts three other accounts were proposed to explain EP effects, which are outlined below.

Evaluation window account. The evaluation window or psychophysical account again assumes that EP effects originate from processes at the conceptual level of valence categories (Klauer, Teige-Mocigemba, & Spruyt, 2009). The account is an overarching model for judgment processes in categorization tasks with a small number of answer categories and with speeded responses that limit the possibility for complete information processing. Though it is based on response competition, it also applies to spreading activation at the level of valence categories, labelled “valence counter” by the authors. The model assumes that a valence counter is continuously keeping track on evaluative input from the environment. When a positive or negative response is required, evidence is accumulated until a threshold is reached in favor of either a positive or a negative response. The prime’s influence on target responses depends on EP timing, prime extremity and context. Prime information is discounted if it is too distant or too extreme to be relevant for target judgments. Thus, there are cases when prime information is not used as evidence in the evaluative decision about the target. However, an effect of similarity was not incorporated in the account. The impact of a specific prime depends on the ease by which it is categorized as positive or negative. As long as a prime activates unambiguous categorizations as positive and negative its influence does not depend on prime-target similarity. Finding similarity effects on EP effects would therefore also challenge the evaluation window account.

Compound cue models. Ratcliff and McKoon (1988) presented a retrieval account of semantic priming in memory. This account assumes that prime and target are processed in unity by forming a compound cue. This compound cue is tested against memory. If a compound is familiar, it cues strong responses from memory. Ratcliff and McKoon (1988) assumed that a compound is familiar when prime and target are associated; directly (e.g., table and chair) or indirectly (e.g., lion and stripes via tiger; McKoon & Ratcliff, 1992). Fockenberg, Koole, and Semin (2008) introduced a compound cue model to the EP paradigm. They argued that primes and targets are combined into a compound (they term it snapshot) because of their temporal proximity. If compounds do not yield enough congruent information for the required response (e.g., evaluative decision) they will be split into distinct prime and target information which is then be analyzed separately. Prime information can be discarded, for instance, if it is extreme or temporally distant. Ratcliff and McKoon (1988) argued that associated prime-target pairs form strong compound cues. However, associations and similarity are often confounded (Hutchison, 2003) thus it is also possible to argue that similar prime-target pairs will form strong compound cues, which will activate strong responses from memory and thus facilitate responses. If prime and target form a coherent compound cue they will enable fast and accurate responses. Thus, this account can imply faster responses for similar prime-target pairs.

Affective matching hypothesis. The affective matching hypothesis assumes that prime and target undergo a spontaneous check for affective consistency (Klauer & Stern, 1992). In case of affective consistency, an affirmative response is triggered. This response than facilitates congruent responses. For example, when the prime-target pair presented is kitten and baby this creates a feeling of consistency and facilitates a “yes”, “correct” or “positive” response. Predictions of the affective matching hypothesis are limited to response tasks that have affirmative nature, especially the evaluative decision task, where participants decide whether a target is positive or negative. The affective matching hypothesis does not make assumptions about similarity. However, it could be argued that similar prime-target pairs also lead to a feeling of consistency and therefore facilitate affirmative responses. As a consequence similar prime-target pairs would facilitate “positive” or “good” responses but inhibit “negative” or “bad” responses. Thus, affective matching can predict similarity effects but would imply an asymmetric effect depending on valence.

Summary. There are three accounts that can incorporate effects of similarity on EP effects: spreading activation, compound cue and affective matching accounts. In contrast, response competition, the major alternative to spreading activation, cannot explain effects of similarity. The same is true for the evaluation window account. Thus, the question whether similarity influences EP effects enables theory testing. Despite this important contribution, effects of similarity were never systematically tested in the domain of EP effects.

The present thesis strives to bridge this gap. To do so my thesis will follow two lines on research. In the first section I will follow up on the research by Unkelbach et al. (2008) who reanalyzed existing EP studies for valence asymmetries, based on their notion that positive and negative information differs in similarity. The first part of my thesis will test whether their basic finding replicates with a broader set of studies. Thus, I will test whether EP effects are stronger for positive (i.e., similar) prime-target pairs in contrast to negative (i.e., dissimilar) prime-target pairs relative to their respective incongruent prime-target pairs. In the second section I will present data from 4 experiments that provide primary evidence for similarity effects on EP effects.

Meta-Analysis of Evaluative Priming

As previous research on EP did not systematically manipulate similarity, the meta-analysis cannot directly test the impact of similarity. Instead, evidence is based on the assumption that positive information is on average more similar to other positive information relative to negative information (Unkelbach, 2012; Unkelbach et al., 2008). This could be based on a higher need to differentiate between different negative stimuli than to differentiate between positive stimuli. Different negative stimuli require specific responses (e.g., fight an attacker or spit out spoiled food) and ignoring these differences has high costs for the organism (Peeters & Czapinski, 1990; Rozin & Royzman, 2001). Irrespective of the cause for this difference in similarity, the implications are clear cut. If positive information is more similar to other positive information and negative information is more diverse and higher similarity between prime and target enhances EP effects, than EP effects should be stronger for positive prime-target pairs in contrast to negative prime-target pairs. Unkelbach et al. (2008) confirmed this assumption in a reanalysis of seven articles. EP effects were stronger for targets following positive primes compared to targets following negative primes. The major shortcoming of this finding is that it is based on a small sample of studies that are not representative of EP research. Further, they might not include a big variety of stimuli and therefore results might not generalize to other stimuli. The first step of this thesis will therefore be to replicate the finding of stronger EP effects for positive congruent trials compared to negative congruent trials by Unkelbach et al. (2008) with the full sample of EP studies in a meta-analysis. Thus, I will test for valence asymmetries in EP effects.

Method

The data presented in this section is a subsample of a dataset collected for a general meta-analysis of EP effects (Burghardt & Unkelbach, submitted). This general meta-analysis included 93 articles with 434 effect sizes. For this thesis the sample is reduced to include only experiments providing data on valence asymmetries in EP. Thus, the sample is reduced to experiments that report EP effects separately per valence. More precisely, the selection process was identical except for criteria 8a and 8b (see below).

Selection of studies. To find all studies using the EP paradigm I retrieved all articles from the PsychInfo database citing the original work by Fazio et al. (1986) and all articles using the terms “affective priming” or “evaluative priming“ in their abstracts published until March 2010. To identify the relevant studies I defined the evaluative priming paradigm as an approach that consists of the presentation of two or more discrete stimuli in a short temporal order. The paradigm requires participants to respond to one stimulus by categorizing, recognizing, pronouncing, by naming it.

Inclusion and Exclusion Criteria. I excluded experiments based on theoretical assumptions and practical requirements. The central inclusion criterion was that an experiment had to adopt an EP paradigm but not used as a measure of prime valence (see below). I excluded studies based on the following criteria.

1. Only peer-reviewed journal articles.

I excluded all books and book chapters, mainly due to the fact that many chapters present studies also reported in published journal articles.

2. The articles contain data about a sequential priming paradigm with two or more discrete stimuli in a short temporal order.

This excludes all reviews, theoretical contributions as well as any study design that did not use primes (e.g., questionnaires or the implicit association test (IAT)).

3. Languages: English and German.

I excluded articles in languages in which I am not proficient (e.g., Chinese).

4. Prime and target vary on the valence dimension; both positive and negative stimuli must be included.

This excludes studies with similar paradigms, especially semantic, conceptual, or repetition priming. Further, I excluded studies that only presented neutral and positive, or neutral and negative stimuli (Hinojosa, Carretié, Méndez-Bértolo, Míguez, & Pozo, 2009; Hock & Egloff, 1998; Miles & Johnston, 2007; Ode & Robinson, 2009; Ortigue, Bianchi-Demicheli, de C. Hamilton, & Grafton, 2007), because they do not represent the full range of the valence dimension. This criterion also excludes studies applying the affect misattribution paradigm (Payne, Cheng, Govorum, & Stewart, 2005), because only neutral targets are presented.

5. Prime and target valence are known by pretest or individual selection by participant.

This excluded studies that use EP as measure of prime valence; in these cases, prime valence was inferred from responses towards targets and was not predetermined. Such studies are not informative, because the absence of EP effects might reflect the correct measurement of a non-existing attitude. This criterion further led to the exclusion of studies where prime valence is based on additional assumptions about effects of certain manipulations, for example, valence transfer by evaluative conditioning (Abrams & Greenwald, 2000; De Houwer, Hermans, & Eelen, 1998; Hermans, Spruyt, & Eelen, 2003; Hermans, Vansteenwegen, Crombez, Baeyens, & Eelen, 2002; Spruyt, Hermans, De Houwer, & Eelen, 2004), goal relevance of primes (Moors & De Houwer, 2001; Moors, De Houwer, & Eelen, 2004;

Moors, De Houwer, Hermans, & Eelen, 2005), approach and avoidance behavior (Rotteveel & Phaf, 2004), mood (Clark, Teasdale, Broadbent, & Martin, 1983; Erber, 1991; Hermans, De Houwer, & Eelen, 1996), or feedback (Rothermund, 2003). This was done to ensure that EP null effects are not due to the incorrectness of these additional assumptions (e.g., unsuccessful evaluative conditioning).

6. Prime and target must be separable stimuli.

The criterion of separation of prime and target led to the exclusion of studies that embedded the target in the prime, namely studies that used videos as primes and integrated the targets as pictures popping up in these videos (Kivikangas & Ravaja, 2009; Ravaja, Kallinen, Saari, & Keltikangas-Jarvinen, 2004). I introduced this criterion because the prime-target integration does not provide the possibility to determine the temporal distance between prime and target.

7. Only non-clinical samples.

I excluded studies using clinical samples, as participants with clinical disorders might differ in regard to their evaluations and response latencies from non-clinical participants. However, I included studies that use non-clinical participants, but incorporate clinically relevant traits, for example, anxiety (Hermans, Spruyt, De Houwer, & Eelen, 2003), or alexithymia (Suslow, Arolt, & Junghanns, 1998).

In the last stage I excluded studies that did not provide the necessary data for effect size estimates. To maximize the number of included effect sizes I conducted two separate analyses: One based on standardized effect sizes and one based on unstandardized effect sizes (for details, see below). These two analyses created the need for two different selection criteria (8a and 8b).

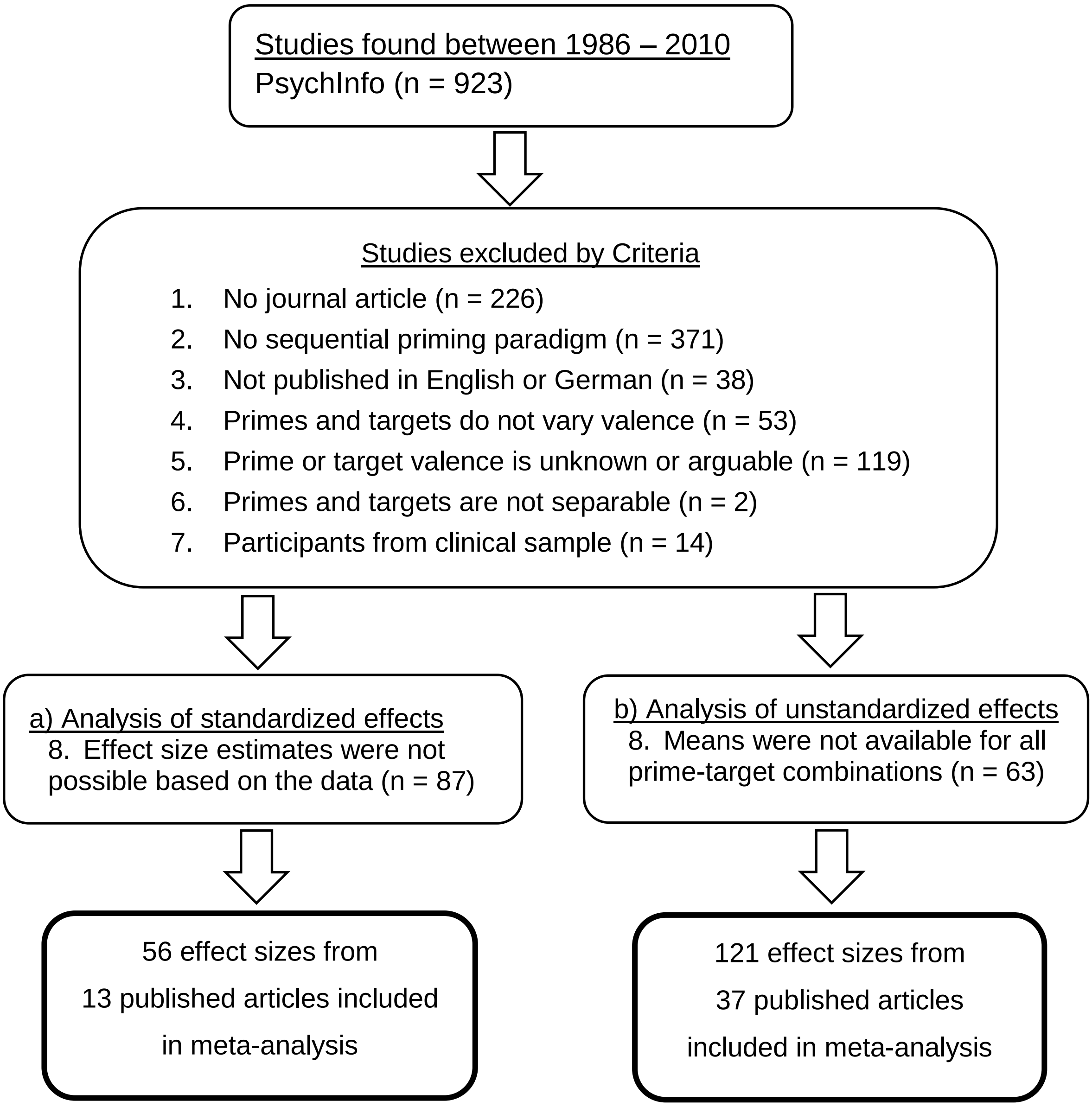

Figure 1. Flowchart of the total number of studies identified (top), excluded by criteria (middle), and accepted in the analyses (bottom).

8a) Estimation of standardized effect sizes are possible.

Means and standard deviations or standard errors were available for all four prime valence target valence combinations (negative primes with negative targets (P-T-), negative primes with positive targets (P-T+), positive primes with negative targets (P+T-) and positive primes with positive target (P+T+)). Standard deviations were not estimated from graphs because of low accuracy.

8b) Response latencies for all four prime valence target valence combinations were available (i.e., unstandardized effect size estimates are possible)

In sum, these criteria led to the inclusion of a wide variety of EP studies. Figure 1 details the study selection process.

Coding. Coding of effects was done by 13 trained research assistants, Christian Unkelbach, and the author using a scoring manual. All effect sizes were double coded by the author. Inconsistencies between the author and coders were resolved through discussion.

Data preparation. There are two different ways to estimate EP effects per valence. Effects can be estimated based on unstandardized or standardized measures (Bond, Wiitala, & Richard, 2003). To ensure that results do not depend on the estimation method I will report both a) standardized and b) unstandardized analyses. The standardized analysis is based on Cohen's d as effect size measure (Borenstein, 2009; Cohen, 1988). The unstandardized analysis is in the raw metric of ms. In both cases I collected mean response latencies from the four different trial types: positive prime positive target (P+T+), positive prime negative target (P+T-), negative prime negative target (P-T-), and negative prime positive target trials (P-T+). To obtain as many effects as possible I included response latencies per condition per experiment. If data was not available per condition, the effect was calculated per experiment instead. Thus, some experiments are included with one effect size per experiment and others are included with more than one effect size per experiment. In cases where experiments report both response latencies and error rates only response latencies were included in the analyses. Regarding the analysis with standardized effect sizes no experiment with error rates reported all information necessary for the estimation; thus leaving only response latency data. Further, I limited the analysis with unstandardized estimates to include only response latency data to keep all effects in the same metric. As a result all analyses are based on response latency data.

Analysis of standardized effects. Mean effects were standardized using standard deviations for all prime valence-target valence pairs. Standard deviations were also calculated from standard errors. Yet, standard deviations were only available for the calculation of 56 effect sizes, which are thus the basis of the analysis of standardized means. Cohen's d was calculated based on standard deviations and means (Cohen, 1988) using Formula 1 for repeated measurement designs:

$$\mathrm{d} = \frac{\mathrm{M_1} - \mathrm{M_2}}{\mathrm{SD_{Within}}} \tag{1}$$

The mean standard deviations were calculated with the following formulas.

$$\mathrm{SD_{Difference}} = \sqrt{(\mathrm{SD_1^2} + \mathrm{SD_2^2} - 2 * \mathrm{r} * \mathrm{SD_1} * \mathrm{SD_2})} \tag{2}$$

$$\mathrm{SD_{Within}} = \frac{\mathrm{SD_{Difference}}}{\sqrt{2(1-\mathrm{r})}} \tag{3}$$

Note. $SD_{Difference}$ = standard deviation of the difference score in a within-subject design; SD_{Within} = standard deviation within groups; M_1 = mean response latency of incongruent trials; M_2 = mean response latency of congruent trials; r = correlation of dependent the measures (i.e., congruent and incongruent trials); d = Cohen’s d; n = number of participants; SD_1 = standard deviation of congruent trials; SD_2 = standard deviation of incongruent trials; adapted from Borenstein (2009, p. 229).

Effect sizes were not estimated from t, F or p-values because they were never available for both prime valence and target valence effects. As can be seen in Formula 3 the calculation of the within-group standard deviation (SD_{within}) requires an estimate of the mean correlation between dependent measures, in this case the correlation between responses latencies in congruent and in incongruent trials. This correlation corrects the estimate of the population effect size for the effects of a dependent measurements design. The dependent measurements design limits the standard deviation relative to an independent design and leads to an underestimation of the deviation in the population. Thus, the correlation is necessary to obtain a valid effect size estimate from dependent measurements (Dunlap, Cortina, Vaslow, & Burke, 1996). However, no article reported correlations between congruent and incongruent trials. Therefore, I estimated this correlation. For this purpose, I contacted 9 authors of recent studies. Four authors sent data from a total of 31 conditions based on responses latency data. The corresponding effect sizes originate from the first experiment from Fockenberg, Koole, and Semin (2006), Frings and Wentura (2008), and Spruyt, Hermans, De Houwer, Vandromme, and Eelen (2007) and from the third experiment from Klauer et al. (2009), which was the first experiment of this study with only one prime. Following Fisher Z-transformation, averaging and retransformation, the estimated mean correlation between mean response latencies in congruent and in incongruent trials was $r = .93$. This mean correlation entered the Formulas 2 and 3.

In addition to providing an estimate of average effect sizes, this analysis also provides an estimate of publication bias. Publication bias is a potential threat to the validity of meta-analyses (Rosenthal & DiMatteo, 2001). As non-significant results tend to be unpublished the data of published studies can be biased to include significant results more often than non-significant results. This leads to an overestimation of population effects. To estimate the impact of publication bias on the data I will report Kendall’s tau (Begg & Mazumdar, 1994). Kendall’s tau is the correlation between effect sizes and standard errors of the effect sizes. It provides an estimate of the size and direction of publication bias. Samples with strong publication bias show high (significant) correlations, whereas samples without publication bias shows a (non-significant) correlation around zero, In the absence of a publication bias, effect sizes with high standard error (i.e., small samples) are randomly distributed around the population effect size, thereby creating a correlation of zero.

The standardized analysis were based on a SPSS syntax for meta-analyses by Field and Gillett (2010) adjusted for repeated measurement (Borenstein, 2009). It provides an estimate of the average effect weighted by the inverse variance.

***Analysis of unstandardized effects*.** Calculations based on unstandardized effects stay in their original metric and require no data about standard deviations (Bond et al., 2003). Because means are being reported more often than means plus the corresponding standard deviations, the analysis of unstandardized effects was based on markedly more data. It yielded 121 effect sizes. I followed the analysis proposed by Unkelbach et al. (2008). My analysis was based on two formulas. Formula P1 tested for target valence effects; it compares mean responses for positive and negative targets. Formula P2 tested for prime valence effects; it compares the effect of positive and negative primes.

$$[(P{+}T{-}) - (P{+}T{+})] – [(P{-}T{+}) - (P{-}T{-})] > 0 \qquad (P1)$$

$$[(P{-}T{+}) - (P{+}T{+})] – [(P{+}T{-}) - (P{-}T{-})] > 0 \qquad (P2)$$

Note. P+T- = positive primes negative targets; P+T+ = positive primes positive targets; P-T+ = negative primes positive targets; P-T- = negative primes negative targets; adapted from Unkelbach et al. (2008)

Description. The analyses of standardized and unstandardized effects were based on different samples. Relatively few data was available for the analysis of standardized effects (56 effect sizes), whereas the analysis for unstandardized effects provided about twice as much data (121 effect sizes).

The analysis of standardized effects relied mainly on student samples (98%). Most participants were English speaking (36%), followed by German speaking (34%). The remaining data was from participants speaking French (14%), Dutch (7%), Spanish (2%), Finnish (4%), and Italian (4%). The most frequent response task was the evaluative decision task (63%). Other response tasks were the naming task (18%) and the lexical decision task (20%; where participants decide whether the target is a word or a non-word).

The majority of effect sizes analyzed used word primes (68%) and word targets (93%). Other primes were faces (14%), pictures (11%), and sounds (7%). Targets also included faces (7%). Stimulus-onset asynchrony (SOA), which is the time between prime onset and target onset ,varied between 71 and 1000 ms, with a mean SOA of 348 ms (SD = 343 ms). In contrast to the standard EP paradigm (see Burghardt & Unkelbach, submitted) most effects relied on data with more incongruent than congruent trials. This is captured by a congruency proportion (CP) smaller than .5 for 61% of the included effects and equal to .5 for 34% of the included effects.

As more data was available for the analysis of unstandardized effects, the data includes a broader variation of EP designs. Nevertheless, mostly students participated (97%). Again, most participants spoke English (55%), followed by German (30%), Dutch (7%), French (3%), Finnish (2%), Italian (2%), Spanish (1%), and Polish (2%). Again, the evaluative decision task was the most frequent task (71%). The sample also included data from dual tasks (3%), which combine more than one type of response to the same target, and data from a recognition task (2%).

Further, naming task (15%) and lexical decision task (9%) were included. As in the analysis of standardized effects primes and targets were mostly words (81% and 93%, respectively). Again, primes included faces (3%), pictures (8%), and sounds (3%). Further, primes included prosody (3%), odor (1%), and flavor (1%). Targets included pictures (2%), faces (5%), and prosody (1%). The high variability of stimuli in this analysis is especially important to ensure that results are not limited to a small set of stimuli (e.g., only words), but do generalize. SOA varied between -100 and 10000 ms with a mean SOA of 457 ms (SD = 962). The most frequent SOA was 300 ms. Again, CP was often smaller than .5 (in 55% of all cases) compared to an equal CP of .5 (only in 33% of all cases).

Results

Results are presented separately for standardized and unstandardized analyses.

Analysis of standardized effects. In the following, I will report results from standardized analysis to estimate the impact of valence on the EP effect. Each estimate calculates the EP effect of a congruent prime-target pair relative to an incongruent prime-target pair. There are four possible combinations of these comparisons, which are all reported below. The EP effect of positive prime positive target pairs (P+T+) is compared to both positive prime negative target (P+T-) and negative prime positive target pairs (P-T+). The EP effect of negative prime negative target pairs (P-T-) is compared to both positive prime negative target (P+T-) and negative prime positive target pairs (P-T+). This, results in an estimate of EP effects per prime valence and per target valence (cf. Formula P1 and P2).

Evaluative priming effects for positive primes. Positive congruent prime-target pairs (P+T+) were reliably faster than negative prime positive target (P-T+) pairs, the average EP effect was $d = 0.15$ (95% CI = [0.10, 0.19]), this was significantly different from zero ($z = 6.89$, $p < .001$). There was no evidence of publication bias (Kendall's tau = .07, $p = .43$). The difference between positive congruent prime-target pairs and positive prime negative target pairs (P+T-) was even more pronounced: Here, the average EP effect was $d = 0.34$ (95% CI = [0.26, 0.42]); this effect was again significantly different from zero ($z = 8.52$, $p < .001$). There was no evidence for publication bias (Kendall's tau = .02, p = .84).

Evaluative priming effects for negative primes. Negative congruent prime target pairs (P-T-) showed reliable EP effects, when compared to positive prime negative target pairs (P+T-): Here, the average EP effect was $d = 0.11$ (95% CI = [0.07, 0.15]). Again, this effect size was significantly different from zero ($z = 4.92$, $p < .001$). There was no evidence for publication bias (Kendall's tau = .08, $p = .37$). Negative congruent prime-target pairs showed a reversed EP effect relative to negative prime positive target (P-T+) trials ($d = -\ 0.09$, 95% CI = [-0.17, -0.02]). This effect was significantly smaller than zero ($z = 2.35$, $p = .019$). Thus, responses in incongruent trials were faster than responses in congruent trials. Again, there was no evidence for publication bias (Kendall's tau = -.06, $p = .50$).

In summary, positive congruent prime-target pairs always showed EP effects. The EP effect was larger when comparing to incongruent trials with negative targets (P+T-). This is in line with a slowdown by negative targets. Negative congruent trials showed a reversed EP effect when compared to incongruent trials with positive targets (P-T+). However, negative congruent trials showed the standard EP effect when compared to incongruent trials with negative targets (P+T-). Thus, the difference between congruent and incongruent prime-target pairs was bigger when compared to trial with negative targets (P+T-). In conclusion, this analysis showed clear evidence for valence asymmetries. Positive stimuli created reliable and larger EP effects than negative stimuli. Differences between positive and negative targets were more pronounced than differences between positive and negative primes. No analysis showed indications of publication bias.

Analysis of unstandardized effects. The second analysis used unstandardized raw means. Figure 2 shows the average response latencies separately for each combination of prime valence and target valence. Visual inspection confirms that positive congruent prime-target pairs (P+T+) evoke the fastest responses. Responses in negative congruent prime-target pairs (P-T-) are faster than responses in incongruent pairs with positive primes (P+T-), but slower than responses in incongruent pairs with negative primes (P-T+). Thus, EP effects do not lead to the same facilitation for positive and negative congruent trials. Following the analysis by Unkelbach et al. (2008), I report two estimates for target and prime valence effects. Formula P1 (see above) calculates differences between responses towards positive and negative targets. Formula P2 (see above) calculates differences between responses following positive primes compared to responses following negative primes. In accordance with prior findings, P1 showed that responses on negative targets were on average 66.95 ms ($SD = 70.74$) slower than responses on positive targets. This difference deviated significantly from zero ($t(120) = 10.41$, $p < .001$). P2 showed that responses after positive primes were on average 9.61 ms ($SD = 42.26$) faster than responses following negative primes ($t(120) = 2.50$, $p = .014$). Thus, these unstandardized differences mirror both the findings of the standardized results as well as the findings by Unkelbach et al. (2008). EP effects differ for negative and positive stimuli. Target valence has stronger impact than prime valence.

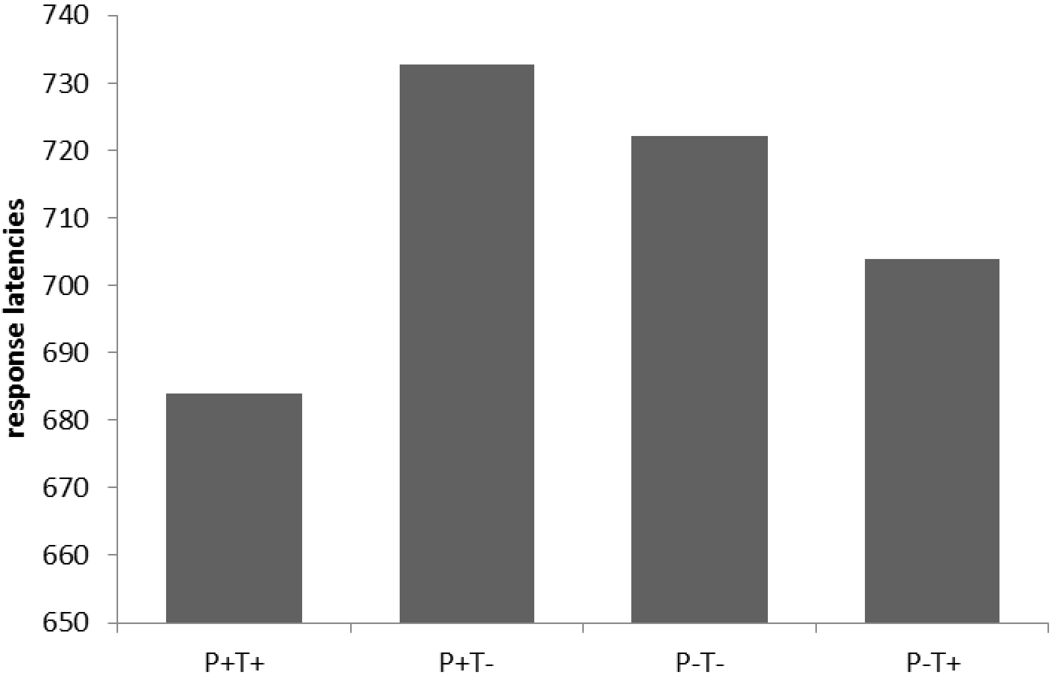

Figure 2. Mean response latencies to all four combinations of prime valence target valence pairs.
Note. P = Prime; T = Target, + = Positive valence, - = Negative valence. Adapted from "A meta-analysis of sequential affective and evaluative priming: Effects, theories and applications" by J. Burghardt and C. Unkelbach, submitted.

Discussion

The two analyses show matching patterns of results. Thus, the type of analysis has no impact on results and conclusions. The results confirm the existence of valence asymmetries in EP effects. There is no evidence of publication bias, which supports the validity of the findings. The data is based on a broad sample of stimuli, which supports the notion that valence asymmetries are a general phenomenon. Moreover, the findings fit into the broader literature of valence asymmetries in categorization, description, and evaluation (Peeters & Czapinski, 1990; Rozin & Royzman, 2001). Further, the findings replicate the reanalysis by Unkelbach and colleagues (2008). Both, the standardized and the unstandardized analysis show that the differences between congruent and incongruent trials (i.e., EP effect) are larger for positive congruent pairs than for negative congruent pairs. Thus, the overall EP effect is mainly driven by positive prime positive target pairs (P+T+); in contrast to negative prime negative target pairs (P-T-). The analysis of standardized effects suggests that EP effects can reverse for negative congruent trials. Both analyses show that target valence has stronger impact on results than prime valence.

These results imply faster responses towards positive stimuli compared to negative stimuli. Thus, they contradict the view that negative stimuli enable faster responses (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Hansen & Hansen, 1988; Taylor, 1991). The results are in line with two interpretations: Either responding to positive stimuli is facilitated or responding to negative stimuli is inhibited. However, as the comparison between congruent and incongruent trials is relative in nature and no baseline measure of “neutral” responses is available, it is not possible to determine whether positive information facilitates processing or negative information hinders responding. Thus, both interpretations are in line with the findings. The following paragraph outlines the processes that could underlie the valence asymmetries in evaluative priming.

Given the wide variety of stimuli used, it seems highly unlikely that the results are caused by specific features of the stimuli considered in this meta-analysis. Thus, the differences should result from general processes. There are three different explanations in terms of processes that could explain the data. First, Unkelbach et al. (2008) argued for a fundamental valence asymmetry in the information environment that also moderates EP effects (Unkelbach, 2012). Unkelbach et al. (2008) postulated that positive information is on average more similar to other positive information, whereas negative information is more diverse. The differential density of positive and negative information explains the observed asymmetry using various EP mechanisms. First, via spreading activation in symbolic networks (Fazio et al., 1986), density indicates stronger connections between positive than between negative concepts. In parallel distributed models (Masson, 1995), higher density indicates stronger overlap between positive patterns compared to negative patterns. Second, via response conflict (Klinger et al., 2000), a core valence pattern might exist which can be the basis of the evaluative categorization. Whereas positive valence consists of a single core pattern, negative valence might have different patterns, for example, one that codes disgust and one that codes anger and so forth. Thus, within congruent negative trials, no response facilitation might arise between pain and disgust, although both are negative.

Irrespective of the theoretical model to explain valence asymmetries (spreading activation or response competition), if similarity mediates EP effects, then the results support differential similarity of positive and negative information for a huge range of stimuli, implying that positive information is on average more often similar to other positive information than negative information is similar to other negative information (Unkelbach et al., 2008).

Second, the observed asymmetry could be due to an affective matching process (Klauer & Stern, 1992). The authors argued that prime and target are checked for consistency. When prime and target are congruent this leads to a positive outcome of this check (e.g., baby and kitten fit), which leads to a feeling of plausibility. A positive result of the consistency/ plausibility check leads to an affirmative response (i.e., positive). This process was proposed in addition to a spreading activation process, but is also compatible with response competition. Thus, a positive prime positive target pair induces response facilitation via spreading activation or response competition and additional facilitation of the response “good” or “positive” based on a feeling of plausibility. In contrast, negative prime negative target pairs imply facilitation via spreading activation or response competition, again the plausibility check leads to an affirmative (i.e., positive) response that is now conflicting and thus needs to be inhibited. The plausibility feeling can be conceptualized as a fluency phenomenon (Unkelbach & Greifeneder, 2013) that goes along with a positive notion, which is conflicting with the “negative” response required by negative congruent word pairs like pain and disgust.

The third explanation assumes general inhibition of processing of negative stimuli (e.g., Suslow, Ohrmann, & Arolt, 2001) or stronger distraction by negative stimuli (Baumeister et al., 2001; Rothermund, Gast, & Wentura, 2011) combined with facilitated processing of congruent trials. These assumptions can also be implemented in different models, for instance in spreading activation accounts. In other words, negative stimuli are either suppressed (e.g., “perceptual defence”; McGinnies, 1949) or receive deeper processing before the ongoing task is proceeded (Baumeister et al., 2001; Rothermund et al., 2011). These assumptions explain the data as follows: Positive congruent trials (P+T+) are facilitated because of their congruency and the absence of negative information. Incongruent trials (P+T- & P-T+) are inhibited because they are not congruent and they both contain one negative concept, which slows down responses. Congruent negative trials (P-T-) are facilitated because they are congruent and inhibited because they contain two negative concepts. They are equally fast as incongruent trials if the inhibition by a second negative concept is approximately as strong as the facilitation by congruency.

The fact that negative prime positive target trials (P-T+) are faster than positive prime negative target trials (P+T-) is in line with inhibition of responses toward task-relevant target stimuli. The prime valence effect does not strongly impact on the results. This contradicts the assumption that negative task-irrelevant distractors (i.e., primes) inhibit processing of following information more strongly than positive distractors. Slower responding can both be caused by deeper processing of a negative stimulus or inhibition of processing of the negative stimulus. Support for favorable processing of negative stimuli in EP comes from neuroimaging data. Ito and Cacioppo (2000) showed more intense processing of negative stimuli in EP in event-related potential data, which contradicts an explanation in terms of inhibition.

However, the unstandardized analysis using P1 showed faster responding to negative targets than to positive targets in 20 out of 121 effects. Similarly, P2 indicated faster responding to negative primes than to positive primes in 43 out of 121 effects. This reversal of results can most parsimoniously be explained by a similarity/ density approach (Unkelbach et al., 2008), which claims that positive information is not always processed faster than negative information but only when it is more similar. Following this argumentation, results with reversed patterns occur when the stimulus set is more similar for negative prime-target pairs in contrast to positive. Thus, the similarity/ density account offers a consistent and overarching approach to valence asymmetries in EP effects.

In conclusion, EP effects show clear evidence of a valence asymmetry. Positive prime-target pairs create stronger EP effects than negative prime-target pairs. This effect is in line with the two assumptions that positive information is more similar to each other than negative information and that similar prime-target pairs create stronger EP effects. However, multiple other processes can explain this asymmetry, especially affective matching and a general suppression of or distraction by negative information. This weakens the ability of this finding to argue in favor of an impact of similarity in EP. To overcome this limitation the following experiments manipulate similarity directly. The first experiment manipulates similarity within the positive and negative valence to investigate whether the effect of valence is mediated by similarity.

Experimental Evidence on Effects of Similarity in Evaluative Priming

The meta-analysis offered first evidence that EP effects are influenced by similarity. However, the evidence requires the assumption that positive information is on average more similar than negative information. Alternative explanations can account for the results, especially a general suppression of negative information (McGinnies, 1949), a stronger ability of negative information to divert attention away from the main task (Baumeister et al., 2001; Rothermund et al., 2011), and affective matching. To test whether the valence asymmetry found is based on similarity or is a general effect of valence further evidence is needed. To provide this evidence I conducted a series of four experiments that manipulated prime-target similarity orthogonally to valence. The first experiment tests for similarity effects by manipulating similarity via item selection. The following three experiments (Experiment 2 - 4) induce prime-target similarity by repeated presentation of a specific stimulus, assuming that identical stimuli are highly similar. Thus, the four experiments test for similarity effects using two different operationalizations of similarity. Experiment 3 and 4 rule out alternative explanations for Experiment 2.

Similarity by Item Selection

The first test of similarity effects uses item selection to create high and low similarity prime-target. If similarity impacts on EP than EP effects should be stronger for highly similar prime-target pairs compared to less similar prime-target pairs. Further, if similarity underlies the valence asymmetries found in the meta-analysis, highly similar prime-target pairs should elicit EP effects irrespective of valence.

Experiment 1. The following study compared two conditions by varying prime-target stimuli: One condition replicates the assumed natural condition where positive stimuli are similar and negative stimuli are dissimilar. This condition is compared to a second condition where positive stimuli are dissimilar and negative stimuli are similar. I manipulated similarity by selecting prime-target stimuli based on graphical inspection of a plotted solution from multidimensional scaling. This solution was based on similarity ratings from a pilot test (Unkelbach et al., 2008). Thus, participants categorized similar and dissimilar prime-target pairs in an EP paradigm. Following this, each participant rated similarity of all prime-target pairs. These ratings were used both as a manipulation check and to predict response latencies in the EP task based on similarity.

Method.

Participants. Fifty-eight University of Heidelberg students (46 female, 9 male) participated either for 3 € or course credit. Participants were randomly assigned to one of the two similarity conditions (*positive similar* vs. *positive dissimilar*). Fifty participants were native speakers of German, 4 reported that German was their first foreign language, 1 reported that German was his or her second foreign language.[1]

Stimuli. I chose eight positive and eight negative words for the two similarity conditions (see appendix). Thus, the experiment used four word sets with similar positive, dissimilar positive, similar negative and dissimilar negative words. The selection was based on MDS data by Unkelbach et al. (2008). They collected similarity ratings of 40 words. All stimuli were nouns with strong valence (Klauer & Musch, 1999). From these stimuli primes and targets were chosen to be either very

[1] Excluding non-native speakers did not affect results.

close (i.e., similar) or very distant (i.e., dissimilar) to each other based on visual inspection. Each word was either used as prime or as target. In both conditions positive nouns (positive similar: M = 3.71, SD= 0.64, positive dissimilar: M = 3.40, SD = 0.52) were rated clearly more positive than negative nouns (positive similar: M = -3.48, SD = 0.58, positive dissimilar: M = -3.80, SD = 0.39) on a scale from -5 to +5; (Klauer & Musch, 1999). This difference in valence was significant (positive similar: $t(14) = 23.58$, $p < .001$, positive dissimilar: $t(14) = 31.42$, $p < .001$). However, positive and negative words did not differ regarding extremity (positive similar: $t(14) = 0.78$, $p = .449$, positive dissimilar: $t(14) = -1.75$, $p = .103$).

Procedure. After arriving at the lab, participants read and signed an informed consent explaining that they would participate in a study about word evaluation. Then, the experimenter seated participants at individual computers. A VisualBasic program controlled the stimulus presentation and recorded responses and latencies; latencies were assessed using a high frequency timer. The experimenter started the program which provided all instructions. The program informed participants that two words would be presented shortly after each other and that they should categorize only the second word as positive or negative by pressing one of two keys on the keyboard. Key assignment was counterbalanced. Participants should respond as quickly and accurately to the second word as possible. The priming task started with 4 practice trials including words that were not used in the experimental trials (guns, sun, death, and baby). Following practice trials experimental trials started. All primes were paired with all targets, resulting in 64 pairs and each pair was presented twice, resulting in 128 trials. Each participant received a new randomized presentation order, with the restriction that each pair was presented once before repeating a pair. Each trial started with the presentation of a fixation cross in the center of the screen for 700 ms, followed by the presentation of the prime for 200 ms. A blank screen followed for 150 ms, until the onset of the target, resulting in a SOA of 350 ms. The target stayed on screen until the participant responded. The next trial started with a delay of 1500 ms (inter trial interval). All words were presented in black on a grey background. After completing the EP task the similarity ratings for the MDS started. The similarity ratings included all words form the EP task and included all combinations of word pairs. Each word was paired with each word irrespective whether it was a prime or a target, unlike in the priming procedure. This resulted in 120 comparisons. Each comparison consisted of two words, one on the left and one on the right side of the screen. The left/right positions of words were determined randomly. Similarity was rated on a scale ranging from 1 (*very similar*) to 9 (*very dissimilar*). Participants had no further instruction what feature of similarity they should use. After the completion of the MDS participants were thoroughly debriefed and thanked. An experimental session lasted approximately 30 min.

Results.

Response latencies. Results compared mean response latencies for positive similar and negative dissimilar with positive dissimilar and negative similar trials. I eliminated response latencies of false decisions, as well as all response latencies under 250 ms. Latencies slower than 1000 ms were equated to 1000 ms. Data from three participants was excluded: Two produced standard deviation that were marked as outliers by deviating more than 3 SD from mean. One showed responses at change level. Excluding participants had no effect on the results. The data was analysed using a 2 (similarity: positive similar and negative dissimilar vs. positive dissimilar and negative similar) x 2 (valence: positive vs. negative) x 2 (congruency: congruent vs. incongruent) ANOVA, with similarity as only between-subject factor. All means are shown in Figure 3. Visual inspection supports the predictions. The positive similar negative dissimilar condition replicated the results of the meta-analysis: Congruent positive trials showed an average EP effect of 23 ms (relative to P+T-). Congruent negative trials again showed a reversed EP effect of -9 ms (when compared to P-T+). Thus, the assumed natural similarity condition replicated the existing results. However, the critical test is whether results change when similarity reverses. Indeed, in the positive dissimilar, negative similar condition positive congruent trials showed a markedly smaller EP effect of 6 ms (relative to P+T-). In contrast, negative congruent trials showed an EP effect of 17 ms (relative to P-T+). This reversal of results was illustrated by a significant three-way interaction of congruency by similarity by valence ($F(1, 53) = 4.67$, $p = .035$, $eta^2 = .08$). Separate ANOVAS per similarity condition informed about the nature of this 3-way interaction. The interaction was marked by a stronger congruency effect for positive primes compared to negative primes in the positive similar condition (valence x congruency: $F(1, 26) = 4.96$, $p = .035$, $eta^2 = .16$). In the positive dissimilar condition no interaction of valence and congruency occurred ($F(1, 27) = 0.67$, $p = .420$). Thus, the congruency effect did not differ for positive and negative prime-target pairs.

Further, the overall EP effect was significant ($F(1, 53) = 5.52$, $p = .023$, $eta^2 = .09$). Participants responded faster in congruent trials than in incongruent trials. The size of the EP effect did not interact with the similarity condition ($F(1, 53) = 0.31$, $p = .578$). The main effect of valence was also not significant ($F(1, 53) = 0.81$, $p = .373$). No other effect reached significance ($F<1$).

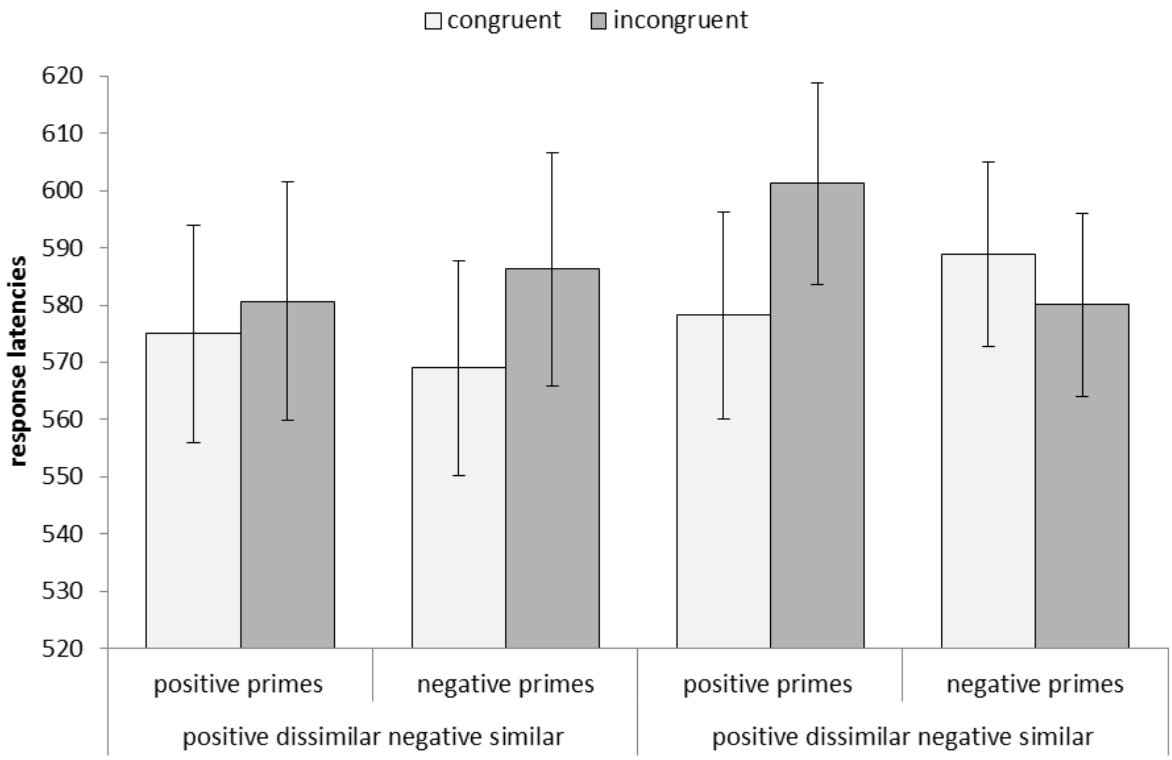

Figure 3. Mean response latencies and standard errors as a function of prime-target congruency, prime valence and similarity condition for Experiment 1.

Similarity ratings. The previous analysis compared differences between the condition of similar and dissimilar stimuli. The following analyses explore differences between specific stimuli within the same condition. For this purposes I calculated similarity scores based on the similarity rating. To do so I averaged similarity ratings of each word pair across all participants separately for each similarity condition. The MDS used an ASCAL scaling procedure (Young & Hamer, 1987) provided by SAS, assuming ordinal structure of similarity ratings. A three dimensional solution reached a satisfying fit to the data as indicated by a stress of .04 for the positive similar condition and a stress of .05 for the positive dissimilar condition.

Manipulation check. The MDS data was used to check whether the similarity conditions varied similarity as intended. For this purpose I summed the squared distances of each word to each word of the same valence to receive the Euclidean distance per stimulus and per dimension. The square root of these sums was then summed across the three dimensions to form an index of density. High density implies high spatial distance and therefore low similarity (Unkelbach et al., 2008). This density index is used as manipulation check. Two analyse confirmed that participants rated stimuli as similar (vs. dissimilar) as predicted. In the positive similar condition positive words had a density of 1.68 and were therefore highly similar to each other whereas negative words had a density of 8.07 and were thus relatively dissimilar to each other. Thus, positive stimuli were more similar than negative stimuli ($t(14) = 20.57$, $p < .001$). For the positive dissimilar condition results were reversed: Negative stimuli had a mean density of 2.99, positive stimuli had a density of 6.36 ($t(14) = -6.41$, $p < .001$). Negative words were more similar than positive words. Thus, the similarity manipulation by item selection was successful.

Predicting response latencies by similarity ratings. If similarity impacts EP effects then prime-target similarity should also predict responses toward specific prime-target pairs. This analysis is more sensitive to the hypothesis that EP is affected by similarity as it also includes variations of specific prime-target pairs. To predict response latencies from similarity I calculated another index of similarity. This index compared prime-target pairs whereas the earlier analysis compared all stimuli of the same valence. For this purpose I summed the Euclidian distances of each prime to all of its 8 targets (4 congruent and 4 incongruent) on each dimension. This index was then correlated with the 16 response latencies associated with each prime-target pair. For the positive similar condition the resulting correlation between index of similarity and response latencies in the priming procedure was $r = .54$. For the positive dissimilar condition the correlation was $r = .48$. Accordingly, primes with higher distance to their targets (i.e., dissimilar) are associated with slower responses and primes with lower distance are associated with faster responses.

Discussion. The data replicates typical valence asymmetries of EP effects as reported in the meta-analysis when positive prime-target pairs are similar and negative prime-target pairs are dissimilar. When the similarity of positive and negative stimuli is reversed EP effects also reverse. No main effect of valence occurred in the data. Further, similarity of prime-target pairs correlated with response latencies. Responses were faster for similar prime-target pairs relative to dissimilar prime-target pairs. This effect of similarity did not depend on valence. This contradicts the assumption of a general inhibition of negative information (McGinnies, 1949) or stronger distractions by negative information (Taylor, 1991) as well as an explanation in terms of a general facilitation of processing of negative information (Baumeister et al., 2001). Thus, these findings clearly contradict alternative interpretations of the meta-analytic results in terms of a general valence effect. Instead, the underlying difference in informational similarity mediated the valence asymmetry found before. Similarity predicted EP effects better than valence.

Implication for theories of evaluative priming. The results contradict the assumption that valence asymmetries in EP are created solely by a target or prime main effect. Further, they do not support an explanation in terms of affective matching. This explanation assumes that responses in positive congruent trials are facilitated more than negative congruent trials because congruency has a positive affective quality (e.g., because it is easy to process) and therefore fosters responses in the positive category. Instead the evidence is in line with stronger EP effects for similar prime-target pairs in contrast to dissimilar prime-target pairs. Thus, similarity seems to impact on EP effects. The effects of similarity are in line with spreading activation explanations that assume encoding facilitation at target level. Models of spreading activation at valence level, where facilitation of the concepts “positive” or “negative” drives the EP effect are not supported because they do not imply effects of similarity. Further, a compound cue model is in line with the results under the assumptions that compound cues form based on similarity.

The findings challenge response competition accounts as explanations of EP effects. Especially, a sole process of response competition is not in line with the results. If congruence and incongruence of responses were the only relevant factor for EP effects then similarity should not influence effects. However, it is possible that a response competition process is involved in EP effects but an additional process occurred that created the similarity effects. This assumption is outlined in the limitations below.

Limitations. A possible critique regarding this experiment is that similar word sets could have more associations than dissimilar word sets. Associations might activate additional processes that are distinct from processes activated by non-associated, semantically similar stimuli (Lucas, 2000). Thus, the faster responses towards similar in contrast to dissimilar prime-target pairs could be based on additional associative relations. This argument is supported by studies showing that priming effect are stronger with than without associations (Lucas, 2000). To test for differences in the frequency of associations I measured associative strength between primes and targets. A sample of 80 participants was instructed to report 5 associations they had per word. Each participant had to respond to five or six words from the list of 32 words used in this and other priming studies. The resulting proportion of associations between each prime and target was low. Eleven percent of associations reported to a given prime were a target. Within the positive similar conditions similar (i.e., positive) prime-target pairs showed more associations (7%) than dissimilar (i.e., negative) prime-target pairs (0%). This difference was significant in one-sided testing ($t(30) = 1.83$, $p = 0.04$). In the positive dissimilar condition similar (i.e., negative) prime-target pairs are also more often associated (4%) than dissimilar (i.e., positive) prime-target pairs (0%). However, a one-sided t-test was not significant ($t(30) = -1.00$, $p = 16$). Though the amount of associations was low similar primes were more often associated with their targets than dissimilar primes. This is in line with the aforementioned finding that associations and similarity are empirically often confounded (Hutchison, 2003). Thus, associations could have affected the results in addition to similarity. To exclude associations as a possible alternative explanation for similarity effects the next experiments will manipulate similarity without creating associations.

A similar critique is that the design of Experiment 1 confounds similarity and valence per participant. High similarity between prime and target is always a valid predictor for either a positive (positive similar condition) or negative (positive dissimilar condition) response. Thus, a participant can develop an expectation about the role of similarity in the design, namely that similar prime-target pairs correspond to a specific (i.e., positive or negative) response. Hence, this experiment might not measure standard EP processes but instead introduces an additional process. To overcome this limitation the next experiments vary similarity within both positive and negative valence simultaneously. Based on this approach similarity is no longer predictive for a specific response and cannot be used intentionally by participants.

Another limitation of the experiment above is that only stimuli with strong valence were used. Thus, it is unclear whether the effect of similarity generalizes to less extreme stimuli. To overcome these limitations the next experiments varied similarity within the same valence and used new stimuli.

Similarity by repetition

The following three experiments again varied similarity of prime and target. To resolve the confound of similarity with valence I varied similarity within the same valence category. Further, to prevent similar prime-target pairs to have more associations than dissimilar prime-target pairs I opted for a different manipulation of similarity. In the next experiments similar prime-target pairs are formed by repeated presentation of a single word as both prime and target. Thus, prime and target are identical. The identical prime-target pairs imply complete feature overlap and low associations as a stimulus rarely co-occurs with itself. A pilot test (see above) confirmed a mean associative strength in identical trials of zero. The pilot test requested 5 free associations for 6 nouns each (including overall 32 nouns) from 80 participants. As a result no word was associated with itself.

The identical trials are interspersed in a standard EP paradigm with congruent (i.e., non-identical), and incongruent trials. For the sake of brevity I will refer to congruent non-identical trials as “congruent” and identical congruent trials as “identical”. However, identical trials are also congruent. The identical trials are thus high in similarity whereas the congruent trials are relatively low in similarity. Hence, only a small number of trials are similar and the similar trials are both positive and negative for all participants. Thus, similarity is not predictive for a specific response and the systematic use of similarity as a response cue is implausible based on the low rate of similar prime-target pairs.

An important aspect of the design is that both congruent trials and identical trials require the same response towards prime and target. If identical trials create stronger EP effects this cannot be attributed to responses competition as responses in identical trials are the same as responses in congruent trials. Thus, similarity effects within these experiments cannot be attributed to response competition. Thus, the design allows testing response competition explanations.

Overview. All following three experiments test the hypothesis that identical prime-target pairs are categorized faster than congruent trials because identical prime-target pairs are more similar than congruent non-identical prime-target pairs. Experiment 2 uses moderate stimuli, Experiment 3 and 4 present extreme stimuli. Experiment 3 reduces perceptual similarity by means of different fonts. Experiment 4 eliminates perceptual similarity by using pictures as primes and words as targets.

Experiment 2. Experiment 2 uses a standard EP paradigm with additional identical prime-target pairs. To generalise results I varied SOA as a between factor.

Method.

Participants. Seventy-one subjects participated in return for course credit or 6€. Participants were mostly students from the University of Heidelberg or recruited from the main street. Six participants were excluded because they did not understand or comply with the instructions. However, including them did not influence results. The remaining participants were randomly assigned to the SOA 50 (33 participants) and SOA 350 (32 participants) conditions. Fifty-five participants were native speakers of German, 7 reported that German was their first foreign language, 3 reported that German was his or her second foreign language.

Apparatus and Stimuli. The design was highly similar to Experiment 1. To test whether similarity effects would generalize to moderate stimuli the experiment used new stimuli. Eight positive and 8 negative nouns from Klauer and Musch (1999) and from Schwibbe, Räder, Schwibbe, Borchardt, and Geiken-Pophanken (1994) were used as both primes and targets. This differs from Experiment 1 where words were either primes or targets. All words were rated to have clear but moderate valence. Based on the two word norms positive words showed average ratings of 1.5 and negative words of -1.7 (on a scale from +5 to -5). Positive and negative words differed significantly in regard to valence ($t(14) = 10.77$, $p < .001$) but not in regard to extremity ($t(14) = -0.59$, $p > .05$). The stimulus list is in the appendix.

Each word was paired with each other word, each pairing was repeated once in interchanging order of prime and target. This resulted in 120 incongruent trials, 120 congruent non-identical trials and 16 identical trials. Thereby, the proportion of congruent trials among all trials departed slightly from 50%, this could increase the congruency main effect (Klauer, Rossnagel, & Musch, 1997) and would not interact with the predictions. Presentation parameters were identical to Experiment 1.

Procedure. The procedure was largely identical to Experiment 1. In contrast to Experiment 1 this experiment included 256 experimental trials. In the SOA 50 (350) condition the prime was presented for 33 (200) ms followed by a blank screen for 17 (150) ms.

Results. Results were based on mean response latencies for correct responses in congruent, incongruent and identical trials. Response latencies faster than 250 ms were excluded. Latencies slower than 1000 ms were equated to 1000 ms. An analyses of variance was conducted for the 2 (SOA: 50 vs. 350) x 3 (congruency: congruent vs. incongruent vs. identical) x 2 (prime valence: positive vs. negative) design (cf. Figure 4). This comparison revealed a strong main effect of congruency ($F(2, 62) = 23.92$, $p < .001$, $eta^2 = 0.44$). Further, prime valence showed a tendency of faster responses based on positive primes (628 ms) relative to negative primes (636 ms). However, this effect did not reach conventional levels of significance ($F(1, 63) = 3.39$, $p = .070$, $eta^2 = 0.05$). No other effect was significant ($F < 2$).

Two additional analyses investigated the congruency effect in more detail. They compared congruent with incongruent trials (i.e., the standard EP effect) and congruent with identical trials. Both analyses of variance included SOA and prime valence. The first analysis showed that the standard priming effect (i.e., congruent vs. incongruent trials) was significant ($F(1, 63) = 24.09$, $p < .001$, $eta^2 = 0.28$); responses in congruent trials were 13 ms faster than in incongruent trials. However, the second analysis reveals that responses in identical trials were even faster; identical trials were 27 ms faster than congruent trials ($F(1, 63) = 14.77$, $p < .001$, $eta^2 = 0.19$).

Descriptively, the standard EP effect was stronger for positive prime-target pairs compared to negative prime-target pairs. Congruent trials with positive primes were 25 ms faster than incongruent trials with positive primes. In contrast, congruent trials with negative primes were only 2 ms faster than incongruent trials. However, this interaction did not reach conventional levels of significance ($F(1, 63) = 5.43$, $p =. 06$, $eta^2=0.05$)[2]. No valence asymmetry was observed for identical trials compared to congruent trials ($F(1, 63) = 0.01$, $p =. 91$).

[2] After excluding non-native speakers this interaction was significant.

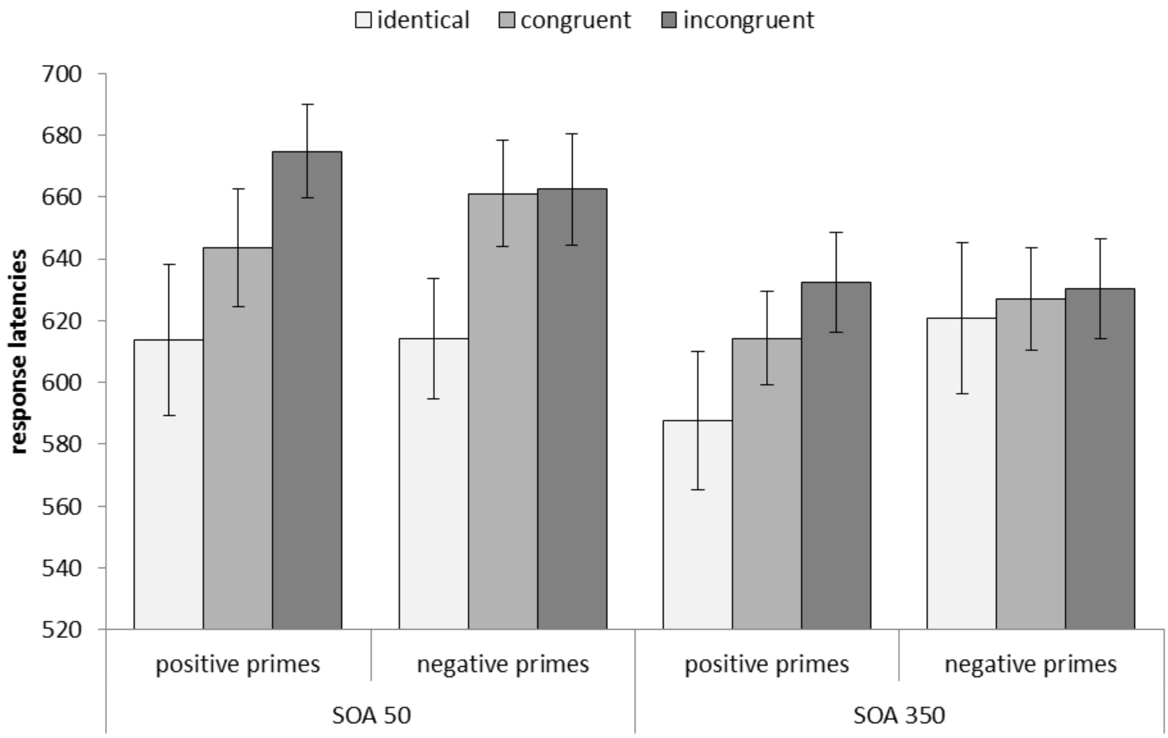

Figure 4. Mean response latencies and standard errors as a function of prime-target congruency, prime valence and stimulus-onset asynchrony (SOA) for Experiment 2.

Discussion. Results show that responses in trials with identical prime-target pairs are faster than responses in both incongruent and congruent trials. Thus, highly similar (i.e., identical) prime-target pairs elicit faster responses than relatively dissimilar (i.e., congruent) prime-target pairs. This acceleration cannot be explained by response competition, as responses in both identical and congruent trials are the same. The finding is in line with a general cognitive process (i.e., spreading activation, compound cue) based on similarity, which creates faster responses for similar trials. The acceleration of identical trials could be caused by semantic overlap of identical primes and targets. The effect in identical trials is not moderated by valence. Thus, responses show no valence asymmetry in identical trials. This is in line with the assumption that valence asymmetries are mediated by similarity. A general inhibition of responses in negative trials should in contrast create less pronounced acceleration in negative identical trials than in positive identical trials. Instead, if similarity is constant (e.g., high) no valence asymmetry is evident.

In this experiment identical trials are rare and were presented in both the positive and negative category, therefore fast responses in identical trials cannot be attributed to a strategic use of similarity by participants as in Experiment 1. It is not possible that participants associated similar prime-target pairs with a specific response because identical prime-target pairs required both positive and negative responses depending on trial. Further, the data implies that the acceleration of responses in similar prime-target pairs occurs without associations between prime and target. Additionally, the results support the notion that the effect of similarity generalizes to moderate stimuli.

Limitations. The advantage of manipulating similarity by repetitions is that associations are less important. However, it introduces a new confound, namely that semantic similarity is confounded with perceptual similarity. Similar prime-target pairs do not only overlap in their semantic meaning but also in morphologic and perceptual aspects. Thus, a plausible alternative interpretation of the results is that not semantic similarity but perceptual or morphologic similarity between prime and target facilitated target encoding and subsequent responding in identical trials (Peressotti & Grainger, 1999). Though there are results showing that perceptual similarity does not play an important role in priming effects based on stimulus repetition (Feldman & Moskovljevic, 1987) we will test this alternative by creating a replication with less perceptual overlap. To counter the argument of perceptual similarity Experiment 3 tested whether identical trials were still faster than congruent trials without high perceptual similarity. This experiment introduced a manipulation of perceptual similarity either leading to higher or lower perceptual similarity by varying letter case.

Experiment 3. In contrast to Experiment 2, this experiment includes a condition with low perceptual similarity as well as a condition with high perceptual similarity. Again SOA was included as between factor. In contrast to Experiment 2, this experiment uses extreme positive and negative stimuli. This ensures that evaluative categorization is never ambivalent. Ambiguous categorization of targets will prolong response latencies, which might have a stronger effect on means in congruent trials than in identical trials because there are only few identical trials (16).

***Method*.**

Participants. The experimenters recruited seventy-nine participants; mostly students from the University of Heidelberg or the main street, who participated in return for course credit or 4€. One participant was excluded because he was over 50 years old. However, inclusion of this participant did not affect levels of significance. The remaining participants were randomly assigned to the four conditions resulting from the combination of SOA (50 vs. 350) and perceptual similarity (high vs. low). Seventy-three participants were native speakers of German, 3 reported that German was their first foreign language, 2 reported that German was his or her second foreign language.

Stimuli and procedure. This experiment used stimuli with extreme valence from Klauer and Musch (1999). Eight positive and 8 negative nouns were used as both primes and targets. All words had clear valence. Positive words were significantly more positive than negative words ($t(14) = 10.77$, $p < .001$) but did not differ in extremity ($t(14) = -0.59$, $p > .05$). The stimulus list is in the appendix. All other aspects of the design were identical to Experiment 2.

Perceptual similarity was manipulated by presenting primes and targets in default German writing style in the perceptually identical condition (i.e., first letter uppercase, other letters lowercase; e.g., “Sommer”) or primes in lowercase letters (e.g., “sommer”) and targets in uppercase letters (e.g., “SOMMER”) in the perceptually dissimilar condition.

Results. As in the experiments before, response latencies were excluded if they belonged to incorrect responses or were faster than 250 ms. Responses slower than 1000 ms were equated to 1000 ms. An analysis of variance was conducted with a 3 (congruency: incongruent vs. congruent vs. identical) x 2 (SOA: 50 vs. 350) x 2 (perceptual similarity: identical vs. dissimilar) x 2 (prime valence: positive vs. negative) design with SOA and perceptual similarity as between-participant factors. Means are depicted in Figure 5. The data shows a strong effect of congruency ($F(2, 73) = 32.21$, $p < .001$, $eta^2 = 0.47$). To analyse this effect I conducted separate analyses per similarity condition. Responses in congruent trials were on average 24 ms faster than in incongruent trials ($F(1, 74) = 31.32$, $p < .001$, $eta^2 = 0.30$). Responses in identical trials were 26 ms faster than in congruent trials ($F(1, 74) = 34.03$, $p < .001$, $eta^2 = 0.32$). Crucially the difference of congruent and identical trials did not significantly interact with perceptual similarity ($F(1, 74) = 1.23$, $p = .27$, $eta^2 = 0.02$). Yet, the difference between identical and congruent trials was reduced from 33 ms in the perceptually identical condition to 19 ms in the perceptually dissimilar condition.

The analysis of the complete design showed an interaction between SOA and congruency, which was significant ($F(2, 73) = 3.67$, $p = .03$, $eta^2 = 0.09$). Differences were larger under short SOA than under long SOA: Under short SOA (vs. long SOA) congruent trials were 31 ms (vs. 13 ms) faster than incongruent trials and identical trials were 36 ms (vs. 16 ms) faster than congruent trials.

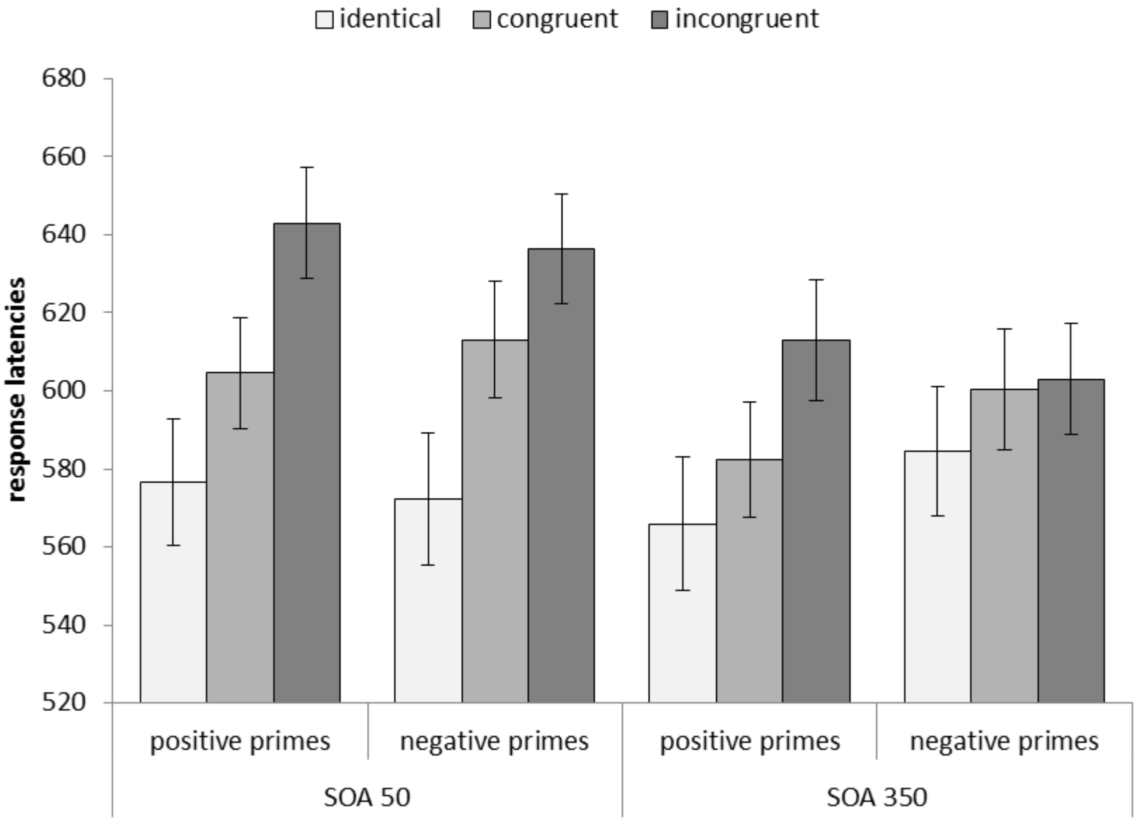

Figure 5. Mean response latencies and standard errors as a function of prime-target congruency, prime valence and stimulus-onset asynchrony (SOA) for Experiment 3.

The Interaction of congruency and valence was significant ($F(2, 73) = 4.45$, $p = .015$, $eta^2 = 0.11$). This effect was mainly driven by differences between congruent and incongruent trials and not by differences between congruent and identical trials. Regarding positive primes congruent trials were 34 ms faster than incongruent trials. Regarding negative primes congruent trials were only 13 ms faster than incongruent trials. Thus, the standard EP effect was stronger for positive than for negative primes ($F(1, 74) = 8.78$, $p = .004$, $eta^2 = 0.11$). For identical trials this valence difference was not significant: Positive identical trials were 57 ms faster than positive congruent trials. Negative identical trials were 41 ms faster than negative congruent trials ($F(1, 74) = 0.53$, $p = .47$, eta^2 = 0.00). Further, a valence main effect with faster responses in trials of positive primes was significant ($F(1, 74) = 4.38$, $p = .04$, eta^2 = 0.06). No other effect reached significance.

Discussion. Again, this data showed faster responses in identical relative to congruent trials. This effect was not moderated by perceptual similarity. Yet, in tendency the advantage of identical trials became smaller in the perceptually dissimilar condition. Thus, there might be an effect of perceptual similarity. The next experiment will therefore enhance the perceptual dissimilarity between primes and targets.

Experiment 3 replicated results from the meta-analysis and Experiment 2 showing that the standard EP effect differed for positive and negative primes. However, responses in identical trials were facilitated relative to congruent trials irrespective of valence. The use of extreme stimuli did not change the pattern of results.

Experiment 4. One objection to Experiment 3 is that the perceptual similarity between uppercase and lower case letters is still too high (e.g., “S” vs. “s”). To overcome this caveat Experiment 4 replicates Experiment 3 with pictures as primes and words as targets thereby eliminating perceptual similarity. If semantic similarity and not perceptual similarity is responsible for faster responses in identical trials this implies that the activation of the concept itself leads to faster categorisations compared to the activation of another concept.

Method.

Stimuli and procedure. All procedural aspects were identical to Experiment 2 and 3; SOA was varied between-participants. Stimuli were the same strongly valenced concepts as in Experiment 3. However, pictures portraying easy to identify concepts replaced the prime words. The pictures displayed the same concepts as the words. To ensure that scenes would be interpreted in the intended way by all participants a learning phase was added. In this phase each picture was presented twice with its label. The label was the word that was used as prime in Experiment 3.

Participants. Sixty-one University of Heidelberg students participated for 4€ or course credit. One participant was excluded because he was older than 40 years [3]. Three participants reported that German was their first foreign language, 5 reported that German was their second foreign language.

Results. I analysed the 3 (congruency: incongruent vs. congruent vs. identical) x 2 (prime valence: positive vs. negative) x 2 (SOA: 50 vs. 350) design with an analysis of variance, with SOA as the only between-participants factor (see Figure 6). The results showed a main effect of congruency ($F(2, 56) = 20.16$, $p < .001$, $eta^2 = 0.42$). Overall, responses were slower in the SOA 50 condition (vs. 350) resulting in a significant main effect of SOA ($F(1, 57) = 4.43$, $p = 0.04$, $eta^2 = 0.08$). No other effect was significant. Separate analyses comparing congruent with incongruent and congruent with identical trials supported the predictions. In congruent trials responses were 34 ms faster than in incongruent trials ($F(1, 57) = 22.88$, $p < .001$, $eta^2 = 0.29$).

[3] Exclusion did not affect results.

Responses in identical trials were 28 ms faster than in congruent trials ($F(1, 58) = 19.40$, $p < .001$, $eta^2 = 0.25$).

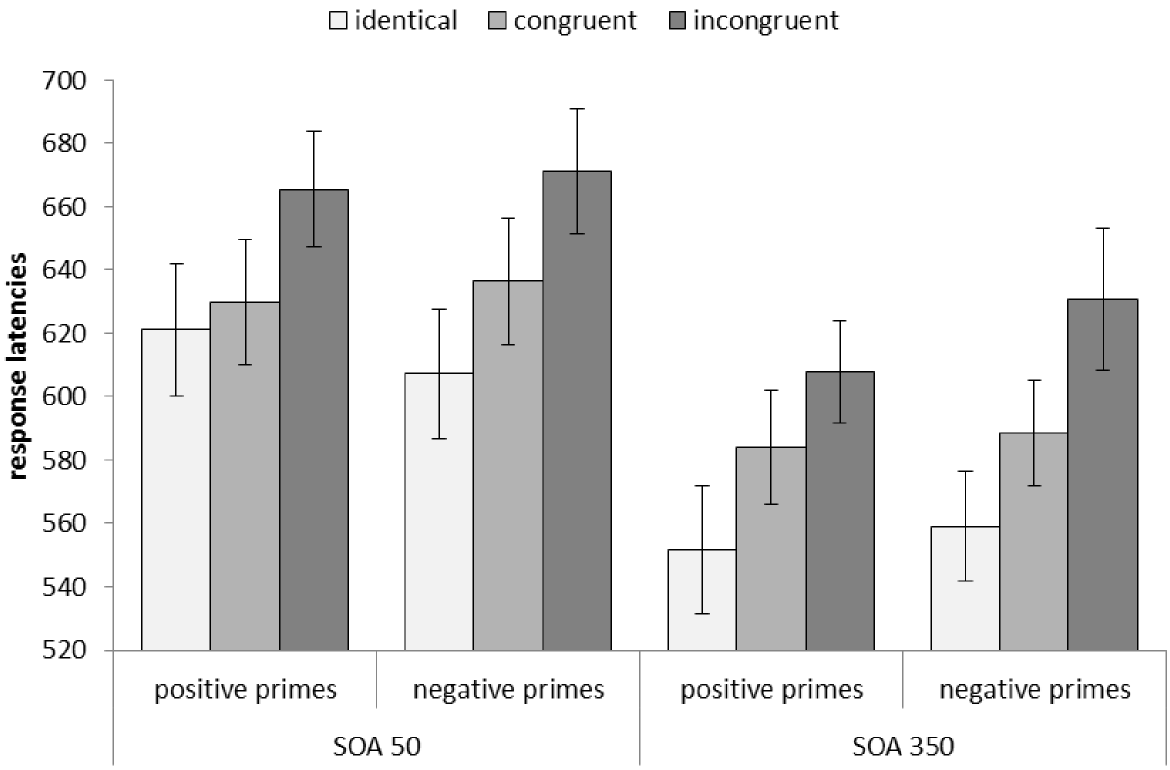

Figure 6. Mean response latencies and standard errors as a function of prime-target congruency, prime valence and stimulus-onset asynchrony (SOA) for Experiment 4.

Discussion. Even without perceptual overlap between prime and target the data replicated the finding of faster responses after identical prime-target pairs compared to congruent pairs. Thus, perceptual overlap is not necessary to accelerate categorizations of targets following identical primes. Instead, the data is in line with stronger EP effects for semantically similar prime-target pairs. No valence asymmetry was apparent in this study. This could be a chance finding. However, it could also be due to a feature of picture stimuli. Pictures are generally more concrete than words. Two pictures might not be as similar to each other as two comparatively abstract words.

General Discussion

Five studies provided evidence that similarity influences the size of EP effects. Higher similarity between prime and target predicted larger EP effects. This was true for prime-target pairs selected from MDS, identical prime-target pairs and positive prime-target pairs (vs. negative prime-target pairs) that are relatively similar to each other according to the density hypothesis (Unkelbach, 2012; Unkelbach et al., 2008). While stronger EP effects for positive stimuli can also be attributed to a general feature of valence, this is not the case for the effect of identical trials (Experiment 2 to 4) and preselected similarity (Experiment 1). Furthermore, Experiment 1 supported the assumption that the valence asymmetries in the meta-analysis are mediated by similarity. The EP effect reversed for positive and negative congruent trials when negative prime-target pairs were selected to be similar and positive prime-target pairs were selected to be dissimilar.

Further, Experiments 1 to 4 showed larger EP effects for similar prime-target pairs at both short and medium SOA, for extreme and moderate stimuli. These findings were replicated by the meta-analysis, which was based on data from multiple research groups, multiple designs, and with various stimuli. Thus, there is strong evidence for the generality of the impact of similarity on EP effects. The repetition priming data (Experiment 2 – Experiment 4) supported the view that similarity is at the heart of similarity effects and not associations.

These findings have important implications for the conceptualization of EP. To clarify these implications I will first outline the consequences of the findings on processes underlying EP effects. Subsequently, I will elaborate on the implications regarding valence asymmetries and evaluative priming as a measure of attitudes. Further, I will outline implications for evaluative processes in general. Eventually, I will discuss limitations and future directions of this research.

Underlying Mechanisms of Evaluative Priming Effects

The evidence regarding the impact of similarity on EP effects is problematic for a response competition explanation of EP effects. Response competition argues that EP effects are solely based on congruence and incongruence of responses (Klauer et al., 1997). Similarity should not affect EP effects as long as it does not interfere with responses. Especially problematic is the repetition priming data where prime and target share the same response for both identical (congruent) and (non-identical) congruent trials. Still responses in identical trials are faster than in congruent trials. There are two ways to interpret this finding: Either, identical trials imply processes in addition to response competition, which foster responses in incongruent trials or response competition is not an appropriate model to describe EP effects in both identical and congruent trials and EP effects are based on other processes. These processes can be spreading activation or compound cue mechanisms. The first interpretation that repetition priming effects are based on multiple processes is difficult to uphold based on the fact that identical trials were interspersed within the complete EP design, including congruent and incongruent trials. This practically excludes the operation of intentional or strategic processes in these trials as it is not possible to predict identical trials. The only possible alternative to explain faster processing of identical trials is that they foster the recognition of the target concept itself. However, this interpretation is not supported by Experiment 1, which showed stronger EP effects for similar prime-target pairs without identical trials and thus without faster recognition of the target by stimulus-repetition. In conclusion, assuming multiple processes in addition to response competition is possible but not parsimonious.

The second interpretation that both congruent and identical trials are fostered by the same mechanism forms a coherent and parsimonious model: The stronger EP effect for similar prime-target pairs can be integrated into models of spreading activation and compound cue. In spreading activation models similar prime-target pairs imply stronger relations between concepts (Collins & Loftus, 1975) or stronger overlap of patterns (Hutchison, 2003). A priming effect occurs, when the target concept is strongly connected to the prime or the overlap between concepts is big enough. In both cases the priming effect stems from faster recognition of a target after presentation of a similar prime. An implication of this model is that the EP effect should not occur for all prime-target pairs of the same valence because not all concepts are connected or strongly overlapping.

As the effect of similarity must be conceptualized on the level of specific prime-target pairs, the findings also imply that spreading activation at valence level is not an appropriate assumption for EP effects. This model assumes that primes activate valence concepts (i.e., positive and negative) and that this activation facilitates responses. However, as long as primes are highly connected to the valence concept, which must be the case for the highly positive and negative stimuli used in Experiments 1, 3, and 4, any prime should create the same activation or responses. Prime-target similarity should be irrelevant. Thus, only those spreading activation models that locate EP effects at the level of target concepts can implement the similarity findings. The same arguments apply to the evaluation window account (Klauer et al., 2009). As responses towards the target are only based on evaluative information by prime and target effects of prime-target similarity cannot be explained.

Despite its ability to explain similarity effects in EP, spreading activation was facing a variety of challenges (see for example Wentura, 1999). Especially, the absence of EP effects in other tasks than the evaluative decision task was seen as problematic. EP effects were repeatedly absent with the pronunciation task (Klauer & Musch, 2001; but see also Spruyt, Hermans, De Houwer, & Eelen, 2002; Spruyt, Hermans, Pandelaere, De Houwer, & Eelen, 2004) or semantic categorization task, which requires participants to classify for instance the animacy of targets (De Houwer et al., 2002; Spruyt, De Houwer, & Hermans, 2009). These findings are problematic if it is assumed that target activation activates all aspects of a concept (e.g., De Houwer et al., 2002). If for instance, the target concept kitten is activated; its evaluation should be faster as well as its pronunciation or its categorization as living or non-living. However, evidence is cumulating that this is not the case (Klauer & Musch, 2002; Klinger et al., 2000; Rothermund & Wentura, 1998). Instead, EP effects seem to depend on feature-specific attention allocation (Spruyt, De Houwer, Everaert, & Hermans, 2012; Spruyt et al., 2009). This means that EP effects occur solely on the dimension that is attended. If the valence dimension is attended due to a response task that requires evaluative decisions EP effects will occur. If a non-evaluative (e.g., semantic dimension) is attended (e.g., animacy), no EP effect will result (Burghardt & Unkelbach, submitted). Based on these findings a further adjustment of spreading activation accounts is necessary. When participants attend to the valence of a given concept such as kitten, the concept must be represented differently than when participants attend to the semantic category of the concept kitten. This requires that EP effects must be located in working memory (Fiedler, Bluemke, & Unkelbach, 2011) where flexible, goal-dependent processes are possible. If EP effects are created in working-memory, the absence of EP effects without attention to the valence dimension is no longer problematic (see Schmitz & Wentura, 2012).

A theory that reconciles the available data is a compound cue explanation of EP effects (Fockenberg et al., 2006; Ratcliff & McKoon, 1988). Based on this account priming effects result from facilitated processing of prime-target pairs that form good compound cues (Ratcliff & McKoon, 1988). To explain the existing data it must be assumed that compound cues form based on similarity. Until now, similarity was not assumed to be relevant for the formation of compound cues (Fockenberg et al., 2006; Ratcliff & McKoon, 1988). However, McKoon and Ratcliff (1992) showed that compound cues form based on associative strength. As associative strength and similarity are often confounded (Hutchison, 2003) their findings could also be explained by similarity. If similarity influences the formation of compound cues than highly similar prime target pairs form good compound cues. Good compounds cues generate intense echoes from memory (Ratcliff & McKoon, 1988) that facilitate categorization. Thus, similar prime target pairs show stronger EP effects.

An interesting aspect of this account is that compound cue models locate priming effect in working memory (Ratcliff & McKoon, 1988). Therefore, the absence of EP effects when valence is not attended is in line with the predictions. Focusing on other aspects than the valence dimension will hinder the formation of a compound cue. For instance, in an evaluative decision task the concepts baby and kitten can form a good compound because they imply the same positive valence. However, in a semantic categorization with the categories “human” and “animal” they do not form a compound.

However, a caveat to compound cue accounts is that they were introduced to explain priming effects in the lexical decision task (categorize targets as word or non-word; Ratcliff & McKoon, 1988). Good compounds trigger strong responses from memory and thus lead to a feeling of familiarity. This feeling is consistent with a “word”-decision. This connection is plausible because non-words are never familiar as they are newly invented. In contrast, words can be familiar. A highly familiar compound cue thus facilitates responses in a lexical decision task. However, in a recent meta-analysis EP effects were not reliable for the lexical decision task (Burghardt & Unkelbach, submitted).

In conclusion, EP models of spreading activation at the target level as well as compound cue models are supported by the findings of this thesis. However, both are unable to explain all existing findings. Models purely based on response competition and spreading activation at concept level are not in line with my data. However, if the EP effect is caused by multiple processes the existence of an additional process of response competition or spreading activation at concept level remains possible. Thus, the findings add to our understanding of EP processes. Yet, they do not provide definite answers regarding the underlying processes.

Implication for Semantic Priming

If EP effects are based on spreading activation or compound cue accounts, this challenges the implications drawn from a response competition account: One of these implications relates to the question whether EP effects are caused by the same processes as semantic priming effects. Semantic priming is a sequential priming task similar to EP. In contrast to EP, congruent primes and targets have a specific semantic relation, for instance belong to the same category (e.g., leg and arm) or are associates (e.g., chair and table; McNamara, 2005; Neely, 1977). Thus, the two paradigms differ in the relation between congruent primes and targets. However, the two paradigms also differ in the response task most commonly used. Evaluative priming uses mainly the evaluative decision task (Burghardt & Unkelbach, submitted) whereas semantic priming uses mainly the lexical decision task (McNamara, 2005). The evaluative decision task confounds the response categories with the congruency categories. The lexical decision task does not imply this confound. Congruent (e.g., chair and table) and incongruent (e.g., chair and lion) trials both require a “word” response. Based on this observation, response competition accounts argue that EP and semantic priming are not based on the same processes (Klauer et al., 1997;

Klinger et al., 2000; Rothermund & Wentura, 1998). In contrast, an explanation of EP effects in terms of spreading activation or compound cue implies that semantic priming and EP are based on the same processes because these are also the major accounts to explain semantic priming effects (McNamara, 2005). This implies that findings within the EP paradigm can be transferred to semantic priming research. For instance semantic priming effects should be as goal-dependent as EP effects (Burghardt & Unkelbach, submitted).

Valence Asymmetries in Evaluative Priming Effects

The data confirmed the existence of valence asymmetries in EP, showing stronger EP effects for trials with positive-positive in contrast to negative-negative prime-target pairs relative to their respective incongruent trials. In line with the density hypothesis (Unkelbach et al., 2008) I argued that these valence asymmetries are based on differential similarity of positive and negative information. This assumption was supported by Experiment 1: Valence asymmetries disappeared when similarity was manipulated. The EP effect was stronger for similar compared to dissimilar prime-target pairs irrespective of valence. Further, no valence asymmetry occurred for identical trials. This contradicts an alternative explanation in terms of general processing differences between positive and negative trials. When similarity was constant no valence asymmetry occurred.

In reverse, under the assumption that similarity impacts on EP effects, the data supports the higher similarity of positive in contrast to negative information. The data of the meta-analysis, which is based on a wide variety of stimuli (including words, faces, pictures, sounds, prosody, odor, and flavor), confirms that positive stimuli are more often similar to each other than negative stimuli.

The findings imply a more complex conceptualization of valence. In traditional conceptualizations of valence, valence is seen as a single dimension with one pole for positive and another pole for negative information (Cacioppo & Berntson, 1994). In contrast, the data supports the notion of one/ few positive representations and multiple/ more negative representations. Thus, if lower similarity of negative information creates the negativity bias in EP effects, this supports the diversity of representations of negative information. In contrast, positive information has a relatively unspecified representation.

The reported valence asymmetry in EP effects is based on the informational value of negative information. Peeters and Czapinski (1990) term this an information-processing explanation of valence asymmetries. They argue that the informational value of negative information underlies many valence asymmetries for instance the higher effectiveness of learning by negative in contrast to positive feedback or the more specific description of target persons with negative in contrast to positive traits. Thus, the findings fit into the broader research on differences in valence processing.

Implications for Evaluative Priming as an Attitude Measure

Using EP as a measure, especially to assess attitudes, requires knowing the direction of the EP effect. The interpretation of the measure is based on the assumption that responses in congruent trials are faster or less error-prone than responses in incongruent trials (see Wittenbrink, 2007). If for any reason, the EP effect reverses and responses in incongruent trials become faster/ less error-prone than responses in congruent trials, then the interpretation of the EP measure will be invalid. There is evidence that reversed EP effects occur for extreme primes (Glaser & Banaji, 1999) and at very long SOA (Klauer et al., 2009). The data provides further evidence that EP effects can disappear or reverse for dissimilar prime-target pairs, especially when they are negative. According to these findings primes and targets should be chosen based on their similarity. Hence, if for instance a stereotype against black people is measured the target should be similar to the stereotype towards black people (i.e., the prime). No EP effect should occur for targets that are dissimilar to the prime (black person) for instance a target like taxes. To find similar prime-target pairs a pre-test using MDS is possible.

Further, negative primes are overall less likely to produce reliable EP effects as became apparent in the meta-analysis. This is based on their overall dissimilarity. Thus, the selection is especially important for negative stimuli. Further, a promising approach is to calculate positive and negative EP effects separately (i.e., based on positive or negative congruent trials). This will allow conclusions about the question which of these effects has higher predictive validity. Subsequent research should study predictions of attitudes and behaviors separately for negative and positive EP effects, which has not been done until now (Cameron, Brown-Iannuzzi, & Payne, 2012; Wittenbrink, 2007).

Implications for Evaluative Processes

The findings regarding the impact of similarity on EP effects have important implications for the conceptualization of everyday evaluations. Traditional conceptualization of EP by spreading activation implied general, unconditional EP effects (Bargh et al., 1992; Bargh, Chaiken, Raymond, & Hymes, 1996; Hermans et al., 1994): The mere encounter with an attitude object, leads to the activation of that concept, which leads to the activation of all other concepts of the same valence category. Practically, this implies that when people encounter positive or negative attitude objects their evaluation affects evaluations of all other attitude objects surrounding them. Instead, I argued and tested the hypothesis that evaluations of one attitude object affect evaluations of other attitude objects only when both are similar.

Apart from this, the task to evaluate the target in EP ensures a specific representation of a given concept that does not result without a goal to evaluate (see Burghardt & Unkelbach, submitted). Thus, attitude objects will be evaluated when a goal to evaluate is active. Furthermore, an evaluation will solely affect evaluations of similar attitude objects.

Limitations and Future Directions

The implications outlined above support the relevance of the findings for the understanding of the cognitive system, evaluative processes, and the development of EP as a measure. However, the findings are subjected to some limitations that require further investigations. These limitations are outlined in the following. Subsequently, future directions of research will be addressed.

One of the possible critiques to the presented studies is the operationalization of similarity. The similarity manipulation in Experiment 1 was based on the spatial approach of similarity, which was criticized because it only captures differences but not commonalities of concepts (Markman & Gentner, 2005). Thus, a more refined measure of similarity could prove superior for future research. However, it would introduce the need to specify dimensions on which specific prime-target pairs are compared.

I argued that identical prime-target pairs are not associated based on the operational definition of associative strength. In a free association task participants did not repeat a word when asked for an association of it. However, participants might assume that they should not repeat a word when asked for associates implying that identical trials can be associated. Thus, identical prime-target pairs might be seen as associated in spite of the test of associative strength not indicating associations. Therefore, further studies are needed to rule out an effect of associations in the data of Experiment 1 to 4.

The presented experimental research solely used the evaluative decision task to study effects of similarity on EP. However, a recent meta-analysis of EP also found reliable EP effects for pronunciation responses with picture primes (Burghardt & Unkelbach, submitted). The ongoing debate whether EP in the naming task is based on the same (De Houwer & Randell, 2004; Pecchinenda, Ganteaume, & Banse, 2006; Spruyt et al., 2009) or different (Klauer & Musch, 2001) processes as EP with the evaluative decision task could be informed by findings regarding the impact of similarity on responses in the pronunciation task. Thus, future research could study the impact of similarity on EP in the naming task. Another interesting question is whether EP effects can be reliable in the lexical decision task. In the recent meta-analysis of EP (Burghardt & Unkelbach, in prep) EP effects were not reliable with the lexical decision task. However, this might have been caused by low similarity of prime-target pairs studied. EP effects could occur in this task if prime-target similarity was high. This is especially important for the question whether semantic priming and EP are based on compound cue processes. As compound cue models predict priming effects for the lexical decision task, probing the existence of EP effects with the lexical decision task is a critical test for this account.

The data supported the existence of stronger EP effects for positive congruent trials in contrast to negative congruent trials. However, the implications for EP as an attitude measure are ambiguous. Though positive congruent pairs provide stronger effects this does not imply that positive trials have a stronger predictive value. Testing for differences in predictive value is needed.

In sum, the findings reinforce the importance of similarity as a basic principle that underlies cognitive processes. The data argues against blatant effects of evaluation; rather the evaluative system uses refined mechanisms that govern processing and responding. It will be the task of future research to uncover these mechanisms.

References

References marked with an asterisk (*) indicate studies included in the meta-analysis of standardized effects.

References marked with a plus (+) indicate studies included in the meta-analysis of unstandardized effects.

Abrams, R. L., & Greenwald, A. G. (2000). Parts outweigh the whole (word) in unconscious analysis of meaning. *Psychological Science, 11*, 118-124. doi: 10.1111/1467-9280.00226

*+Aguado, L., Pierna, M., & Saugar, C. (2005). Affective priming with associatively acquired valence. *Psicologica, 26*, 261-279.

*+Baldwin, M. W., Baccus, J. R., & Fitzsimons, G. M. (2004). Self-esteem and the Dual Processing of Interpersonal Contingencies. *Self and Identity, 3*, 81-93. doi: 10.1080/13576500342000068

*+Baldwin, M. W., & Sinclair, L. (1996). Self-esteem and "if...then" contingencies of interpersonal acceptance. *Journal of Personality and Social Psychology, 71*, 1130-1141. doi: 10.1037/0022-3514.71.6.1130

+Bargh, J. A., Chaiken, S., Govender, R., & Pratto, F. (1992). The generality of the automatic attitude activation effect. *Journal of Personality and Social Psychology, 62*, 893-912. doi: 10.1037/0022-3514.62.6.893

+Bargh, J. A., Chaiken, S., Raymond, P., & Hymes, C. (1996). The Automatic Evaluation Effect: Unconditional Automatic Attitude Activation with a Pronunciation Task. *Journal of Experimental Social Psychology, 32*, 104-128. doi: 10.1006/jesp.1996.0005

Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. D. (2001). Bad is stronger than good. *Review of General Psychology, 5*, 323-370. doi: 10.1037/1089-2680.5.4.323

Begg, C. B., & Mazumdar, M. (1994). Operating characteristics of a rank correlation test for publication bias. *Biometrics, 50*, 1088-1101.

Bond, C. F., Jr., Wiitala, W. L., & Richard, F. D. (2003). Meta-analysis of raw mean differences. *Psychological Methods, 8*, 406-418. doi: 10.1037/1082-989X.8.4.406

Borenstein, M. (2009). Effect sizes for continuous data. In H. Cooper, L. V. Hedges & J. C. Valentine (Eds.), *The Handbook of research synthesis and meta-analysis* (2nd Edition ed., pp. 221 - 237). New York: Russell Sage Foundation.

Bower, G. H. (1981). Mood and memory. *American Psychologist, 36*, 129-148.

Burghardt, J., & Unkelbach, C. (in prep). A meta-analysis of sequential affective and evaluative priming: Effects, theories and applications.

Burghardt, J., & Unkelbach, C. (in prep.). Evaluative priming effects occur irrespective of response competition: Identical prime-target pairs accelerate responses based on high similarity.

Burghardt, J., & Unkelbach, C. (submitted). A meta-analysis of sequential affective and evaluative priming: Effects, theories and applications.

Cacioppo, J. T., & Berntson, G. G. (1994). Relationship between attitudes and evaluative space: A critical review, with emphasis on the separability of positive and negative substrates. *Psychological Bulletin, 115*, 401-423. doi: 10.1037/0033-2909.115.3.401

Cameron, C. D., Brown-Iannuzzi, J. L., & Payne, B. K. (2012). Sequential Priming Measures of Implicit Social Cognition: A Meta-Analysis of Associations With Behavior and Explicit Attitudes. *Personality and Social Psychological Review, 16*, 330-350. doi: 10.1177/1088868312440047

*+Castelli, L., Zogmaister, C., Smith, E. R., & Arcuri, L. (2004). On the Automatic Evaluation of Social Exemplars. *Journal of Personality and Social Psychology, 86*, 373-387. doi: 10.1037/0022-3514.86.3.373

+Chan, E., Ybarra, O., & Schwarz, N. (2006). Reversing the affective congruency effect: The role of target word frequency of occurrence. *Journal of Experimental Social Psychology, 42*, 365-372. doi: 10.1016/j.jesp.2005.04.008

Clark, D. M., Teasdale, J. D., Broadbent, D. E., & Martin, M. (1983). Effect of mood on lexical decisions. *Bulletin of the Psychonomic Society, 21*, 175-178.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2. ed. ed.). Hillsdale, NJ: Erlbaum.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review, 82*, 407-428. doi: 10.1037/0033-295x.82.6.407

De Houwer, J., Hermans, D., & Eelen, P. (1998). Affective and Identity Priming with Episodically Associated Stimuli. *Cognition & Emotion, 12*, 145 - 169. doi: 10.1080/026999398379691

De Houwer, J., Hermans, D., Rothermund, K., & Wentura, D. (2002). Affective priming of semantic categorisation responses. *Cognition & Emotion, 16*, 643-666. doi: 10.1080/02699930143000419

*+De Houwer, J., Hermans, D., & Spruyt, A. (2001). Affective priming of pronunciation responses: Effects of target degradation. *Journal of Experimental Social Psychology, 37*, 85-91. doi: 10.1006/jesp.2000.1437

*+De Houwer, J., & Randell, T. (2002). Attention to primes modulates affective priming of pronunciation responses. *Experimental Psychology, 49*, 163-170. doi: 10.1026//1618-3169.49.3.163

De Houwer, J., & Randell, T. (2004). Robust affective priming effects in a conditional pronunciation task: Evidence for the semantic representation of evaluative information. *Cognition and Emotion, 18*, 251-264. doi: 10.1080/02699930341000022

+de Liver, Y., van der Pligt, J., & Wigboldus, D. (2007). Positive and negative associations underlying ambivalent attitudes. *Journal of Experimental Social Psychology, 43*, 319-326. doi: 10.1016/j.jesp.2006.02.012

*+Deutsch, R., & Gawronski, B. (2009). When the method makes a difference: Antagonistic effects on 'automatic evaluations' as a function of task characteristics of the measure. *Journal of Experimental Social Psychology, 45*, 101-114. doi: 10.1016/j.jesp.2008.09.001

+Duckworth, K. L., Bargh, J. A., Garcia, M., & Chaiken, S. (2002). The automatic evaluation of novel stimuli. *Psychological Science, 13*, 513-519. doi: 10.1111/1467-9280.00490

Dunlap, W. P., Cortina, J. M., Vaslow, J. B., & Burke, M. J. (1996). Meta-Analysis of Experiments With Matched Groups or Repeated Measures Designs. *Psychological Methods, 1*, 170-177. doi: 10.1037//1082-989x.1.2.170

Erber, R. (1991). Affective and semantic priming: Effects of mood on category accessibility. *Journal of Experimental Social Psychology, 27*, 480-498. doi: 10.1016/0022-1031(91)90005-Q

Fazio, R. H. (2001). On the automatic activation of associated evaluations: An overview. *Cognition & Emotion, 15*, 115-141. doi: 10.1080/0269993004200024

+Fazio, R. H., Sanbonmatsu, D. M., Powell, M. C., & Kardes, F. R. (1986). On the automatic activation of attitudes. *Journal of Personality and Social Psychology, 50*, 229-238. doi: 10.1037/0022-3514.50.2.229

Feldman, L. B., & Moskovljevic, J. (1987). Repetition priming is not purely episodic in origin. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13*, 573-581. doi: 10.1037/0278-7393.13.4.573

Fiedler, K., Bluemke, M., & Unkelbach, C. (2011). On the adaptive flexibility of evaluative priming. *Memory & Cognition, 39*, 557-572. doi: 10.3758/s13421-010-0056-x

Field, A. P., & Gillett, R. (2010). How to do meta-analysis. *British Journal of Mathematical and Statistical Psychology, 63*, 665-694. doi: 10.1348/000711010x502733

Fockenberg, D. A., Koole, S. L., & Semin, G. R. (2006). Backward affective priming: Even when the prime is late, people still evaluate. *Journal of Experimental Social Psychology, 42*, 799-806. doi: 10.1016/j.jesp.2005.12.003

Fockenberg, D. A., Koole, S. L., & Semin, G. R. (2008). Priming in Concert: Assimilation and Contrast with Multiple Affective and Gender Primes. *Social Cognition, 26*, 647-669. doi: 10.1521/soco.2008.26.6.647

Frings, C., & Wentura, D. (2008). Trial-by-trial effects in the affective priming paradigm. *Acta Psychologica, 128*, 318-323. doi: 10.1016/j.actpsy.2008.03.004

+Garcia, M. T., & Bargh, J. A. (2003). Automatic Evaluation of Novel Words: The Role of Superficial Phonetics. *Journal of Language and Social Psychology, 22*, 414-433. doi: 10.1177/0261927x03258192

+Gawronski, B., Deutsch, R., & Seidel, O. (2005). Contextual Influences on Implicit Evaluation: A Test of Additive Versus Contrastive Effects of Evaluative Context Stimuli in Affective Priming. *Personality and Social Psychology Bulletin, 31*, 1226-1236. doi: 10.1177/0146167205274689

*+Giner-Sorolla, R., Garcia, M. T., & Bargh, J. A. (1999). The automatic evaluation of pictures. *Social Cognition, 17*, 76-96. doi: 10.1521/soco.1999.17.1.76

Glaser, J., & Banaji, M. R. (1999). When fair is foul and foul is fair: Reverse priming in automatic evaluation. *Journal of Personality and Social Psychology, 77*, 669-687. doi: 10.1037/0022-3514.77.4.669

+Greenwald, A. G., Klinger, M. R., & Liu, T. J. (1989). Unconscious processing of dichoptically masked words. *Memory & Cognition, 17*, 35-47. doi: 10.3758/BF03199555

Hansen, C. H., & Hansen, R. D. (1988). Finding the face in the crowd: An anger superiority effect. *Journal of Personality and Social Psychology, 54*, 917-924. doi: 10.1037/0022-3514.54.6.917

+Hermans, D., Baeyens, F., & Eelen, P. (1998). Odours as Affective-processing Context for Word Evaluation: A Case of Cross-modal Affective Priming. *Cognition & Emotion, 12*, 601 - 613. doi: 10.1080/026999398379583

+Hermans, D., De Houwer, J., & Eelen, P. (1994). The affective priming effect: Automatic activation of evaluative information in memory. *Cognition & Emotion, 8*, 515-533. doi: 10.1080/02699939408408957

Hermans, D., De Houwer, J., & Eelen, P. (1996). Evaluative decision latencies mediated by induced affective states. *Behaviour Research and Therapy, 34*, 483-488. doi: 10.1016/0005-7967(96)00017-4

Hermans, D., Smeesters, D., De Houwer, J., & Eelen, P. (2002). Affective priming for associatively unrelated primes and targets. *Psychologica Belgica, 42*, 191-212.

Hermans, D., Spruyt, A., De Houwer, J., & Eelen, P. (2003). Affective priming with subliminally presented pictures. *Canadian Journal of Experimental*

Psychology/Revue canadienne de psychologie expérimentale, 57, 97-114. doi: 10.1037/h0087416

Hermans, D., Spruyt, A., & Eelen, P. (2003). Automatic affective priming of recently acquired stimulus valence: Priming at SOA 300 but not at SOA 1000. *Cognition & Emotion, 17*, 83-99.

Hermans, D., Vansteenwegen, D., Crombez, G., Baeyens, F., & Eelen, P. (2002). Expectancy-learning and evaluative learning in human classical conditioning: Affective priming as an indirect and unobtrusive measure of conditioned stimulus valence. *Behaviour Research and Therapy, 40*, 217-234. doi: 10.1016/S0005-7967(01)00006-7

+Hietanen, J. K., & Korpela, K. M. (2004). Do Both Negative and Positive Environmental Scenes Elicit Rapid Affective Processing? *Environment and Behavior, 36*, 558-577. doi: 10.1177/0013916503261391

Hinojosa, J. A., Carretié, L., Méndez-Bértolo, C., Míguez, A., & Pozo, M. A. (2009). Arousal contributions to affective priming: Electrophysiological correlates. *Emotion, 9*, 164-171. doi: 10.1037/a0014680

Hock, M., & Egloff, B. (1998). Interindividuelle Differenzen in Priming- und Gedächtniseffekten bedrohungsbezogener Stimuli: Der Einfluß kognitiv vermeidender und vigilanter Angstbewältigung. *Zeitschrift für Experimentelle Psychologie, 45*, 149-166.

Hutchison, K. A. (2003). Is semantic priming due to association strength or feature overlap? A microanalytic review. *Psychonomic Bulletin & Review, 10 (4)*, 785-813. doi: 10.3758/Bf03196544

Ito, T. A., & Cacioppo, J. T. (2000). Electrophysiological evidence of implicit and explicit categorization processes. *Journal of Experimental Social Psychology, 36*, 660-676. doi: 10.1006/jesp.2000.1430

Kivikangas, M. J., & Ravaja, N. (2009). Suboptimal affective primes in video messages: Effects on positive activation and negative activation. *Journal of Media Psychology: Theories, Methods, and Applications, 21*, 37-46. doi: 10.1027/1864-1105.21.1.37

*+Klauer, K. C., Mierke, J., & Musch, J. (2003). The positivity proportion effect: A list context effect in masked affective priming. *Memory & Cognition, 31*, 953-967. doi: 10.3758/BF03196448

Klauer, K. C., & Musch, J. (1999). A standardization of various aspects of the evaluation of 92 nouns. *Zeitschrift für Sozialpsychologie, 30*, 1-11. doi: 10.1024//0044-3514.30.1.1

+Klauer, K. C., & Musch, J. (2001). Does sunshine prime loyal? Affective priming in the naming task. *The Quarterly journal of experimental psychology, 54 A*, 727-751. doi: 10.1080/02724980042000444

Klauer, K. C., & Musch, J. (2002). Goal-Dependent and Goal-Independent Effects of Irrelevant Evaluations. *Personality and Social Psychology Bulletin, 28*, 802-814. doi: 10.1177/0146167202289009

Klauer, K. C., Musch, J., & Eder, A. B. (2005). Priming of semantic classifications: Late and response related, or earlier and more central? *Psychonomic Bulletin & Review, 12*, 897-903.

+Klauer, K. C., Rossnagel, C., & Musch, J. (1997). List-context effects in evaluative priming. *Journal of Experimental Psychology: Learning, Memory & Cognition, 23*, 246-255. doi: 10.1037/0278-7393.23.1.246

Klauer, K. C., & Stern, E. (1992). How attitudes guide memory-based judgments: A two-process model. *Journal of Experimental Social Psychology, 28*, 186-206. doi: 10.1016/0022-1031(92)90038-L

Klauer, K. C., Teige-Mocigemba, S., & Spruyt, A. (2009). Contrast effects in spontaneous evaluations: A psychophysical account. *Journal of Personality and Social Psychology, 96*, 265-287. doi: 10.1037/a0013248

Klinger, M. R., Burton, P. C., & Pitts, G. S. (2000). Mechanisms of Unconscious Priming: I. Response Competition, Not Spreading Activation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*, 441-455. doi: 10.1037/0278-7393.26.2.441

+Kolańczyk, A., & Pawłowska-Fusiara, M. (2002). Automatic correction or controlled processing of affective priming. *Polish Psychological Bulletin, 33*, 37-46.

+Korpela, K. M., Klemettilä, T., & Hietanen, J. K. (2002). Evidence for rapid affective evaluation of environmental scenes. *Environment and Behavior, 34*, 634-650. doi: 10.1177/0013916502034005004

Lewin, K. (1939). Field theory and experiment in social psychology: concepts and methods. *American Journal of Sociology, 44*, 868-896. doi: 10.1086/218177

+Lodge, M., & Taber, C. S. (2005). The Automaticity of Affect for Political Leaders, Groups, and Issues: An Experimental Test of the Hot Cognition Hypothesis. *Political Psychology, 26*, 455-482. doi: 10.1111/j.1467-9221.2005.00426.x

Lucas, M. (2000). Semantic priming without association: A meta-analytic review. *Psychonomic Bulletin & Review, 7*, 618-630. doi: 10.3758/Bf03212999

Markman, A. B., & Gentner, D. (1993). Splitting the differences: A structural alignment view of similarity. *Journal of Memory and Language, 32*, 517-535. doi: 10.1006/jmla.1993.1027

Markman, A. B., & Gentner, D. (2005). Nonintentional similarity processing. In T. Hassin, J. A. Bargh & J. Uleman (Eds.), *The new unconscious* (pp. 107-137). New York: Oxford University Press.

Masson, M. E. J. (1995). A distributed memory model of semantic priming. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 3-23. doi: 10.1037/0278-7393.21.1.3

McClelland, J. L., Rumelhart, D. E., & the PDP research group. (1986). *Parallel distributed processing: Explorations in the microstructure of cognition Volume II*. Cambridge, MA: MIT Press.

McGinnies, E. (1949). Emotionality and perceptual defense. *Psychological Review, 56*, 244-251. doi: 10.1037/h0056508

McKoon, G., & Ratcliff, R. (1992). Spreading activation versus compound cue accounts of priming: Mediated priming revisited. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18*, 1155-1172. doi: 10.1037/0278-7393.18.6.1155

McNamara, T. P. (2005). *Semantic priming: Perspectives from memory and word recognition*. New York: Psychology Press.

Medin, D. L., & Schaffer, M. M. (1978). Context theory of classification learning. *Psychological Review, 85*, 207-238. doi: 10.1037//0033-295x.85.3.207

Miles, L., & Johnston, L. (2007). Detecting happiness: Perceiver sensitivity to enjoyment and non-enjoyment smiles. *Journal of Nonverbal Behavior, 31*, 259-275. doi: 10.1007/s10919-007-0036-4

Moors, A., & De Houwer, J. (2001). Automatic appraisal of motivational valence: Motivational affective priming and Simon effects. *Cognition & Emotion, 15*, 749-766. doi: 10.1080/02699930143000293

Moors, A., De Houwer, J., & Eelen, P. (2004). Automatic stimulus-goal comparisons: Support from motivational affective priming studies. *Cognition and Emotion, 18*, 29-54. doi: 10.1080/02699930244000462

Moors, A., De Houwer, J., Hermans, D., & Eelen, P. (2005). Unintentional processing of motivational valence. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology, 58*, 1043-1063. doi: 10.1080/02724980443000467

Moss, H. E., Ostrin, R. K., Tyler, L. K., & Marslen-Wilson, W. D. (1995). Accessing different types of lexical semantic information: Evidence from priming. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 863-883. doi: 10.1037/0278-7393.21.4.863

+Musch, J., Elze, A., & Klauer, K. C. (1998). Gibt es Wortlängeneffekte in der evaluativen Entscheidungsaufgabe? *Zeitschrift für Experimentelle Psychologie, 45*, 109-119.

Neely, J. H. (1977). Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited-capacity attention. *Journal of Experimental Psychology: General 106*, 226-254. doi: 10.1037/0096-3445.106.3.226

Neumann, R., Förster, J., & Strack, F. (2003). Motor compatibility: The bidirectional link between behavior and evaluation. In J. Musch & K. C. Klauer (Eds.), *The psychology of evaluation: Affective processes in cognition and emotion* (pp. 371–392). NJ: Erlbaum: Mahwah.

Nosofsky, R. M. (1985). Overall similarity and the identification of separable-dimension stimuli: A choice model analysis. *Perception & Psychophysics, 38*, 415-432. doi: 10.3758/Bf03207172

Nosofsky, R. M. (1986). Attention, similarity, and the identification-categorization relationship. *Journal of Experimental Psychology: General, 115*, 39-57. doi: 10.1037/0096-3445.115.1.39

Ode, S., & Robinson, M. D. (2009). Can agreeableness turn gray skies blue? A role for agreeableness in moderating neuroticism-linked dysphoria. *Journal of Social and Clinical Psychology, 28*, 436-462. doi: 10.1521/jscp.2009.28.4.436

Ortigue, S., Bianchi-Demicheli, F., de C. Hamilton, A. F., & Grafton, S. T. (2007). The neural basis of love as a subliminal prime: An event-related functional magnetic resonance imaging study. *Journal of Cognitive Neuroscience, 19*, 1218-1230. doi: 10.1162/jocn.2007.19.7.1218

Payne, B. K., Cheng, C. M., Govorum, O., & Stewart, B. D. (2005). An inkblot for attitudes: Affect misattribution as implicit measurement. *Journal of Personality and Social Psychology, 89*, 277 - 293. doi: 10.1037/0022-3514.89.3.277

Pecchinenda, A., Ganteaume, C., & Banse, R. (2006). Investigating the mechanisms underlying affective priming effects using a conditional pronunciation task. *Experimental Psychology, 53*, 268-274. doi: 10.1027/1618-3169.53.4.268

Peeters, G., & Czapinski, J. (1990). Positive-negative asymmetry in evaluations: The distinction between affective and informational effects. In W. Stroebe & M. Hewstone (Eds.), *European review of social psychology* (Vol. 1, pp. 33-60). New York: Wiley.

+Pell, M. D. (2005a). Nonverbal emotion priming: Evidence from the "Facial affect decision task". *Journal of Nonverbal Behavior, 29*, 45-73. doi: 10.1007/s10919-004-0889-8

+Pell, M. D. (2005b). Prosody-face interactions in emotional processing as revealed by the facial affect decision task. *Journal of Nonverbal Behavior, 29*, 193-215. doi: 10.1007/s10919-005-7720-z

+Pell, M. D., & Skorup, V. (2008). Implicit processing of emotional prosody in a foreign versus native language. *Speech Communication, 50*, 519-530. doi: 10.1016/j.specom.2008.03.006

Peressotti, F., & Grainger, J. (1999). The role of letter identity and letter position in orthographic priming. *Perception & Psychophysics, 61*, 691-706. doi: 10.3758/BF03205539

Ratcliff, R., & McKoon, G. (1988). A retrieval theory of priming in memory. *Psychological Review, 95*, 385-408. doi: 10.1037/0033-295X.95.3.385

Ravaja, N., Kallinen, K., Saari, T., & Keltikangas-Jarvinen, L. (2004). Suboptimal Exposure to Facial Expressions When Viewing Video Messages From a Small Screen: Effects on Emotion, Attention, and Memory. *Journal of Experimental Psychology: Applied, 10*, 120-113. doi: 10.1037/1076-898x.10.2.120

Reed, S. K., Ernst, G. W., & Banerji, R. (1974). The role of analogy in transfer between similar problem states. *Cognitive Psychology, 6*, 436-450. doi: 10.1016/0010-0285(74)90020-6

Rohr, M., Degner, J., & Wentura, D. (2012). Masked emotional priming beyond global valence activation. *Cognition and Emotion, 26*, 224-244. doi: 10.1080/02699931.2011.576852

*+Root, J. C., Wong, P. S., & Kinsbourne, M. (2006). Left hemisphere specialization for response to positive emotional expressions: A divided output methodology. *Emotion, 6*, 473-483. doi: 10.1037/1528-3542.6.3.473

Rosch, R. H. (1975). Cognitive reference points. *Cognitive Psychology, 7*, 532-547. doi: 10.1016/0010-0285(75)90021-3.

Rosenthal, R., & DiMatteo, M. R. (2001). Meta-analysis: Recent developments in quantitative methods for literature reviews. *Annual Review of Psychology, 52*, 59-82. doi: 10.1146/annurev.psych.52.1.59

Rothermund, K. (2003). Motivation and attention: Incongruent effects of feedback on the processing of valence. *Emotion, 3*, 223-238. doi: 10.1037/1528-3542.3.3.223

Rothermund, K., Gast, A., & Wentura, D. (2011). Incongruency effects in affective processing: Automatic motivational counter-regulation or mismatch-induced salience? *Cognition and Emotion, 25*, 413-425. doi: 10.1080/02699931.2010.537075

Rothermund, K., & Wentura, D. (1998). Ein fairer Test für die Aktivationsausbreitungshypothese: Untersuchung affektiver Kongruenzeffekte in der Stroop-Aufgabe. *Zeitschrift für Experimentelle Psychologie, 45*, 120 - 135.

Rotteveel, M., & Phaf, R. H. (2004). Automatic Affective Evaluation Does Not Automatically Predispose for Arm Flexion and Extension. *Emotion, 4*, 156-172. doi: 10.1037/1528-3542.4.2.156

Rozin, P., & Royzman, E. B. (2001). Negativity bias, negativity dominance, and contagion. *Personality and Social Psychology Review, 5*, 296-320. doi: 10.1207/S15327957pspr0504_2

+Sanbonmatsu, D. M., Posavac, S. S., Vanous, S., Ho, E. A., & Fazio, R. H. (2007). The deautomatization of accessible attitudes. *Journal of Experimental Social Psychology, 43*, 365-378. doi: 10.1016/j.jesp.2006.04.008

+Schirmer, A., Kotz, S. A., & Friederici, A. D. (2005). On the role of attention for the processing of emotions in speech: Sex differences revisited. *Cognitive Brain Research, 24*, 442-452. doi: 10.1016/j.cogbrainres.2005.02.022

Schmitz, M., & Wentura, D. (2012). Evaluative priming of naming and semantic categorization responses revisited: A mutual facilitation explanation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 38*, 984-1000. doi: 10.1037/a0026779

Schwibbe, M., Räder, K., Schwibbe, G., Borchardt, M., & Geiken-Pophanken, G. (1994). Zum emotionalen Gehalt von Substantiven, Adjektiven und Verben

[The emotional meaning of substantives, adjectives, and verbs.]. In W. Hager & M. Hasselhorn (Eds.), *Handbuch deutschsprachiger Wortnormen [Handbook of German word norms]* (pp. 272-284). Göttingen: Hogrefe.

*+Sollberger, B., Reber, R., & Eckstein, D. (2003). Musical chords as affective priming context in a word-evaluation task. *Music Perception, 20*, 263-282. doi: 10.1525/mp.2003.20.3.263

Spruyt, A., De Houwer, J., Everaert, T., & Hermans, D. (2012). Unconscious semantic activation depends on feature-specific attention allocation. *Cognition, 122*, 91-95. doi: 10.1016/j.cognition.2011.08.017

Spruyt, A., De Houwer, J., & Hermans, D. (2009). Modulation of automatic semantic priming by feature-specific attention allocation. *Journal of Memory and Language, 61*, 37-54. doi: 10.1016/j.jml.2009.03.004

Spruyt, A., Gast, A., & Moors, A. (2011). The sequential priming paradigm: A primer. In K. C. Klauer, A. Voss & C. Stahl (Eds.), *Cognitive methods in social psychology* (pp. 48-77). New York, NY: Guilford Press.

Spruyt, A., Hermans, D., De Houwer, J., & Eelen, P. (2002). On the nature of the affective priming effect: Affective priming of naming responses. *Social Cognition, 20*, 227. doi: 10.1521/soco.20.3.227.21106

Spruyt, A., Hermans, D., De Houwer, J., & Eelen, P. (2004). Automatic non-associative semantic priming: Episodic affective priming of naming responses. *Acta Psychologica, 116*, 39-54. doi: 10.1016/j.actpsy.2003.12.012

Spruyt, A., Hermans, D., De Houwer, J., Vandromme, H., & Eelen, P. (2007). On the nature of the affective priming effect: Effects of stimulus onset asynchrony and congruency proportion in naming and evaluative categorization. *Memory & Cognition, 35*, 95-106. doi: 10.3758/BF03195946

Spruyt, A., Hermans, D., Pandelaere, M., De Houwer, J., & Eelen, P. (2004). On the Replicability of the Affective Priming Effect in the Pronunciation Task. *Experimental Psychology 51*, 109 -115. doi: 10.1027/1618-3169.51.2.109

Suslow, T., Arolt, V., & Junghanns, K. (1998). Alexithymie und automatische Aktivierung emotional-evaluativer Information. *Psychotherapie, Psychosomatik, Medizinische Psychologie, 48*, 168-175.

*Suslow, T., Ohrmann, P., & Arolt, V. (2001). Ausgestaltung sogenannter affektiver Voraktivierungseffekte in der evaluativen Entscheidungsaufgabe: Hinweise auf automatische Vigilanz für negative Informationen. *Zeitschrift für Psychologie mit Zeitschrift für angewandte Psychologie, 209*, 137-152. doi: 10.1026//0044-3409.209.2.137

Taylor, S. E. (1991). Asymmetrical effects of positive and negative events: The mobilization-minimization hypothesis. *Psychological Bulletin, 110*, 67-85. doi: 10.1037/0033-2909.110.1.67

Tversky, A. (1977). Features of similarity. *Psychological Review, 84*, 327-352. doi: 10.1037/0033-295x.84.4.327

Unkelbach, C. (2012). Positivity advantages in social information processing. *Social Psychology Compass, 6*, 83-94. doi: 10.1111/j.1751-9004.2011.00407.x

Unkelbach, C., & Burghardt, J. (in prep.). Density in Semantic Space predicts Categorical Priming Effects.

Unkelbach, C., Fiedler, K., Bayer, M., Stegmueller, M., & Danner, D. (2008). Why positive information is processed faster: The density hypothesis. *Journal of Personality and Social Psychology, 95*, 36-49. doi: 10.1037/0022-3514.95.1.36

Unkelbach, C., & Greifeneder, R. (Eds.). (2013). *The experience of thinking: How the fluency of mental processes influences cognition and behavior*. Hove: Psychology Press.

+Veldhuizen, M. G., Oosterhoff, A. F., & Kroeze, J. H. A. (2010). Flavors prime processing of affectively congruent food words and non-food words. *Appetite, 54*, 71-76. doi: 10.1016/j.appet.2009.09.008

*+Vermeulen, N., Luminet, O., & Corneille, O. (2006). Alexithymia and the automatic processing of affective information: Evidence from the affective priming paradigm. *Cognition & Emotion, 20*, 64-91. doi: 10.1080/02699930500304654

+Wentura, D. (1998). Affektives Priming in der Wortentscheidungsaufgabe: Evidenz für postlexikalische Urteilstendenzen. *Sprache & Kognition, 17*, 125-137.

Wentura, D. (1999). Activation and Inhibition of Affective Information: Evidence for Negative Priming in the Evaluation Task. *Cognition & Emotion, 13*, 65-91. doi: 10.1080/026999399379375

Wentura, D., & Degner, J. (2010a). Automatic evaluation isn’t that crude! Moderation of masked affective priming by type of valence. *Cognition and Emotion, 24*, 609-628. doi: 10.1080/02699930902854587

Wentura, D., & Degner, J. (2010b). Guide to sequential Priming In B. Gawronski & B. K. Payne (Eds.), *Handbook of implicit social cognition: Measurement, theory, and applications*. New York, NY: Guilford Press.

Wittenbrink, B. (2007). Measuring attitudes through priming. In B. Wittenbrink & N. Schwarz (Eds.), *Implicit measures of attitudes* (pp. 17-58). New York: Guilford Press.

Young, F. W., & Hamer, R. M. (1987). *Multidimensional scaling: History, theory, and applications*. Hillsdale, England: Lawrence Erlbaum.

Appendix

Primes and Targets used in Experiment 1 to 4 (German translations in parentheses).

Positive		Negative	
Primes	Targets	Primes	Targets
Experiment 1			
positive similar negative dissimilar			
birthday (Geburtstag)	gift (Geschenk)	cancer (Krebs)	taxes (Steuer)
sunshine (Sonnenschein)	music (Musik)	alcoholism (Alkoholismus)	recession (Rezession)
cake (Kuchen)	flowers (Blumen)	toothache (Zahnschmerz)	cockroach (Kakerlake)
summer (Sommer)	friend (Freund)	virus (Virus)	bombs (Bomben)
positive dissimilar negative similar			
kitten (Kätzchen)	pizza (Pizza)	bombs (Bomben)	war (Krieg)
gift (Geschenk)	Hawaii (Hawaii)	death (Tod)	hate (Hass)
strawberry (Erdbeere)	holiday (Urlaub)	disease (Krankheit)	crime (Verbrechen)
music (Musik)	movies (Kino)	hell (Hölle)	guns (Gewehre)

Positive Primes and Targets		Negative Primes and Targets	
Experiment 2			
salary (Gehalt)	right (Recht)	blemish (Makel)	radiation (Strahlung)
armchair (Sessel)	eagle (Adler)	chasm (Kluft)	hornet (Hornisse)
cat (Katze)	swimming (Schwimmen)	rat (Ratte)	smoking (Rauchen)
benefit (Nutzen)	snow (Schnee)	error (Irrtum)	hardness (Härte)
Experiment 3 - 4			
summer (Sommer)	gift (Geschenk)	divorce (Scheidung)	virus (Virus)
ice cream (Eiscreme)	music (Musik)	litter (Abfall)	cancer (Krebs)
friend (Freund)	hawaii (Hawaii)	war (Krieg)	hell (Hölle)
movies (Kino)	kitten (Kätzchen)	taxes (Steuern)	hate (Hass)

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der Ruprecht-Karls-Universität Heidelberg**
Doctoral Committee of the Faculty of Behavioural and Cultural Studies, of Heidelberg University

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für die Fakultät für Verhaltens- und Empirische Kulturwissenschaften**
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