Evaluative priming in non-evaluative priming tasks
A mutual facilitation account

Dissertation zur Erlangung des akademischen Grades
eines Doktors der Philosophie der Philosophischen
Fakultät III der Universität des Saarlandes

vorgelegt von

Melanie Schmitz
aus Saarlouis

Saarbrücken, Juli 2012

Dekan:

Prof. Dr. Jochen Kubiniok, Universität des Saarlandes

Berichterstatter:

Prof. Dr. Dirk Wentura, Universität des Saarlandes

Prof. Dr. Hubert D. Zimmer, Universität des Saarlandes

Tag der Disputation: 11. Juli 2012

Dank

Zunächst und vor allem möchte ich meinem Betreuer Dirk Wentura danken, der mir jederzeit mit fachlichem Rat und praktischer Unterstützung zur Seite stand. Ich danke ihm besonders für seine unermessliche Geduld, seine Menschlichkeit, sein außerordentliches Engagement für seine Mitarbeiter, die Studenten und die wissenschaftliche Arbeit an sich, und seine ermutigenden Worte in schwierigen Phasen dieser Arbeit. Ohne seine inhaltliche und motivationale Unterstützung wäre diese Arbeit nicht möglich gewesen.

Ich danke auch den Verantwortlichen des Graduiertenkollegs *Adaptive Minds*, das mir einen sehr angenehmen und motivierenden Rahmen zum Promovieren geboten und mir unter anderem einen interessanten Aufenthalt in Peking ermöglicht hat. Besonders danke ich Hubert Zimmer für die Gutachtertätigkeit.

Herzlichst möchte ich mich bei meinen lieben und stets hilfsbereiten Kolleginnen bedanken, die in zahlreichen Mittags-/Mensapausen einen sehr wichtigen, besonders motivationalen Beitrag zu dieser Arbeit geleistet haben.

Außerdem möchte ich mich bei Tobias und Heiko für die große Hilfe rund ums Testen bedanken, und Thorsten danke ich für die vielen praktischen Ratschläge und die umfangreiche Unterstützung bei der Durchführung der EEG-Studie.

Ganz besonders möchte ich mich bei den zahlreichen Versuchspersonen bedanken, ohne deren Bereitschaft zur Teilnahme an psychologischen Experimenten eine solche Arbeit nicht möglich wäre.

Abschließend möchte ich mich bei meinen Freunden, Geschwistern und Eltern für ihr Verständnis und ihre unendliche Geduld in den letzten drei Jahren und vor allem in der akuten Schreibphase dieser Arbeit bedanken. Ganz besonders danke ich meinen Eltern für die bedingungslose, finanzielle Unterstützung während meines gesamten Studiums und dafür, dass sie stets wertschätzen, was ich tue.

ABSTRACT

The main purpose of this thesis is to introduce and examine a three-process model on evaluative priming which may account for evaluative priming effects (i.e., faster and more accurate responses to a target following an evaluatively congruent when compared with an incongruent prime) in various task settings. The model was developed with regard to theoretical interpretations of evaluative priming and on the basis of the empirical evidence of the evaluative priming effect. On the one hand, different variants of the evaluative priming paradigm (i.e., the S–R-based variant with the evaluative categories being task-relevant and the S–S-based variant with the evaluative categories being task-irrelevant) have remarkably different and partly conflicting requirements on the memory representation of evaluative connotations. On the other hand, the empirical evidence of evaluative priming effects beyond the S–R-based variant is highly ambiguous since positive, null, and even negatively signed effects have been published (see Klauer & Musch, 2003, for a review).

Taking these inconsistencies into account, the three-process model suggests an interaction of three processes in any evaluative priming task. The first process characterizes the mutual facilitation of evaluatively congruent concepts which may result in facilitated target encoding on one hand (as it is necessary for the explanation of S–S-based evaluative priming) and maintained prime activation on the other (as it was suggested by Wentura & Rothermund, 2003); the second process describes the parallel activation of prime and target concepts (as it is a precondition for the explanation of S–R-based evaluative priming); finally, the third process takes the response-related interactions of prime and target concepts into account. Generally speaking, the three-process model postulates that the specific interaction and the relative size of the suggested processes determine the direction and magnitude of the evaluative priming effect.

I conducted five experiments on evaluative priming in which both tasks and stimulus modalities varied. The main focus was to provide evidence of interaction of the three processes—as suggested by the three-process model—in an S–S-based variant of the evaluative priming paradigm, that is, with a nonevaluative primary task. As the facilitative component of maintained prime activation given evaluative congruency was largely neglected in previous

evaluative priming studies, I aimed to create experimental conditions that would increase the facilitative influence of an evaluatively congruent target on prime maintenance, while decreasing the facilitation of an evaluatively congruent prime on target encoding. For this, I applied a procedure with a negative stimulus-onset asynchrony (SOA), that is, the prime onset followed the target onset. Maintained prime activation in case of evaluative congruency was expected to yield a delayed target response given response-incompatibility between prime and target, thus, resulting in negatively signed evaluative priming effects. This was found precisely in the naming task (i.e., the target requires a naming response; Experiment 1) with response-incompatible prime and target pictures as well as in the semantic categorization task (i.e., the target requires a nonevaluative, semantic categorization response; Experiment 2a/b) with primes and targets from opposite semantic categories. In the respective conditions, without response conflict, small positive evaluative priming effects emerged. Further and more fine-grained corroboration of the suggested interaction of the three processes was searched for in event-related potential (ERP) correlates (Experiment 3). Priming effects in the N2 component (reflecting response conflict detection), the lateralized readiness potential (LRP; reflecting response preparation) and also within the P3 component (reflecting, among others, categorization effort) replicated the behavioral findings. Applying a negative and a positive SOA-procedure in different blocks of the same experiment (Experiment 4) influenced whether facilitated target encoding or maintained prime activation was the more dominant process in case of evaluative congruency. Compared with the negative SOA-procedure, a positive SOA led to a positive shift of the evaluative priming effects, indicating a larger influence of target-encoding facilitation in relation to prime-activation maintenance. Facilitated activation of evaluatively congruent stimuli seems to be no general phenomenon of same category membership, as no comparable facilitation effects were observed within the—when compared with the evaluative categories—rather cold semantic categories such as *persons* and *animals* (Experiment 5a/b).

My experiments provide evidence for the idea that in a sequential evaluative priming task, evaluative congruency may support prime activation in a similar way as it facilitates target encoding. While the latter process was often considered accountable for S–S-based evaluative priming effects, the former process was rather neglected within previous evaluative priming research. Since the evaluative connotations of prime and target are activated and influence the response process—even without task requirement—the evaluative features of semantic concepts seem to be processed in a prioritized manner. These findings create specific requirements for the memory representation of the evaluative connotations: An appropriate representation model should allow for mutual facilitation of evaluatively congruent concepts as well as simultaneous activation and potential response competition of these concepts. While facilitative activation of evaluatively congruent concepts may be realized by concept pre-activation, due to feature overlap, synchronous firing of all features belonging to the same concept may enable parallel activation of several concepts.

CONTENTS

PREFACE

In everyday life, there are numerous objects and events that bombard our senses at any given moment in time. However, only very few of these experiences arrive at the level of consciousness; otherwise, our cognitive system would be highly overloaded and could possibly collapse (e.g., Bargh, 1997). It is on one hand, nonetheless, very important and relevant for our survival that we continuously check our environment for potential dangers and threats while at the same time checking for advantages or potential benefits; otherwise, we could miss benefits or overlook dangers. This process of examining the environment for potential benefits and dangers indicates the process of evaluation. In fact, it is difficult to imagine objects that are not evaluated (e.g., Neumann, Förster, & Strack, 2003; Zajonc, 1980). In correlation to this subject, Duckworth, Bargh, Garcia, and Chaiken (2002, p. 518) concluded that “all experience is continually evaluated as either positive or negative, whether one ponders one’s feelings about it or not”. Thus, it is highly accepted that humans continuously evaluate their environment in regard to advantages and disadvantages. Evaluative processing encompasses the categorization of something as good or bad, positive or negative, pleasant or unpleasant. In this context, Frijda (1986, p. 207) claimed that “events, objects, and situations may possess positive and negative valence; that is, they may possess intrinsic attractiveness or aversiveness”. Evaluating something as good or bad activates the positive or negative attitude toward the specific person, object or event. According to Fazio (1989), attitudes can be comprised as a link between an attitude object in memory and the evaluation of this object.

Numerous empirical findings substantiate the assumption of automatic attitude activation: when humans detect objects in the environment (e.g., Öhmann, Flykt, & Esteves, 2001), when they remember studied material in a recognition memory task (e.g., Zajonc, 1980) or even when they are confronted with new verbal or pictorial stimuli (see Duckworth et al., 2002), their positive and negative attitudes toward the relevant stimuli are almost automatically activated. Due to these findings, some researchers in the field of cognition and emotion postulated a prioritized processing of the evaluative meaning of semantic concepts in comparison with the semantic, non-evaluative meaning (e.g., Bargh, 1997; Bargh, Chaiken, Raymond, & Hymes, 1996; Murphy & Zajonc, 1993; Öhmann et al., 2001; Zajonc, 1980).

Further corroboration for the privileged status of the evaluative features of semantic concepts comes from the development of the semantic differential by Osgood (1967). He defined the evaluative dimension as one of three major dimensions of semantic meaning, along with the dimensions activity (active – passive) and potency (strong – weak). In comparison to the two other dimensions, the evaluative dimension turned out to be the most important one. This was, for example, empirically shown in a priming task in which congruency and incongruency effects were reported for the evaluative dimension, but not for the two other dimensions (see Bargh, Raymond, & Chaiken, 1996, cited by Bargh, 1997). Osgood (1967) also premised that the evaluative meaning allows for the immediate preparation of appropriate behavioral responses, as positive evaluation may be directly related to approach and negative evaluation to avoidance behavioral tendencies. Solarz (1960) was the first researcher to report empirical evidence for a relation between evaluation and behavioral responses: Participants were faster at pulling a lever in response to positive than negative words, while they were faster at pushing a lever in response to negative than positive words. Within recent years, different models were introduced that more precisely specify the relation between evaluation and behavioral responses (e.g., Eder & Klauer, 2009; Eder, Müsseler, & Hommel 2011; Neumann et al., 2003). The automatic activation of the evaluative content of semantic concepts has a highly functional value as it informs the organism about the presence of positive and negative objects in the environment and supports an approaching behavior to positive and an avoiding behavior to negative objects (see Fazio, 2001; Wentura & Rothermund, 2003; Zajonc, 1980).

One crucial research question regarding this matter is how the evaluative connotations are represented in the semantic memory so that favored processing of the evaluative features is enabled. To examine the activation and representation of the evaluative connotations of semantic concepts, various indirect measures have been developed which all commonly explore the mechanisms of evaluative processing without directly asking the participants. The evaluative responses are primarily inferred from the speed or accuracy of the responses to the experimental stimuli in speeded reaction time tasks (see, e.g., De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009). One main advantage of indirect measures in comparison with direct measures is that the purpose of the former measures is less evident. While participants can easily guess the aim of direct measures—like verbal self-reports or questionnaires—by which these measures are highly prone to strategical faking and social desirability (e.g., Dunton & Fazio, 1997; Fazio & Olson, 2003), indirect measures may be less vulnerable to such strategic behavior (see Fazio & Olson, 2003; Wittenbrink, 2007; but see Degner, 2009; Klauer & Teige-Mocigemba, 2007; Teige-Mocigemba & Klauer, 2008 for counterevidence).

Prominent examples of indirect measures on the dynamics and mechanisms of evaluative processing are the evaluative priming paradigm (see Fazio, Sanbonmatsu, Powell, and Kardes, 1986), the implicit association test (IAT; see Greenwald, McGhee, & Schwartz, 1998), the evaluative Simon task (see De Houwer & Eelen, 1998; De Houwer, Crombez, Baeyens, & Hermans, 2001; Duscherer, Holender, & Molenaar, 2008), as well as the evaluative Stroop task (see Pratto & John, 1991; Williams, Mathews, & MacLeod, 1996). All of these tasks were developed to explore the processing of the evaluative connotations of positive and negative stimuli. Importantly, the evaluative connotations are not response-relevant in these tasks for either all used stimuli (i.e., in a variant of the evaluative priming paradigm with a non-evaluative task, in the evaluative Simon task, and in the evaluative Stroop task) or for a part of the employed stimuli (i.e., in a variant of the evaluative priming paradigm with an evaluative task and in the IAT).

Since the purpose of my experiments was to examine the underlying mechanisms of the evaluative priming effect, I will constrain the detailed description on this paradigm. Concisely, the evaluative priming paradigm provides information about the representation of the evaluative connotations in semantic memory, via exploring the effect of evaluative congruency versus incongruency between two sequentially presented semantic concepts in speeded reaction time tasks. Since the seminal paper by Fazio and colleagues (1986) was published, different variants of the evaluative priming paradigm were introduced that require quite different interpretations concerning the evaluative processing. In the following sections I will give a short outline of my thesis.

Outline

In Chapter I, I provide a theoretical overview of the specific characteristics of evaluative processing. Specifically, I characterize the evaluative priming paradigm with a special focus on the differentiation of the S–R-based and the S–S-based variant of it, including the respective empirical evidence and the respective interpretation of evaluative priming effects. Additionally, I discuss the memory representation of the evaluative connotations with respect to different models of semantic memory. Accounting for the crucial inconsistencies concerning the explanation of evaluative priming effects in different variants of the evaluative priming paradigm, I introduce the three-process model of evaluative priming. Subsequently, I aim to apply the model assumptions to previously published findings in evaluative priming studies and derive the empirical hypotheses for my experiments.

In Chapter II, I report the basic empirical finding of evaluative priming in the naming task (Experiment 1) and the semantic categorization task (Experiment 2a/b). Basically, these studies showed that—due to the negative SOA-procedure—evaluative congruency did not primarily facilitate target encoding, but mainly supported prime activation and increased subsequent response conflicts of prime and target. This resulted in negatively signed evaluative priming effects. If prime and target did not compete for response resources, evaluative congruency slightly facilitated the target response, yielding small positive evaluative priming effects.

In Chapter III, I report further corroboration for the behavioral findings and the theoretically suggested processes in the event-related potential (ERP). In a fairly exact replication of Experiment 2b (Experiment 3), several theoretically relevant ERP correlates were analyzed; selectively, the N2 component, the P3 component, as well as the lateralized readiness potential (LRP). Compared with the behavioral effects, a similar interaction of the evaluative and response factors emerged in the ERP correlates.

Chapter IV deals with critical aspects of the basic finding. In Experiment 4, I tested in how far the conditional priming effects could be manipulated by a SOA-variation. In Experiment 5a/b, the valence-specificity of the conditional priming effects was examined. For this, I applied the evaluation task instead of the semantic categorization task, whereby the evaluative categories were made task-relevant and the semantic categories, conversely, task-irrelevant.

In Chapter V, I sum up my findings and discuss their theoretical relevance to the interpretation of evaluative priming. I argue that the three-process model is well suited to account for the present and previously published evaluative priming findings. Additionally, I consider crucial implications of my results and the main assumptions of the three-process model for the memory representation of the evaluative connotations. Finally, I address some limitations and critical aspects of the present experiments and close with a short conclusion.

1 Evaluation: Activation and Representation

In the following sections, I will first characterize the evaluative priming paradigm and distinguish two of its broad variants which largely differ with regard to the underlying, cognitive processes. Thereafter, I will discuss the implications of evaluative priming effects in both variants for the memory representation of the evaluative connotations. Finally, I will introduce the three-process model of evaluative priming that aims to provide an integrative explanation model for both variants of evaluative priming.

1.1 Evaluative priming: One label – Two paradigms

The evaluative priming paradigm represents a promising indirect measure of the processes underlying stimulus evaluation and describes an evaluative variant of the sequential semantic priming paradigm.[1] This paradigm has been widely used when examining how semantic concepts are structured and processed in long-term memory (see Bargh & Chartrand, 2000) and was first applied in order to explore the semantic or associative relations between different semantic concepts (see McNamara, 2005; Neely, 1991). The evaluative priming paradigm, by analogy, examines the evaluative relation (i.e., congruency and incongruency) between evaluatively connoted concepts. First applied by Fazio and colleagues (1986), a positive or negative target is preceded by a positive or negative prime, while only the target requires a response. Typically, faster and more accurate target responses arise in evaluatively congruent conditions (e.g., both prime and target are positive) compared to incongruent conditions (e.g., the prime is positive and the target is negative; see, e.g., Bargh, Chaiken, Govender, & Pratto, 1992; Bargh et al., 1996; Degner, 2009; Eder, Leuthold, Rothermund, & Schweinberger,

[1] In previous studies, the term *affective priming* was often used instead of the term *evaluative priming* (see Wittenbrink, 2007). As the purpose of my experiments was to examine the processing of the evaluative features of semantic concepts and as I selected my experimental stimuli primarily with respect to their evaluative connotations (and not with respect to their affective content), I will term the kind of priming that I explored *evaluative priming*. By this notion, I aim to refer to the features good/bad, positive/negative or pleasant/unpleasant.

2011; Fazio et al., 1986; Greenwald, Klinger, & Liu, 1989; Hermans, De Houwer, & Eelen, 1994, 2001; Klauer et al., 1997; Teige-Mocigemba & Klauer, 2008). This difference in mean response times (RTs) and mean errors is labeled the *evaluative priming effect*. It indicates how far target processing is facilitated if the preceding prime shares the evaluative connotation with the target. On the basis of this basic effect, evaluative priming effects were examined in different variants of the paradigm (see Klauer & Musch, 2003 for a review). Several parameters were varied in order to test their influence on the evaluative priming effect.

One of the most influential parameters represents the temporal distance of prime and target onset (i.e., the stimulus-onset asynchrony [SOA]). While most studies reported positive evaluative priming effects with SOAs between 150 and 300 ms (see, e.g., Bargh et al., 1992, 1996; Degner, 2009; De Houwer et al., 1998; Eder et al., 2011; Fazio et al., 1986; Fockenberg, Koole, & Semin, 2006; Giner-Sorolla, Garcia, & Bargh, 1999; Hermans et al., 1994; Hermans, Spruyt, & Eelen, 2003; Klauer & Teige-Mocigemba, 2007; Teige-Mocigemba & Klauer, 2008; Wentura, 1999, 2000), studies using longer SOAs failed to find any evaluative priming effect (De Houwer et al., 1998; Fazio et al., 1986; Hermans et al., 1994, 2001, 2003; Klauer et al., 1997). Therefore, the evaluative priming effect was interpreted as fast-acting and short-lived automatic process (e.g., Hermans et al., 2001, 2003). Some authors examined evaluative priming even with negative SOA-procedures (i.e., the target precedes the prime) and reported positive (Fockenberg et al., 2006) or null evaluative priming effects (Hermans et al., 2001; Klauer et al., 1997), respectively. (Further information on this issue will be addressed latterly.) Fockenberg and colleagues (2006) interpreted their finding of a positive evaluative priming effect in such that stimulus evaluation represents a continuous process that does not end at target onset. Instead, it may serve adaptive functions and alert the individual to sudden critical changes, like the presentation of the following, evaluatively connoted prime.

As a further parameter, the stimulus modality of the primes was varied across experiments: While most studies used written or spoken words (e.g., Bargh et al., 1992, 1996; Chaiken & Bargh, 1993; De Houwer, Hermans, Rothermund, & Wentura, 2002; Fazio et al., 1986; Hermans et al., 1994; Klauer & Musch, 2001), also pictures (e.g., Everaert, Spruyt, & De Houwer, 2011; Spruyt, Hermans, De Houwer, & Eelen, 2002, 2004; Wentura & Frings, 2008), linedrawings (Giner-Sorolla et al., 1999), photographs (Banse, 2001), and odours (Hermans, Baeyens, & Eelen, 1998) were applied as primes. In several studies, the prime presentation was even masked (e.g., Abrams & Greenwald, 2000; Banse, 2001; Draine & Greenwald, 1998; Greenwald, Draine, & Abrams, 1996).

Of high relevance for the interpretation of the evaluative priming effect and for the implications concerning the memory representation of the evaluative connotations, there is a further characteristic of the evaluative priming paradigm, namely, the applied task. The tasks used in previous studies can roughly be categorized into two groups: tasks requiring an evaluative categorization of the target (i.e., the evaluation task) and tasks requiring no evaluative response. Prominent examples for the latter group of tasks are (a) the naming task that solely requires target naming, (b) the semantic categorization task, in which the target is categorized according to semantic, nonevaluative categories, and (c) the lexical decision task, which is associated with target categorizations according to their lexicality (e.g., word or nonword). Since the differentiation of these both broad groups of evaluative priming tasks plays an important role in my theoretical considerations regarding an account of evaluative priming, I will characterize both variants of the evaluative priming paradigm and discuss the empirical evidence for both variants. Referring to both kinds of the evaluative priming paradigm, I will use the terminology proposed by De Houwer (2003) that takes the level of processes that are responsible for the prime-target interaction into account.

1.1.1 The S–R-based variant

In this variant of the evaluative priming paradigm, the evaluative connotation of the target is task-relevant, that is, participants are required to categorize the target according to its valence (e.g., Bargh et al., 1992; Fazio et al., 1986; Giner-Sorolla et al., 1999). As the prime also varies according to the evaluative dimension, it may also call for evaluative categorization that is, in turn, either compatible or incompatible with the target evaluation. Since evaluative congruency and response-compatibility of prime and target are directly interconnected, the evaluative priming effect in this case is typically explained by response-related processes: In evaluatively compatible trials (i.e., both target and prime are positive or negative, respectively), prime and target are associated with the same response category (i.e., categorization as *positive* or *negative*). In contrast, within evaluatively incompatible trials, prime and target call for opposing responses. Hence, the prime either supports the correct target response or interferes with it (see Klauer et al., 1997; Wentura, 1999). As priming effects can be attributed to the similarity between stimulus and response features (i.e., the evaluative feature of the prime and the evaluative categorization of the target), this kind of evaluative priming is considered *S–R-based* priming (see De Houwer, 2003). Note that the term *response priming design* was alternatively introduced to refer to the evaluative priming paradigm with the evaluation task (see Wentura & Degner, 2010). The reasons for this terminology are the structural analogy of the evaluation task with different non-evaluative response priming tasks (see Banaji & Hardin, 1996; Rosenbaum & Kornblum, 1982; Vorberg, Mattler, Heinecke, Schmidt, & Schwarzbach, 2003) and the fact that evaluative priming effects can be traced back to the similarity between prime and target responses.

Fazio and colleagues (1986) claimed that the evaluative connotations of valenced objects are stored in a way that they are automatically activated by related stimuli. According to Fazio’s (1989) attitude theory, there are strong and direct associations between a given attitude object and its evaluation. In line with this theory, the mere activation of the attitude object automatically activates the corresponding evaluation, even if no evaluation is required. Thus, in a sequential evaluative priming task the evaluation that is associated with the prime should automatically be activated at prime onset and—in case of evaluative congruency—pre-activate the target evaluation. Given evaluative incongruency, the evaluation associated with the prime may hamper the target evaluation (see Klinger, Burton, & Pitts, 2000; Wentura, 1999).

The S–R-based evaluative priming effect was reliably reported in a large number of studies (see, e.g., Bargh et al., 1992; De Houwer, Hermans, & Eelen, 1998; Fazio et al., 1986; Greenwald et al., 1989; Hermans et al., 1998; Hermans, De Houwer, & Eelen, 1996) and was even found with subliminal prime presentation (Abrams & Greenwald, 2000; Draine & Greenwald, 1998; Greenwald et al., 1989). With long SOA-procedures around 1000 ms, no S–R-based evaluative priming effects were reported (see De Houwer et al., 1998; Hermans et al., 2001; Klauer et al., 1997). These null findings speak for the short-lived character of the S–R-based evaluative priming effect.

Several authors (e.g., De Houwer, 2003; Hermans et al., 1994; Klauer et al., 1997; Rothermund & Wentura, 1998; Wentura, 1999) related the S–R-based variant of the evaluative priming paradigm to the Stroop paradigm (i.e., the ink color of color words has to be named, while the color name has to be ignored; see Stroop, 1935; MacLeod, 1991) or the flanker paradigm (i.e., a centrally presented target stimulus is flanked by response-compatible or incompatible distractors; see Eriksen & Eriksen, 1974; Shaffer & LaBerge, 1979). In all these paradigms, a task-relevant stimulus (or a task-relevant stimulus feature in the Stroop task) requires a specific response, while a distractor (or a distracting feature in the Stroop task) activates a competing response. Thus, the S–R-based evaluative priming effect can easily be explained with a response-based account, that is, the prime either facilitates (in case of evaluative congruency) or hampers (in case of incongruency) the target response (see De Houwer et al., 2002; Klauer et al., 1997; Klinger et al., 2000; Rothermund & Wentura, 1998; Wentura, 1999, 2000).

Empirical corroboration for an analogy of the S–R-based evaluative priming effect with the Stroop effect came from different research lines. Musch and Klauer (2001) showed attentional influences on the S–R-based evaluative priming effect: If prime and target appeared at the same time and the target location was cued, no evaluative priming effect emerged. That means, since the attention was restricted to a single location, the prime could be successfully ignored. Similar attentional effects were reported in the Stroop task (e.g., Besner & Stolz, 1999).

Further support was given by different studies with a negative priming variant of S–R-based evaluative priming (see Wentura, 1999; Frings & Wentura, 2008). The target response in the current trial (i.e., the probe trial according to the terminology of the negative priming paradigm) was slowed down if the preceding trial (i.e., the prime trial according to the same terminology) was an evaluatively incongruent one and the target response in the current trial was congruent to the prime response in the preceding trial. This effect was interpreted in such that the prime-associated response in the preceding, incongruent trial had to be inhibited, yielding a residual inhibition in the current trial. This residual inhibition was observable if the inhibited response was the target-associated response in the current trial. As such sequential effects were also found with the flanker and the Stroop task (see Botvinick, Nystrom, Fissell, Carter, & Cohen, 1999; Frings &

Wentura, 2008; Greenwald & Rosenberg, 1978), these findings confirm the analogy of the S–R-based evaluative priming paradigm with these paradigms.

Furthermore, strategic influences on the S–R-based evaluative priming effect were shown. Klauer and colleagues (1997), for example, reported significant influences of the proportion of evaluatively congruent trials on the S–R-based evaluative priming effect: If at least half of the trials were evaluatively congruent the effect was significantly positive, while when the majority of the trials was incongruent, it broke down. In other studies, the S–R-based evaluative priming effect disappeared or even reversed if the participants were explicitly instructed how to respond in order to eliminate any positive effect (see Degner, 2009; Klauer & Teige-Mocigemba, 2007; Teige-Mocigemba & Klauer, 2008). These findings suggest that strategic influences play an important role in the S–R-based evaluative priming task and that positive effects do not occur unconditionally and automatically.

Further evidence for the response-based account of S–R-based evaluative priming comes from event-related potential (ERP) studies that provided brain-electrical correlates of the S–R-based evaluative priming effect in the activity of the motor cortex (see Bartholow, Riordan, Saults, & Lust, 2009; Eder et al., 2011).

Several authors examined S–R-based evaluative priming with a negative SOA-procedure. Yet only Fockenberg and colleagues (2006) reported positive effects with a SOA of -100 ms, while others failed to find any effect (Hermans et al., 2001; Klauer et al., 1997). Fockenberg and colleagues' (2006) findings of a positive S–R-based evaluative priming effect correlates with the response-based account of S–R-based evaluative priming (see Klauer et al., 1997; Wentura, 1999). Despite the negative SOA, the prime may appear before the target response preparation has been finished and, thereby, the prime can still interfere with the target response. If, however, the prime onset is too late after target onset and the target response preparation has progressed too much, the prime is no longer able to influence the target response. So, Fockenberg and colleagues (2006) found no S–R-based evaluative priming effect with SOAs longer than -100 ms (in particular, -250 and -400 ms). An explanation for the positive effect reported by Fockenberg, but the null effects in other studies (Hermans et al., 2001; Klauer et al., 1997) might be that in the former study, primes and targets were the same stimuli, while in the latter studies, primes and targets were selected from different stimulus sets. This feature may have manipulated the prime response association and, thereby, the S–R-based evaluative priming effect.

Given the response-based account for S–R-based evaluative priming, one implicitly accepts that both responses, that is, the response corresponding to the prime as well as the response corresponding to the target, are simultaneously activated. Since only if both responses are activated at the same time, can they either support (in case of evaluative congruency) or interfere (in case of evaluative incongruency) with each other. Further reference to this hidden assumption of S–R-based evaluative priming will follow later as it is crucial for my theoretical considerations on the explanation of evaluative priming and the memory representation of the evaluative connotations.

1.1.2 The S–S-based variant

In the S–S-based variant of the evaluative priming paradigm, the evaluative connotation of the target is not task-relevant. Here, various conceivable tasks have this one thing in common; no response concerning the evaluative connotation of the target is required. One prominent example is the naming task, in which participants are simply required to name the target stimulus, while prime and target vary according to the evaluative dimension. An evaluative priming effect in this task means that participants are able to pronounce the target faster and more accurately if it is preceded by an evaluatively congruent prime (compared with an incongruent one), even though the evaluative connotations of both target and prime are task-irrelevant. As priming effects can be attributed to the similarity between stimulus features (rather than the similarity between prime and target *responses*), this kind of evaluative priming is considered *S–S-based* priming (see De Houwer, 2003). Alternatively, Wentura and Degner (2009) suggested the term *semantic priming design* referring to evaluative priming with tasks that do not require evaluative responses, as any evaluative priming effect in such tasks has to be traced back—analogous to semantic priming effects (see Neely, 1991; McNamara, 2005, for reviews)—to the prime-target relation with regard to their evaluative connotations in the sense of semantic features (rather than the prime-target relation with regard to their responses).

The most important difference between the S–S-based and the S–R-based variant of the evaluative priming paradigm represents the allowed interpretations of the evaluative priming effects. Since S–R-based evaluative priming effects can plausibly be explained with response-compatibility in case of evaluative congruency and incompatibility in case of incongruency, the evaluative feature could easily be exchanged by any other prime and target feature, while similar S–R-based priming effects could still be anticipated (see, e.g., Klinger et al., 2000, Exp. 4). Thus, the S–R-based evaluative priming effect reflects no effect that is specific for the evaluative dimension. In contrast, S–S-based evaluative priming effects suggest an interaction of the evaluative connotations corresponding to the prime and the target concepts, since evaluatively congruent and incongruent prime-target pairs differ only with respect to their evaluative connotations (while the response-based prime-target relations vary independently from the evaluative relations). Thus, an evaluative priming effect in an S–S-based design indicates that valenced concepts are evaluated independent from an evaluative goal and that a currently activated concept facilitates the encoding of an evaluatively congruent one.

In this sense, the S–S-based variant of evaluative priming can be related to the semantic priming paradigm. Here, the semantic or associative relatedness between prime and target has typically been examined in the naming or lexical decision task, in that the semantic meaning of the target is not task-relevant (see McNamara, 2005). Priming effects due to associative relatedness (e.g., the relatedness between the semantic concepts *gardener* and *plant*) have reliably been reported (see Neely, 1991) and have been explained with temporal contiguity in speech or text (McKoon & Ratcliff, 1992) or word co-occurrence within a proposition (McNamara, 1992). Furthermore, semantic priming effects due to *pure* semantic relatedness without associative relatedness (e.g., the relatedness between the semantic concepts *tree* and *plant*) have been reported (see Lucas, 2000, for a review).

Numerous studies on S–S-based evaluative priming applied the naming task, just as this task was often used in the field of semantic priming research (see Neely, 1991; McNamara, 2005). The popularity of the naming task in evaluative priming studies is due to the advantage of this task in which priming effects are not explainable with response-compatibility effects, since prime and target are always associated with different responses, independent from evaluative congruency or incongruency. Instead, priming effects of naming responses are most plausibly explained with the assumption that an evaluatively congruent prime facilitates the encoding of the target (see, e.g., Bargh et al., 1996; De Houwer, Hermans, & Spruyt, 2001; De Houwer & Randell, 2004; Duckworth et al., 2002; Ferguson, Bargh, & Nayak, 2005; Spruyt et al., 2002). Before I turn to differently suggested interpretations of the S–S-based evaluative priming effect and the respective implications for the representation of evaluatively connoted concepts, I will discuss the empirical evidence of S–S-based evaluative priming effects.

Compared with the reliable findings of S–R-based evaluative priming effects, the empirical evidence for evaluative priming with an S–S-based design has been rather inconsistent (see Klauer & Musch, 2003, for a review). With the naming task, for example, some studies reported reliable positive evaluative priming effects (e.g., Bargh et al., 1996; Giner-Sorolla et al., 1999; Hermans et al., 1994; Spruyt & Hermans, 2008; Spruyt, Hermans, De Houwer, & Eelen, 2004; Spruyt, Hermans, De Houwer, Vandromme, & Eelen, 2007), while others failed to show any evaluative priming effect (e.g., Spruyt, Hermans, Pandelaere, De Houwer, & Eelen, 2004), even in almost exact replications (see Klauer & Musch, 2001). Glaser and Banaji (1999) even reported negatively signed evaluative priming effects for extremely valenced prime words. Furthermore, several authors found evidence for evaluative priming effects with the naming task only under specific conditions (e.g., De Houwer, Hermans, & Spruyt, 2001; De Houwer & Randell, 2002, 2004; Everaert et al., 2011; Hermans et al., 2001; Spruyt, De Houwer, & Hermans, 2009; Spruyt, De Houwer, Everaert, & Hermans, 2012; Spruyt et al., 2002). Compared with the naming task, evidence for evaluative priming effects in the semantic categorization task (i.e. the target is categorized according to prespecified semantic, nonevaluative categories) is still less convincing. Some authors reported null effects (De Houwer et al., 2002; Klinger et al., 2000, Exp. 4), while others observed conditional positive effects (Spruyt, De Houwer, Hermans, & Eelen, 2007). Introducing the three-process model of evaluative priming in Section 1.3, I will provide possible reasons for this inconsistent pattern of S–S-based evaluative priming effects in the naming and the semantic categorization task.

For the sake of completeness, I would like to mention that a few studies examined evaluative priming in the lexical decision task (see Hill & Kemp-Wheeler, 1989; Kemp-Wheeler & Hill, 1992; Wentura, 2000). In all of these studies, positive S–S-based evaluative priming effects were reported, implying faster target lexicality categorization (i.e., word or non-/pseudoword) if prime and target were evaluatively congruent compared to incongruent. Wentura proposed that specific mechanisms which are characterized in the judgmental tendency account by Klauer and Stern (1992; see also Klauer & Musch, 2002, who employed the term affective-matching mechanism) might be responsible for evaluative priming effects in the lexical decision task. Overall, this account postulates that producing a judging statement about the truth of a proposed relation between a specific attitude object and a specific trait (e.g., “The German chancellor Angela Merkel is competent.”) involves a three-component process. First, the evaluative connotations of both concepts *chancellor* and *competent* are separately activated. Second, both evaluations are compared with respect to congruency or incongruency, while the outcome of this comparison is a spontaneous feeling of plausibility or implausibility. This plausibility check serves to derive an a priori hypothesis. As a consequence, in the case of evaluative congruency a judgmental tendency to affirm is qualified, while in the case of incongruency the judgmental tendency is characterized by a rejecting response. These two components are supposed to be automatic. In contrast, the third component characterizes a controlled mechanism that uses the a priori hypothesis and the available information to create an appropriate judgmental statement about the relation of the attitude object and the trait. That is, a person who likes the chancellor evaluates her as positive. Since the trait *competent* is also positively connoted, both concepts are evaluatively congruent. This leads to a feeling of plausibility and a response tendency to affirm the statement “The chancellor Angela Merkel is competent”. This tendency will bias the judgmental statement that is produced in the third controlled processing step.

Applying the judgmental tendency account to the lexical decision task, Wentura (2000) suggested that participants could interpret the lexical categorization of the target in the sense of an affirmative (i.e., “Yes, this is a word.”) or a refusing response (i.e., “No, this is not a word.”) toward the compound of prime and target. According to this logic, evaluative congruency should facilitate an affirmative response, while evaluative incongruency should facilitate a refusing response. Wentura tested this interpretation of positive evaluative priming effects in the lexical decision task against the alternative interpretation of faster target encoding by an evaluatively congruent prime. For this, he labeled the target responses as *yes*- and *no*-responses and manipulated the assignment of the responses to words and pseudowords in a between-subjects design. For half of the participants, words required the *yes*-response and pseudowords the *no*-response, while for the other half of the participants, the response assignments to the target categories were the other way around. Target words associated with the *yes*-response elicited a positive evaluative priming effect, while target words associated with the *no*-response elicited a negative effect. The significant interaction of evaluative congruency and response assignment corroborated the judgmental tendency explanation for evaluative priming effects in the lexical decision task and did not support the explanation by facilitated target encoding in case of evaluative congruency.

Thus, evaluative priming effects in the lexical decision task are most plausibly explained with processes at response instead of stimulus encoding level. Therefore, this task—just like the evaluation task—does not provide considerable information about the memory representation of the evaluative connotations. In contrast, evaluative priming effects in the naming and the semantic categorization tasks can hardly be explained with processes beyond the prime-target relation with respect to their evaluative connotations, wherefore these tasks rather allow exploring the memory representation of the evaluative connotations.

In the next Section, I will characterize different models about the memory representation of the evaluative connotations and discuss how the respective models are suited to account for evaluative priming effects in the different variants of the evaluative priming paradigm.

1.2 Memory representation of valence

One reason for the popularity of the evaluative priming paradigm is justified by the allowed theoretical implications of evaluative priming effects on the memory representation of the evaluative connotations. Positive evaluative priming effects indicate two phenomena: the first being that valenced prime stimuli seem to be evaluated immediately and without task requirement (as reflected in S–R-based evaluative priming effects); and the second being that valenced prime stimuli increase the accessibility and facilitate the processing of evaluatively congruent target stimuli (as reflected in S–S-based evaluative priming effects). These effects suggest that the evaluative features of semantic concepts have a privileged status of accessibility in the semantic memory. The question, however, remains as to how such a preferential status may be enabled in a model of semantic memory.

In the next sections, I will characterize two broad groups of semantic memory models, namely, semantic network models and parallel distributed memory models, in which both allow for a privileged representation of the evaluative features, whereas both propose largely different manifestations of the semantic knowledge. I will first describe how the evaluative connotations may be represented in semantic network models and then continue with the representation of the evaluative connotations in parallel distributed memory models.

1.2.1 Valence representation in semantic network models

Semantic network models characterize the semantic memory as a network of the representations of a person's knowledge and beliefs about semantic concepts and ideas (see, e.g., Anderson 1983; Collins & Loftus, 1975). The semantic concepts are assumed to be represented as interconnected nodes, while the strength of the connection between two nodes depends on the semantic relation between both corresponding concepts. Via these connections, the activation of one semantic concept is expected to spread to semantically related concepts, thereby increasing the accessibility of these concepts. This process is labeled *spreading activation* and has been taken into account for the interpretation of semantic priming effects (see, e.g., Anderson, 1983; Balota & Lorch, 1986; Shelton & Martin, 1992). Semantic priming effects—as explained by semantic network models—mean that the target concept is activated more easily if it is preceded by a semantically related prime concept when compared with an unrelated one. For example, the naming of the target word *coffee* may be facilitated if it is preceded by the semantically related prime word *tea* compared with the unrelated prime word *soap*.

Of special interest for the interpretation of evaluative priming effects is the adaptation of the semantic network model by Bower (1991) who considered the representation of the evaluative content of semantic concepts. He suggested an associative network model with additional nodes for positive and negative valence linked to all nodes representing positively and negatively connoted objects, respectively. In alignment with the assumption of valence nodes in Bower's adaption of a semantic network model, several authors claimed the same representational status for evaluative connotations as for semantic features (e.g., De Houwer & Hermans, 1994; De Houwer & Randell, 2004). Bower developed his model on the basis of several empirical findings providing evidence for a direct influence of a positive or negative mood on the performance in memory tasks (see Bower, 1981, 1987; Bower & Mayer, 1989). For example, if participants were in a happy mood in the learning phase, they showed a better learning performance for positively connoted stimuli compared with negatively connoted ones. A comparably beneficial effect for negatively over positively connoted stimuli emerged if participants learned the stimuli in a negative mood (e.g., Bower, 1981, 1987). Similarly, the performance in the retrieval phase did profit from a match of the induced mood in the learning and the retrieval phase compared with mismatching mood inductions in both phases (e.g., Bower, 1981; Bower & Mayer, 1989; Bower, Monteiro, & Gilligan, 1978). Furthermore, mood-congruent material was more attended to as well as more deeply processed (e.g., Forgas & Bower, 1987), and more mood-congruent than incongruent associations were stated in free associations to ambiguous words (e.g., the words *future* or *life*; see Bower, 1981). There is, however, also evidence against the preferential processing of mood-congruent material (see Bower & Forgas, 2001), so that various parameters like the personality and the motivation of the subjects (see Berkowitz, Jaffee, Jo, & Troccoli, 2000; Smith & Petty, 1995) or contextual factors (e.g., the complexity of the task; see Fiedler, 1991) have been shown to influence the impact of the participants' mood on the behavior in the current task. Thus, the affective or evaluative content of a situation may not in general but under specific conditions influence the behavior in a current task, even if it is irrelevant for the task.

Returning to the objective of evaluative priming, an interesting observation is that the associative network model by Bower (1991) is well suited to account for S–S-based evaluative priming effects. According to the model, whenever a valenced object is activated, its activation may automatically spread via the linked valence node to all evaluatively congruent memory representations that may (mutually) facilitate their activation. In a sequential evaluative priming task, the current presentation of a negative prime word (e.g., *enemy*) may activate its corresponding node in the associative network. From this node, the activation may spread to the negative valence node and—from there—to all nodes corresponding to negatively connoted concepts. Thereby, a following negative target word (e.g., *poor*) may be pre-activated, whereas a positive target word (e.g., *rich*) may be rather inhibited by a preceding negative prime word. This difference in the level of pre-activation of an evaluatively congruent target compared with an incongruent one may yield a positive S–S-based evaluative priming effect. Analogously, the activation from a positive prime may spread to a positive target. Thus, Bower's model *prima facie* provides a conclusive mechanism for the typical explanation of S–S-based evaluative priming effects: an evaluatively congruent prime is expected to facilitate target encoding (see Spruyt et al., 2002).

However, there are considerable arguments that speak against the plausibility of spreading activation as the underlying mechanism of evaluative priming effects. First, a mechanism of spreading activation between evaluatively congruent concepts does not account for several empirical findings in evaluative priming studies with an S–R-based design. For example, it does not predict a significant influence of the evaluative priming effect by the proportion of evaluatively congruent and incongruent trials, as reported by Klauer and colleagues (1997). Moreover, the spreading activation mechanism is not suited to account for sequence effects (see Greenwald et al., 1996; Wentura, 1999) that have also been found in the evaluation task. Such effects were evidenced in slower target evaluations in the current trial if the previous trial was an incongruent one and the prime in the previous trial, as well as the target in the current trial, were evaluatively congruent. As previously mentioned, however, S–R-based evaluative priming effects are most plausibly explained with response-related processes, wherefore a mechanism like spreading activation—even if existent—might be superimposed by the more dominant response process. That is, the fact that specific evaluative priming phenomena in the evaluation task are not explained by a spreading activation mechanism does not provide an argument against any impact of such a mechanism on S–R-based evaluative priming effects.

An argument that yet markedly speaks against the explanation of evaluative priming effects with a spreading of activation mechanism is provided by the fan effect (see Anderson, 1974). This effect illustrates the phenomenon that one single concept or node, respectively, is the less activated the more the total activation in the network is distributed over different semantic concepts or nodes, respectively. Since the number of evaluatively connoted concepts is quite high, the activation that is left for a single valenced concept should be too low to yield a measurable priming effect (see Bargh et al., 1996; De Houwer & Randell, 2004; Ferguson & Bargh, 2003; Hermans et al., 1996; Spruyt et al., 2002; Wentura, 1999).

Moreover, further empirical findings are not compatible with a semantic network explanation of evaluative priming. For example, Duckworth and colleagues (2002) reported evaluative judgments of novel stimuli, for which neither memory representations nor associations with valence nodes had existed before. Interpreting their effects, the authors suggested that automatic evaluation does not require strongly accessible attitude representations, but may be driven by on-line evaluative processes. In other studies (e.g., Deacon, Hewitt, & Tamny, 1998; Masson, 1991), the semantic priming effect was eliminated by the presentation of an intervening, unrelated stimulus between prime and target presentations. If the activation were to always spread automatically from the currently activated node to related ones, this should yield observable encoding facilitation of related concepts, independent from the presentation of an intervening, unrelated concept. Thus, such effects can hardly be explained with the mechanism of spreading activation.

Due to these considerable difficulties which account for several empirical findings, spreading activation may not represent the only explanatory mechanism for evaluative priming effects. As a consequence, this, however, also challenges the suitability of semantic network models which deal with evaluative priming effects. A promising alternative to the rather outdated semantic network models is illustrated by adaptations of parallel distributed memory models to the objective of priming research (see Masson, 1991, 1995; McRae, de Sa, & Seidenberg, 1997). Following in Section 1.2.2, I will characterize the basic idea of these models and their appropriateness to account for evaluative priming effects.

It should be noted that a memory model aiming to explain evaluative priming effects needs to provide a mechanism that allows for the enhanced accessibility of negative information by the processing of negative information and—in a comparable manner—for the enhanced accessibility of positive information by the processing of positive information, as it is allowed by Bower's (1991) model.

1.2.2 Valence representation in parallel distributed memory models

In comparison with semantic network models, parallel distributed models of priming (see Masson, 1991, 1995; McRae et al., 1997) suggest a largely different structural organization of the semantic memory. Instead of allocating a single node to each semantic concept, the semantic knowledge is to be distributed over a multidimensional space of activation units displaying semantic features or micro-features. In order for this, each semantic concept is constituted by a specific pattern of activated units, while the number of shared activation units determines semantic relatedness between different concepts. Thus, semantic priming effects can be explained by a faster transition from the pattern corresponding to the prime concept to a semantically related than to an unrelated one (i.e., the pattern corresponding to the target) because the shared activation units are already in the appropriate mode of activation. Although this model was initially developed in order to interpret semantic priming effects (see McNamara, 2005, for a review), it is *prima facie* perfectly suited to account for S–S-based evaluative priming effects as well. It is sufficient to additionally assume that a considerable part of the activation pattern of a specific semantic concept corresponds to its evaluative connotation (see Spruyt et al., 2002; Wentura, 1999, 2000). Thereby, the activation patterns of evaluatively congruent concepts overlap in the activation units corresponding to their evaluative connotation. That means that in a sequential evaluative priming task, the transition from the prime pattern to the target pattern is facilitated in case of evaluative congruency, since the target pattern is partly pre-activated by the prime pattern. Thus, parallel distributed models provide an elegant mechanism for the explanation of S–S-based evaluative priming effects as they allow for target-encoding facilitation by an evaluatively congruent prime (see, e.g., Wentura, 2000).

At this point, it is important to go back a step in order to emphasize a hidden inconsistency in the interpretation and the understanding of evaluative priming. S–R-based evaluative priming effects have typically been explained with response-based processes, assuming that an evaluatively congruent prime facilitates the target evaluation, while an evaluatively incongruent prime interferes with the target evaluation. Such response-related processes have been made responsible for the emergence of positive S–R-based evaluative priming effects (see Klauer et al., 1997; Wentura, 1999). An observable interaction between prime and target responses, however, requires a simultaneous activation of both concepts or—at least—both responses. This raises the following question: Does the parallel distributed structure of semantic memory provide a mechanism for response-related processes between two concepts as well as the concomitant parallel activation of these concepts?

In the distributed memory model—as it has been introduced by Masson (1991, 1995)—the activation of one semantic concept is necessarily accompanied by the activation of semantically related concepts because of shared activation units. Simultaneous activation of more than one concept is thereby, however, restricted to their overlapping parts and the completely activated pattern corresponding to one concept allows for only partial activation of related patterns. As previously mentioned, this aspect is yet crucial for the response-based explanation of S–R-based priming, since response facilitation and interference require the parallel activation of the activation units corresponding to prime and target responses, even if these activation units do not overlap in the response-incompatible condition. Thus, the distributed organization of semantic memory conflicts with the response-based account of S–R-based evaluative priming, since no simultaneous activation of the full pattern of two distinct concepts is allowed. In contrast, the distributed memory model (Masson, 1991, 1995) provides a conclusive implementation accounting for S–S-based evaluative priming: a currently activated concept (i.e., the prime) facilitates the encoding of an evaluatively congruent concept (i.e., the target) via pre-activation of the overlapping activation units.

Since the S–R-based and the S–S-based variants of evaluative priming differ in the required task only, while the whole task setting is comparable, it is quite dissatisfying to assume largely different representational structures of the semantic memory including the evaluative connotations of the semantic concepts. I concede that evaluative priming effects in both variants of the paradigm implicitly involve different explanatory mechanisms: The response-based explanation is simply not applicable to the S–S-based variant of evaluative priming, while it is the more plausible and more parsimonious explanation of S–R-based evaluative priming effects in comparison with the explanation when taking facilitated target encoding by evaluative congruency into account. Therefore, it is not necessary to create an overall explanation of evaluative priming effects, but it is crucial to search for a memory model that is compatible with evaluative priming in an S–S-based as well as in an S–R-based design. In Section 1.3, I will introduce the three-process model of evaluative priming that gives indications for the representation of the evaluative connotations in semantic memory and allows for both S–R-based and S–S-based evaluative priming.

1.3 The three-process model: A mutual facilitation account on evaluative priming

The objective of this Section is to characterize the three-process model of evaluative priming and to discuss its suitability to account for the inconsistent findings in prior S–S-based evaluative priming studies. I will first characterize the theoretical conception and the main claims of the three-process model. Thereafter, I will post-hoc interpret previously reported effects in prominent S–S-based evaluative priming studies with the naming and the semantic categorization task, applying the logic of the three-process model. Based on the theoretical conception of the three-process model and the findings in prior studies, I will derive the hypotheses for my experiments on S–S-based evaluative priming.

1.3.1 Theoretical conception

Until now, I had considered both variants of the evaluative priming paradigm, (i.e., the S–R-based and the S–S-based variant) to be separate entities. I decided to use for this a detached description of the evaluative priming variants in order to elucidate the largely different cognitive processes that are involved in S–R-based and S–S-based evaluative priming tasks. While response processes sufficiently explain S–R-based evaluative priming effects (see Klauer et al., 1997; Wentura, 1999), S–S-based effects require an interaction of the evaluative features of prime and target at the level of their semantic meanings, since response-compatibility and evaluative congruency are not correlated in an S–S-based design. To allow for positive S–S-based evaluative priming effects, this interaction should affect target processing in the way that an evaluatively congruent, as opposed to an incongruent prime, facilitates target encoding. As described above, the distributed memory model (Masson, 1991, 1995) provides an elegant mechanism for facilitated target encoding in case of evaluative congruency. Even though the encoding facilitation interpretation may also account for S–R-based evaluative priming effects, the response-based explanation is theoretically more plausible and more parsimonious (see Frings & Wentura, 2008; Klauer et al., 1997; Musch, 2000; Musch & Klauer, 2001; Wentura, 1999). At first glance, these different interpretations of evaluative priming effects—the response-based explanation for S–R-based and the encoding-facilitation explanation for S–S-based priming effects—do not necessarily pose a problem, since the different variants of evaluative priming suggest different cognitive processes being involved. With regard to the activation of the evaluative features of prime and target concepts, however, there is an important discrepancy between both interpretations. This being that the explanation of S–R-based evaluative priming effects assumes that prime and target compete for response determination. While in compatible trials, the prime activates the same response category as the target, in incompatible trials, the prime activates the opposite response category compared with the target. For this, prime and target representations, in particular their response-relevant features, must be activated in parallel. By contrast, the explanation of S–S-based evaluative priming effects, applying the logic of the parallel distributed models, suggests that the prime representation transitions into the target representation and that the formation of the target representation is facilitated if a part of this representation is already in a pre-activated state. As in the case of evaluative congruency as opposed to incongruency, prime and target representations overlap in the evaluative part of their representational patterns, target encoding is facilitated. A hidden and crucial consequence of this explanation implicates that all features of the prime that are not shared by the target (and which in principle interfere with the target response selection) are no longer active. Thus, while the interpretation of S–R-based evaluative priming requires the parallel activation of both prime and target representations, the S–S-based evaluative priming allows for parallel activation restricted to the shared parts of prime and target.

Given that all parameters of the experimental setting (e.g., the sequential presentation of prime and target, the SOA), except the task-relevance of the evaluative categories, are comparable in S–R-based and S–S-based evaluative priming tasks, this seems to be an unacceptable discrepancy. I aim to resolve this discrepancy by proposing a general model of evaluative priming that accounts for evaluative priming effects in different variants of the paradigm. Such a model should have implemented mechanisms for all cognitive processes that are potentially relevant in evaluative priming tasks.

Thinking back to the explanation of S–S-based evaluative priming effects—as suggested by the semantic network or the parallel distributed models—target encoding is assumed to be facilitated by an evaluatively congruent prime. This interpretation implicitly presupposes that the prime precedes the target and that it is, consequently, able to support the target encoding in case of evaluative congruency. Why should, however, the facilitative effect of evaluative congruency between prime and target be restricted to one direction? In other words, why should only the target processing, but not the prime processing, benefit from evaluative congruency? This idea was first considered by Wentura and Rothermund (2003): They claimed that if an evaluatively congruent prime may facilitate target encoding, the target may help maintain the activation of an evaluatively congruent prime as well. That is, evaluative congruency between prime and target may have a facilitative effect in both directions, namely, from the prime activation to target encoding and from the target activation to prime maintenance. According to this consideration, in the model of evaluative priming—I will characterize here—mutual facilitation of evaluatively congruent representations constitutes a crucial process.

Looking back to the S–R-based variant of the evaluative priming paradigm and to the response-based explanation of S–R-based evaluative priming effects, it becomes evident that processes, other than mutual facilitation of evaluatively congruent concepts, have to be involved in a model of evaluative priming as well. Initially, prime and target representations have to be activated in parallel. As a consequence, prime and target should compete for response execution. This response-based interaction of prime and target may yield largely different consequences, depending on the specific response association of prime and target: If both prime and target are associated with an unambiguous response, the responses may be either compatible or incompatible. Thus, the prime either facilitates the target response or conflicts with it. This is prototypically the case in any S–R-based priming paradigm. A third conceivable scenario arises if the prime is not associated with any task-relevant response; in this case, there is neither response facilitation nor response conflict. This is usually a tacit assumption in the S–S-based priming variant with the naming task and prime pictures that require no naming response (e.g., Spruyt et al., 2002; Spruyt, Hermans et al., 2007). This tacit assumption can, however, be challenged (e.g., Wentura & Frings, 2008). Thus—in order to account for S–R-based evaluative priming—a theoretical model should allow for parallel activation as well as response-associated processes between prime and target representations.

All things considered, a model of evaluative priming that aims to account for evaluative priming effects in an S–R-based as well as in an S–S-based design should provide mechanisms that enable the three following processes: a mutual facilitation between evaluatively congruent prime and target representations (a precondition for S–S-based evaluative priming), a parallel activation of prime and target representations (a precondition for S–R-based evaluative priming), and an interaction of prime and target responses (a precondition for S–R-based evaluative priming). Therefore, this model is labeled the *three-process model of evaluative priming*, whereas the three processes are regarded as interactive processes in such a way that an increase or decrease of one of the three processes may affect the magnitude of the remaining processes.

In this context, I do not want to ignore the fact that De Houwer and colleagues (2002) also considered possible loci of evaluative priming effects. They distinguished three levels of cognitive processes being potentially responsible for evaluative priming effects. At a subordinate level, an evaluatively congruent prime may facilitate the target identification by a pre-activation of all semantic representations corresponding to the target. This kind of process is implemented in the mechanism of spreading activation, as it is suggested by semantic network models (see Bower, 1991; Collins & Loftus, 1975), or in the mechanism of facilitated transition from the prime to the target representation due to shared activation units, as it is suggested by the distributed memory model (Masson, 1995). At a superordinate level, an evaluatively congruent prime is assumed to pre-activate the evaluative features associated with the target, as opposed to the whole target concept. At response level, an evaluatively congruent prime may pre-activate the target response. Analogous to the distinct interpretations of S–R-based and S–S-based evaluative priming—as described above—processes at the subordinate level can account for S–S-based and S–R-based evaluative priming effects, while processes at both higher levels are applicable to S–R-based evaluative priming only.

Referring back to the considerations concerning the three-process model, I would like to emphasize that the specific impact of each individual process in a given evaluative priming task is a matter of empirical research. While differentially increasing and weakening the magnitude of the three processes, their influences may be manipulated. Before I report my experiments in Section 2, with which I simply aimed to test the existence and the impact of the three processes, I will apply the three-process model to previously reported, prominent findings from the evaluative priming literature. As mentioned above, the empirical evidence of S–S-based evaluative priming effects is largely inconsistent, since positive, null, and even negatively signed effects have been reported. Taking into account that the three suggested processes interact in any evaluative priming task and that the impact of every single process depends on the experimental conditions, differently signed evaluative priming effects may be explained with and predicted by the three-process model.

Regarding the first assumed process of mutual facilitation given evaluative congruency, for example, it is highly relevant whether the first component of facilitated target encoding or the second component of maintained prime activation is the more influential one. The net effect of the first component is a positive evaluative priming effect, as facilitated target encoding may lead to a faster target processing and response; in contrast, the net effect of the second component is not as unambiguous, rather depends on the response association of prime and target: If prime and target are response-compatible, maintained prime activation may not hamper the target response, whereas maintained prime activation given response-incompatibility may yield a negatively signed priming effect due to a prolonged response conflict. Roughly speaking, if the experimental setting mainly supports target-encoding facilitation (e.g., by the use of a positive SOA), a positive evaluative priming effect can be expected, while a rather negatively signed evaluative priming effect can be expected given an experimental setting that mainly supports prime-activation maintenance (e.g., by the use of a negative SOA).

The specific manifestation of the second process, that is, parallel activation of prime and target representations, should also have a direct influence on the resulting priming effect. Evidently, the interaction of simultaneously activated prime and target may be pronounced to a larger extent in comparison with the interaction of prime and target that are not activated at the same time. I claim that this process can actively be manipulated by the experimental setting (e.g., the requirement to attend to the primes should increase the prime activation; see Spruyt, De Houwer et al. 2007).

Similarly, the third response-associated process is expected to affect the resultant priming effect. While a response-compatible prime facilitates the target response and a response-incompatible one interferes with it, a prime that is not associated with any task-relevant response, should not influence the target response. The simplest form of manipulation within this process illustrates the selection of appropriate stimuli for primes and targets.

1.3.2 Application to prior S–S-based evaluative priming results

The three-process model may be suited to *post-hoc* account for the inconsistent pattern of positive, null, and negatively signed effects in prior S–S-based evaluative priming studies. This does not imply that I am the first person who shed light on the puzzling empirical evidence of S–S-based evaluative priming. Of course, several authors have already considered the puzzling empirical findings and provided conclusive interpretations for some critical aspects of the mixed empirical evidence (see, e.g., De Houwer et al., 2002; Spruyt et al., 2009, 2012; Everaert et al., 2011; Wentura & Frings, 2008). I will discuss S–S-based evaluative priming effects of naming as well as semantic categorization responses in line with the three-process model, while these explanations are not necessarily in conflict with the interpretations mentioned in prior publications.

S–S-based evaluative priming in the naming task

Positive effects and failures to replicate. Applying the naming task, Bargh and colleagues (1996) as well as Hermans and colleagues (1994) reported positive S–S-based evaluative priming effects with verbal stimuli. These positive findings, however, repeatedly failed to be replicated (see, e.g., Klauer & Musch, 2001; Spruyt, Hermans, Pandelaere et al., 2004). Given the rationale of the three-process model, the following processes are expected to be involved in the naming task with evaluatively connoted words as prime and target stimuli: mutual facilitation of evaluatively congruent prime and target (i.e., facilitated target encoding and maintained prime activation), parallel activation of both concepts, as well as response conflicts between the unique naming responses associated with prime and target words. While facilitated target encoding should yield a positive evaluative priming effect, maintained prime activation should prolong the response conflict between prime and target responses, thereby diminishing any positive priming effect. Therefore, in the experiments yielding positive effects (i.e., Bargh et al., 1996; Hermans et al. 1994) prime maintenance and response conflict must have been minimized, so that the positive effect of facilitated target encoding, in case of evaluative congruency, could fully unfold. In contrast, in the experiments with null effects (e.g., Klauer & Musch, 2001; Spruyt, Hermans, Pandelaere et al., 2004), prime maintenance and response conflict must have been more influential, so that these processes weakened the positive effect of facilitated target encoding given evaluative congruency. In this regard, it is important to remark that Bargh and colleagues found positive evaluative priming effects with English words, whereas Klauer and Musch (who used exactly the same procedure) failed to replicate these positive findings with German words. Linguistic differences between both languages may be responsible for the conflicting findings, since the English and the German language differ in their orthographical depth, that is, in the extent to which the orthography and the phonology of a word match. While German is an orthographically shallow language (i.e., specific phonemes correspond to specific graphemes in a direct and unambiguous manner), English is an orthographically deep language with a more opaque correspondence between phonemes and graphemes (see Frost, Katz, & Bentin, 1987). This might be associated with an immediate translation from the graphology to the phonology for German but not for English words. With regard to the processes in the evaluative priming paradigm with the naming task, one may consequentially predict that a prime might evoke a naming response more directly in German as compared with English that, hence, competes with the target response. According to the three-process model, this competition is primarily expected in the evaluatively congruent condition (due to increased prime maintenance), where it cancels out benefits of facilitated target encoding. Thus, null effects in the evaluative priming paradigm with the naming task might reflect an interaction of maintained prime activation and increased response conflict in case of evaluative congruency; in contrast, positive effects might arise as a consequence of facilitated target encoding given evaluative congruency without enhanced response conflict, since the prime does not immediately prepare a naming response.

I should like to point out that the language issue has already been raised in prior studies (see Klauer & Musch, 2001; Spruyt, Hermans, Pandelaere et al., 2004). These authors aimed to test the idea that S–S-based evaluative priming effects might have been found using English words (but not using German words), since the naming of English words requires a deep (i.e., semantic) processing, while German words can be named via the direct orthography-to-phonology route. That means that a minimum amount of orthographical depth might be necessary for evaluative priming effects to occur; since, otherwise, a direct translation from the graphemes to the phonemes might allow for target naming without semantic and evaluative processing. Thus, so the authors argued, a process of encoding facilitation, which is located at the semantic level, might arise in English alone. In order to test this idea, Klauer and Musch conducted a study with English-German bilinguals, but they found evaluative priming effects for neither the English nor the German version of the task. Similarly, Spruyt, Hermans, Pandelaere, and colleagues reported a null effect in a nearly exact replication of the study by Bargh and colleagues (1996). In contrast, Hermans and colleagues (1994) found a positive evaluative priming effect in a Dutch version of the naming task, even though Dutch is a language with a shallow orthography (see Frost et al., 1987). In sum, these findings do not corroborate the interpretation that

S–S-based evaluative priming effects arise in English alone since words from orthographically shallow languages are not semantically processed.

However, the findings in these studies apparently also speak against the *post hoc* explanation given by the three-process model. In line with this model, I postulate mutual facilitation of evaluatively congruent concepts that should arise independent from the orthographical depth of the language. The reason why mutual facilitation was observed in English only (by Bargh et al., 1996) lies in the less intense response conflict in the English version compared with the German version of the task. Since bilinguals might generally transfer habits from one language to the other, for my *post hoc* explanation of the null findings by Klauer and Musch (2001) it suffices to assume that the English-German bilinguals transferred the German habit to the reading of English words (see, Tzelgov, Henik, Sneg, & Baruch, 1996, for evidence concerning English-Hebrew bilinguals). This might well be the case for some participants who did not acquire English as their first language. That is, the bilinguals in Klauer and Musch's study might have had a general tendency to directly transfer the graphemes to phonemes. Thereby, the prime, just like the target word, immediately evoked a naming response, resulting in a distinctive response competition.

Comparing the studies by Bargh and colleagues (1996) and by Spruyt, Hermans, Pandelaere, and colleagues (2004), there were slight procedural changes that may have been responsible for the different findings. While Bargh and colleagues did not mention the irrelevance of the prime words, Spruyt, Hermans, Pandelaere, and colleagues explicitly instructed their participants to ignore the prime words. This may have reduced the attention to the primes and weakened the facilitative effect of evaluative congruency on target encoding. Furthermore, the participants in the study by Spruyt, Hermans, Pandelaere and colleagues were American English native speakers who studied in Belgium, whereby they differed from the participants in the study by Bargh and colleagues who were American English native speakers studying at an American university. Some participants in the former study have possibly acquired Dutch what might have changed their cognitive processes during reading and pronouncing even English words. Applying the interpretation provided by the three-process model, a single finding still remains difficult to explain: Hermans and colleagues (1994) reported a positive evaluative priming effect in a Dutch version of the naming task. In this study, the facilitative effect of evaluative congruency on target encoding outweighed naming conflicts between prime and target, even though shallow language stimulus material was used.

Conditional effects. Further studies were conducted in order to test the conditionality of S–S-based evaluative priming effects in the naming task. For example, Spruyt and colleagues (Spruyt & Hermans, 2008; Spruyt et al., 2002; Spruyt, Hermans et al., 2007; Spruyt, Hermans, Pandelaere et al., 2004) observed reliable positive evaluative priming effects with prime pictures but not with prime words. The authors explained the conditional evaluative priming effects by referring to the idea that picture naming requires semantic processing, while for word naming a *pure* lexical processing without any involvement of the semantic system is sufficient (see also Glaser, 1992; Glaser & Glaser, 1989). Assuming that the evaluative features of semantic concepts are stored in the semantic system (see, e.g., Bower, 1991; De Houwer & Hermans, 1994; De Houwer, & Randell, 2004; Spruyt, Hermans, Pandelaere et al., 2004), evaluative priming effects may consequently be predicted using prime pictures but not using prime words. With regard to the three-process model, I alternatively argue that both prime pictures and prime words are semantically processed and activate their corresponding evaluative connotations (thereby facilitating the encoding of evaluatively congruent targets). Prime pictures, however, are not as strongly associated with a naming response as words are. Thus, since prime pictures do not evoke conflicting naming responses, target-encoding facilitation given evaluative congruency may lead to a positive net effect. In this regard, the finding by Wentura & Frings (2008) provides conclusive evidence. I would like to discuss this study in more detail at the end of this Section.

There happens to be another instance of conditional evaluative priming effects in the naming task which was reported by De Houwer, Hermans, and Spruyt (2001). They observed a positive evaluative priming effect with degraded target presentation but not with undegraded targets. Taking the idea of a conditional involvement of semantic processing into account, the authors claimed that the phonological pattern of undegraded words can be easily derived from the corresponding orthographical pattern, while the distorted orthographical information of degraded words requires additional semantic processing in order to establish the phonological pattern. Here, again, the three-process model provides an alternative interpretation: since the perception of a degraded target is hampered, the identification of a degraded target needs the facilitation by an evaluatively congruent prime to a larger extent than an undegraded target. This advantage for evaluatively congruent targets might outweigh potential naming response conflicts (see also Wentura & Rothermund, 2003).

Salience effects. In recent years, several authors examined how far a certain degree of salience of the evaluative features is crucial for the occurrence of evaluative priming effects in the naming task (see Everaert et al., 2011; Spruyt et al., 2009, 2012). Everaert and colleagues, for example, aimed to manipulate the salience of the evaluative categories in a between-subjects design, varying the proportion of trials with evaluatively connoted and neutral stimuli: either in 100 % of the trials (high valence proportion group), evaluatively connoted prime pictures and target words were presented or only 25 % of the trials consisted of evaluatively connoted stimuli, while in the remaining 75 % of the trials neutral stimuli were used (low valence proportion group). RT analyses of the 25 % of trials with evaluatively connoted stimuli that were identical in both groups yielded a significantly positive S–S-based evaluative priming effect in the high valence proportion group, while the effect decreased to zero in the low valence proportion group. That is, if the salience of the evaluative dimension was attenuated by the frequent use of neutral stimuli, the positive S–S-based evaluative priming effect that was repeatedly found using prime pictures (see Spruyt & Hermans, 2008; Spruyt et al., 2002; Spruyt, Hermans et al., 2007; Spruyt, Hermans, Pandelaere et al., 2004) disappeared. Thus, evaluative processing of valenced concepts and mutual facilitation of evaluatively congruent concepts may demand a certain amount of salience of the evaluative features. The three-process model does not provide a plausible explanation for this finding.

The objective of the study by Spruyt and colleagues (2009) was to manipulate the attention allocation to the evaluative categories and to provide corroborative evidence for the context-dependency of S–S based evaluative priming effects. Therefore, they mixed evaluative categorization and naming trials: either an evaluative categorization response was required in 75 % of trials (and a naming response in 25 % of trials) or a naming response was required in 75 % of trials (and an evaluative categorization response in 25 % of trials). If in most trials the target word called for evaluative categorization (i.e., 75 % categorization group), a positive evaluative priming effect emerged even still in the remaining naming trials. In contrast, if in most trials the target word called for naming (i.e., 25 % categorization group), no evaluative priming effect emerged in the naming trials. It is important to note that the cue indicating the required response in a trial-by-trial manner was presented simultaneously with target onset, that is, after the presentation of the prime word. Due to this temporal sequence, the more likely response (i.e., an evaluative categorization response in the 75 % categorization group and a naming response in the 25 % categorization group) was supposedly pre-activated before target onset. Empirical corroboration for this idea was reflected in significantly slower naming responses in the 75 % compared with the 25 % categorization group. At this point, it becomes evident that the three-process model is well suited to post hoc account for the conditional S–S-based evaluative priming effect. In the 75 % categorization group, the preparation of a naming response by the prime word should have been attenuated, since evaluative categorization was the more probable response. Thereby, the facilitative effect of evaluative congruency on target encoding outweighed any naming response conflict, thus, resulting in a positive evaluative priming effect even in the naming trials. If, however, most trials required a naming response (i.e., 25 % categorization condition), the prime word should have evoked its corresponding naming response that was in conflict with the naming response corresponding to the target. Thus, mutual facilitation and enhanced naming conflict between evaluatively congruent prime and target canceled each other out and yielded a null effect.

Negatively signed effects. There is one puzzling finding in the literature that was not yet convincingly solved but can be well explained by the three-process model. Glaser and Banaji (1999) reported robust and replicable negatively signed evaluative priming effects in the naming task with verbal stimuli. The authors (see also Glaser, 2003) considered that extremely valenced primes may nonconsciously elicit an attempt to correct for the prime influence. Since such a correction may lead to an overcompensation of the prime impact, negatively signed evaluative priming effects may emerge for extremely valenced primes. It remains, however, unclear which mechanisms are responsible for automatic correction and overcompensation processes in a sequential evaluative priming task, even if several authors proposed different interpretations.

Fazio (2001) assumed that the extent of automatic correction processes may depend on the experimental instructions concerning the attention to the primes. According to this notion, the more participants see a reason to attend to the primes (e.g., memorizing the primes for a memory task after the priming task), the less automatic correction may occur, thus, resulting in positive evaluative priming effects. In contrast, the more participants try to ignore the primes and to overcome any prime influence, the more automatic correction may occur, resulting in negatively signed effects. This consideration is not corroborated by most evaluative priming findings, since in the majority of studies participants are not instructed to actively attend to the primes (exceptions are Fazio et al., 1986; Spruyt, De Houwer et al., 2007), but—nevertheless—negatively signed evaluative priming effects represent by far the minority of effects (see Klauer & Musch, 2003, for a review).

An alternative specification of a corrective mechanism with the objective to minimize the prime influence on target responding was considered by Klauer, Teige-Mocigemba, and Spruyt (2009; I will characterize the respective account in Section 5.2). To put it simply—accounting for S–R-based priming effects—they suggested two activation counters, that is, one counter for each possible response (e.g., the response counters *positive* and *negative* in the evaluation task), and assumed that the activation increase within a counter can be regarded either from prime onset or just from target onset onwards. Thereby, the activation being contributed to by the prime can be rather in- or excluded from target processing, leading to positively or negatively signed S–R-based evaluative priming effects, respectively. Such a mechanism may not easily be applied to evaluative priming in the naming task, since this would require an activation counter for each single target or its corresponding naming response, respectively.

Chan, Ybarra, and Schwarz (2006) also proposed an explanation for Glaser and Banaji’s (1999) findings of negatively signed S–S-based evaluative priming effects. They claimed a change-in-affect mechanism that means—basically—that the identification of the valence corresponding to the target may be facilitated in case of evaluatively incongruent prime and target, since the evaluative input changes from prime to target which is, itself, informative. Chan and colleagues reported corroborative evidence for this mechanism by the findings of a negatively signed evaluative priming effect for highly frequent targets and a positive effect for low frequent targets. Since highly frequent targets are assumed to be highly accessible, these targets elicited—according to the authors—a rapid evaluative response, so that in case of evaluative incongruency there was a fast change in the evaluative dimension from prime to target. In contrast, congruent targets did not yield a change in the evaluative dimension, wherefore an additional separation of the information corresponding to prime and target was necessary. Since low frequent (and, thereby, low accessible) targets did not elicit a rapid evaluative response, evaluatively congruent primes facilitated the target response to a larger extent than incongruent primes, resulting in a positive evaluative priming effect for low frequent targets.

While Chan and colleagues (2006) examined evaluative priming in an S–R-based design, they also aimed to apply the change-in-affect mechanism to Glaser and Banaji's (1999) findings in the naming task. For this, they referred to the consideration by Wentura and Rothermund (2003) that target naming requires an unambiguous separation of prime and target information, which could reason that evaluative incongruency might help successfully distinguish the source of prime and target. Chan and colleagues reasoned that extreme primes may trigger an accuracy motive that may, in turn, increase the attention to the target and lead to a more pronounced change in the evaluative dimension given evaluative incongruency. Furthermore, extreme primes may—as compared to weakly valenced ones—directly elicit larger changes in the evaluative dimension given evaluative incongruency. Interpreting the findings of Glaser and Banaji according to the change-in-affect mechanism, as proposed by Chan and colleagues, would suggest (at least tendentially) more accurate target responses with extremely compared with weakly valenced primes, since extreme primes should support an accuracy motive. As Glaser and Banaji did not report mean accuracies, the explanation proposed by Chan and colleagues remains speculative and is a matter of future research.

A further suggested interpretation of the findings by Glaser and Banaji (1999) illustrates the activation-dependent inhibition model by Maier, Berner, and Pekrun (2003; see also Berner & Maier, 2004). The authors replicated the results of Glaser and Banaji, but only in subgroups of highly anxious participants, and introduced the activation-dependent inhibition model in order to account for these effects. The main assumption of the model is that the activation spreading from the prime to evaluatively congruent memory representations turns into inhibition if a certain threshold level of activation is exceeded. Since extremely valenced primes may engender more activation in comparison with moderate primes, the specific activation threshold may more easily exceeded by extremely valenced than moderate primes. Furthermore, highly anxious individuals may be more strongly activated by evaluatively connoted stimuli or they may even possess higher base activation levels of the evaluative features compared with individuals low in trait anxiety. Berner and Maier considered that such an activation-dependent inhibition might specify the automatic over-correction mechanism, as it was suggested by Glaser and Banaji. Alternatively, they argued that an application of the interpretation by Glaser and Banaji to their own results would mean that highly anxious individuals have a higher engagement to automatically over-correct the impact of extremely valenced primes in comparison with individuals with low trait anxiety. One result, however, that strongly speaks against the activation-dependent inhibition explanation was reported by Maier and colleagues (Exp. 2) who observed a negatively signed effect only for moderate primes in a subgroup of moderately anxious participants, thereby not replicating their own result.

In summation, all explanations of the highly meaningful finding by Glaser and Banaji (1999) discussed so far are somehow problematic: they lack a concrete specification of the explanatory mechanism or are not compatible with the naming task or they are insufficiently corroborated by empirical results. As mentioned earlier, the three-process model provides a conclusive explanation of Glaser and Banaji’s negatively signed S–S-based evaluative priming effects for extremely valenced primes in the naming task. Please note that in the three-process model, negatively signed effects are expected if prime maintenance by an evaluatively congruent target, as well as response competition between primes and targets can plausibly be assumed. This raises the question of whether Glaser and Banaji applied experimental manipulations that maximized these processes in comparison with the process of target-encoding facilitation. One important manipulation was the selection of primes and targets from the same set of words, while prime and target were, of course, never the same word on a given trial. Since words were repeated throughout the trial sequence, primes had already been named (as targets) in preceding trials for large parts of the experiment. This aspect may likely have enhanced the preparation of the naming response corresponding to the prime and, thereby, the response competition between prime and target. Such a response interference is—according to the three-process model—expected to be particularly pronounced for evaluatively congruent prime-target pairs, since the activation of an evaluatively congruent prime is maintained by the target. Consequentially, a negatively signed evaluative priming effect was found. Interestingly, when Glaser (2003) used the same procedure and stimuli as Bargh and colleagues (1996), that is, weakly and strongly valenced primes and targets from different word lists, he failed to replicate the negatively signed evaluative priming effect for strongly valenced primes. In fact, he replicated Bargh and colleagues' finding of positive evaluative priming effects for both weak and strong primes. Thus—in correspondence with the three-process model—negatively signed evaluative priming effects of naming responses arise if the experimental setting supports a pronounced response competition between prime and target.

S–S-based evaluative priming in the semantic categorization task

Evaluative priming in the semantic categorization task was examined in only a few studies, in which either null effects (De Houwer et al., 2002; Klinger et al., 2000, Exp. 4) or conditional positive effects (Spruyt, De Houwer et al., 2007) were reported. Interpreting the null findings by Klinger and colleagues, it is important to note that they selected primes and targets from the same set of words. They varied the categories *valence* and *animacy* (i.e., animate vs. inanimate) orthogonally across primes and targets and manipulated the task-relevance of both dimensions as between-subjects factor. For both manifestations of the factor task-relevance, they reported positive S–R-based priming effects (i.e., evaluative or animacy priming) but they failed to find any S–S-based evaluative priming effect (i.e., if animacy was task-relevant). This null effect may be a genuine null effect for the reason that, among others, the masked priming procedure might be responsible. However, as the authors did not report the S–S-based evaluative priming effect separately for the response-compatible and incompatible conditions (but only an overall evaluative priming effect), a positive effect may have in fact been emerged in case of response-compatibility and a null effect in case of incompatibility. Such a pattern of S–S-based evaluative priming effects would at least suit very well with the idea of interactive processes, as suggested in the three-process model. I will explain this consideration in more detail: In line with the three-process model, mutual facilitation is assumed for evaluatively congruent prime and target, that is, facilitated target encoding and maintained prime activation. Since for response-incompatible prime and target the latter component results in a strong categorization (i.e., animacy categorization in the study by Klinger et al.) conflict, the facilitative effect of evaluative congruency may be canceled out by the pronounced categorization conflict. This should, consequentially, yield a null S–S-based evaluative priming effect. Since—in contrast—response-compatible prime and target are not in categorization conflict, the facilitation due to evaluative congruency should lead to a positive S–S-based evaluative priming effect given response-compatibility.

Unlike Klinger and colleagues (2000), De Houwer and colleagues (2002) as well as Spruyt, De Houwer, and colleagues (2007) used primes that did not belong to the same semantic categories as the targets did; that is, the primes were neutral with regard to the response categories. Therefore, maintained prime activation by an evaluatively congruent target (as suggested in the three-process model) should be of no consequence for the interpretation of the results in these studies. Spruyt, De Houwer, and colleagues reported positive evaluative priming effects only if the valence dimension was attended to, whereby they elucidated the null finding by De Houwer and colleagues. The question remains as to why De Houwer and colleagues failed to find any S–S-based evaluative priming effect. One reason might be that attentional processing in the semantic categorization task is highly constrained to the task-relevant, semantic categories, with the result that concepts which do not belong to any of the task-relevant categories are not processed to a sufficiently deep degree. Consequentially, in the study by De Houwer and colleagues, the evaluatively connoted verbs (used as primes in Exp. 1) or the abstract nouns (used as primes in Exp. 2) might have been incompletely processed, wherefore no S–S-based evaluative priming effect emerged.

To which extent do the postulated processes of mutual facilitation, parallel activation, and response facilitation/competition interact in a specific evaluative priming task can be examined by differentially increasing and weakening their impact in order to disentangle them. In this sense, Wentura and Frings (2008) explored the influence of the response process on S–S-based evaluative priming, inventing an S–S-based evaluative priming design with a manipulation of the response relationship between prime and target. In a naming task with target and prime pictures, half of the prime pictures were associated with a clear naming response (as were all target pictures), whereas the other half were not, thereby varying the primes' response binding. Only the primes without response binding yielded a significant S–S-based evaluative priming effect, whereas for response-bound primes no priming effect emerged. In order to interpret the interaction of prime response binding and evaluative congruency, the authors suggested that with nonresponse-bound primes, an evaluative priming effect was based purely on target-encoding facilitation by evaluatively congruent primes because maintained prime activation (by a congruent target) had no consequence for the target response. With response-bound primes, however, maintained prime activation led to a prolonged response conflict between prime and target naming. Thus, in case of evaluative congruency, two processes—namely, target-encoding facilitation and increased response conflict due to maintained prime activation—canceled each other out. There is, however, a more simple explanation for the null effect with response-bound primes: It might be that the naming conflict between response-bound prime and target—irrespective of evaluative congruency or incongruency—minimizes any advantage of target-encoding facilitation; hence, any positive S–S-based evaluative priming effect might be masked.

In order to decide for one of both conflicting interpretations of the finding by Wentura and Frings (2008), they should be tested against each other. In order to achieve this, it is necessary to more thoroughly examine the process of mutual facilitation due to evaluative congruency, that is, the facilitative impact of evaluative congruency on target encoding on the one hand and prime maintenance with the potential of a subsequent response conflict on the other. For that purpose, I utilized a negative-SOA version of the evaluative priming task (i.e., prime onset is after target onset). This stimulus sequence implicates that an evaluatively congruent prime only minimally supports target encoding (as its appearance is after target onset), whereas the target maximally maintains the activation of an evaluatively congruent prime. Since the former facilitation is associated with a positive evaluative priming effect, but the latter leads to a negatively signed effect due to prolonged response competition, overall I expected a negatively signed evaluative priming effect.[2]

To sum up the characterization of the three-process model, I would like to point out that the three-process model aims to account for evaluative priming effects in different variants of the evaluative priming paradigm, assuming interactive processes between prime and target concepts at stimulus encoding, stimulus activation, as well as response level. Applying the three-process model to previously reported S–S-based evaluative priming effects indicated that the model suits well for the explanation of several findings in S–S-based evaluative priming studies. However, since post-hoc interpretations do not provide a comparable argumentation in favor of the three-process model, as correct predictions would do, I tested several hypotheses derived from the three-process model in different experiments. Beyond examining the main theoretical claims of the three-process model, I also aimed to elucidate the reasons for the puzzling findings in prior S–S-based evaluative priming studies and to figure out the constraints for a model of the memory representations of valence.

Overview of Experiments

I conducted five studies with the aim to test the three-process model of evaluative priming. For this, I applied slightly different variants of the evaluative priming paradigm. One of the main postulates of the model is that facilitation by evaluative congruency can have an effect on target encoding as well as on prime activation, while experimental parameters are assumed to influence the relative magnitude of the facilitative components. As in a standard priming procedure with a positive SOA, the component of facilitated target encoding is typically favored and the more dominant one, I aimed to differentially manipulate the relative size of both components and enhance the component of maintained prime activation. Therefore, I mainly used a negative SOA-procedure in order to increase the facilitation on prime activation, and—simultaneously—to decrease the effect on

[2] As mentioned in Section 1.1, only few studies examined evaluative priming with a negative SOA-procedure (Fockenberg et al., 2006; Hermans et al., 2001; Klauer et al., 1997). Since all these studies applied an S–R-based design that suggests the response-based explanation of evaluative priming effects (see Klauer et al., 1997; Wentura, 1999), these studies are not informative with regard to the assumption of mutual facilitation due to evaluative congruency.

target encoding. In one experiment (Experiment 4), I additionally applied a positive SOA-procedure and, thereby, varied the relative magnitude of the facilitative components in the same experiment.

In order to test another important postulate of the three-process model which concerns the response processes in evaluative priming tasks, I varied the response relation between prime and target within and across the experiments. For this, in Experiment 1, I used the naming task (requiring the target to be named) with target and prime pictures. The response relation between prime and target was manipulated by associating all target and half of the prime pictures with a verbal label. Thus, in one half of the trials, prime and target elicited competitive naming responses, while in the other half of the trials, the primes were not associated with any verbal label, thereby not eliciting a competing naming response. In Experiments 2a/b, 3, and 4, I applied the semantic categorization task (requiring the target to be categorized as person or animal) in which the task-relevant, semantic categories were varied orthogonally to the evaluative categories.

Beside the use of different tasks, I varied the modality of the stimulus material across the experiments, employing pictures in Experiments 1, 2a, 4, and 5a, and words in Experiments 2b, 3, and 5b. In Experiment 3, I additionally analyzed the brain-electrical activity in order to get a temporally more exact measurement of the cognitive processes which are involved in S–S-based evaluative priming tasks. In a replication of Experiment 2a/b (Experiment 5a/b), I searched for evidence of valence-specificity of the findings in the previous experiments. Therefore, I applied the evaluative instead of the semantic categorization task (thereby changing the task-relevant categories) and tested the influence of task-irrelevant, semantic congruency on evaluative categorization processes.

2 When the target helps and the prime distracts

The three-process model postulates an interaction of processes at encoding, activation, and response level during any evaluative priming task, whose influences may—depending on the particular experimental setting—be differently large. As first suggested by Wentura and Rothermund (2003), mutual facilitation of evaluatively congruent prime and target represents one of the core theoretical assumptions of the three-process model. This process is assumed to consist of two components which are characterized as facilitated target encoding and maintained prime activation. As discussed earlier, the first component was taken into account for the explanation of S–S-based evaluative priming effects, while the second component was largely neglected in previous evaluative priming research. Thus, in order to test the influence of the second component on evaluative priming effects, I aimed to develop an evaluative priming design with a maximization of the second component and a simultaneous minimization of the first component. For this, I applied a negative SOA-procedure, that is, the prime onset followed the target onset. With this manipulation, I expected the prime appearing too late to be able to facilitate the encoding of an evaluatively congruent target. Instead, the target was predicted to support the prime activation. The prolonged prime activation given evaluative congruency should, in turn, lead to larger target response interference. In order to examine the generality of this interaction between evaluative congruency and response conflict, I applied different tasks and varied the modality of the stimulus material. In Experiment 1, evaluative priming was examined in the naming task with pictures as primes and targets; in Experiment 2a/b, I used the semantic categorization task with pictorial or verbal material, respectively.

2.1 Evaluative priming in the naming task (Experiment 1)[3]

The purpose of Experiment 1 was to provide evidence for a facilitative effect of an evaluatively congruent target on prime activation in a comparable manner as an evaluatively congruent prime is supposed to facilitate target encoding, resulting in a positive S–S-based evaluative priming effect. For this, in Experiment 1 I replicated the study by Wentura and Frings (2008) with a negative SOA-procedure and aimed to disentangle the two alternative explanations of their findings. I used positively and negatively connoted pictures as primes and targets. While for half of the prime pictures (and all target pictures), participants first learned unequivocal naming responses, the other half of the prime pictures were not associated with an unambiguous response. This served to manipulate the degree of response conflict between target and prime. Thus, the evaluative relation and the existence of a response conflict of prime and target were orthogonally varied across trials. The negative SOA-procedure was predicted to minimize target-encoding facilitation (by an evaluatively congruent prime) and maximize prime-activation maintenance (by an evaluatively congruent target). Therefore, in case of response conflict (i.e., for response-bound primes) I expected this conflict being prolonged given evaluative congruency compared with incongruency. Regarding the S–S-based evaluative priming effects, I predicted a negatively signed effect for response-bound primes. For nonresponse-bound primes, I predicted no (negatively signed) effect because prolonged prime activation should not influence target naming. If the prime would, however, still partially support the encoding of an evaluatively congruent target—despite its posttarget onset—I hypothesized a positive S–S-based evaluative priming effect for nonresponse-bound primes.

[3] Please note that Experiments 1, 2a/b, and 5a/b have been reported in Schmitz & Wentura (2012).

2.1.1 Method

Participants. In all experiments reported in the present thesis, all participants were German native speakers and had normal or corrected-to-normal vision. At the beginning of every experiment, participants gave written informed consent and they were debriefed at the end of every experiment. For their participation, they were paid 8 €/hour or received course credit, respectively.

In Experiment 1, 31 students (20 women; 11 men) participated; their median age was 22 years (range from 17 to 35 years).

Design. I employed a 2 (prime response association) × 2 (prime valence) × 2 (target valence) within-participants design.

Material. Positive and negative pictures were selected from the International Affective Picture System (IAPS; Center for the Study of Emotion and Attention, 1994). IAPS numbers for all selected pictures are listed in Appendix A.

Four positive and four negative pictures were used as targets. Mean valences for positive and negative pictures differed significantly, $M_{positive}$ = 7.96 (*SD* = 0.55) and $M_{negative}$ = 3.59 (*SD* = 0.09; norm ratings for IAPS pictures are on a scale from 1 to 9), $t(3) = 14.55$, $p < .001$. Mean arousal values were matched as closely as possible and did not differ significantly, $M_{positive}$ = 4.38 (*SD* = 1.01) and $M_{negative}$ = 5.17 (*SD* = 0.52), $t(3) = -1.79$, $p = .17$. All target pictures showed concrete objects and were therefore associated with names that suggested themselves.

Eight positive and eight negative pictures were used as primes. Mean valences for positive and negative pictures differed significantly, $M_{positive}$ = 7.27 (*SD* = 0.52) and $M_{negative}$ = 2.56 (*SD* = 0.93), $t(7) = 14.69$, $p < .001$. Mean arousal values were matched as closely as possible and were not significantly different, $M_{positive}$ = 4.83 (*SD* = 1.04) and $M_{negative}$ = 5.37 (*SD* = 1.07), $t(7) = -0.81$, $p = .45$. Compared with target pictures, prime pictures portrayed more complex real life scenes and were not as unequivocally nameable with a single word. However, they could easily be associated with a naming response (e.g., *family* for a couple with a young child). I created two sets of prime pictures, each containing four positive and four negative pictures. The sets did not differ in regard to mean valence or arousal, $M_{Set\ 1}$ = 4.96 (*SD* = 2.71) and $M_{Set\ 2}$ = 4.87 (*SD* = 2.54), $t(7)$ =

0.25, $p = .81$, for valence ratings, and $M_{Set\ 1} = 5.17$ ($SD = 0.98$) and $M_{Set\ 2} = 5.03$ ($SD = 1.19$), $t(7) = 0.27$, $p = .79$, for arousal ratings. The assignment of the two sets to the conditions of the prime response association factor was counterbalanced across participants.

Procedure. All experiments described in the thesis were run using the E-Prime program (Psychology Software Tools, Version 2.0) with standard PCs. In all experiments—except from Experiment 3—participants were tested in groups consisting of maximally 5 participants and were seated in front of 15 in. CRT monitors at a distance of approximately 0.7 m.

Experiment 1 consisted of a learning phase, a practice phase, and the evaluative priming task. At the beginning of every phase, participants received instructions written on the screen. In a first phase, participants learned to associate each target picture as well as one set of the prime pictures (the response-bound set) with a specific name. Each trial started with a fixation period of 470 ms, during which four points moved from the four edges of the screen toward the screen's center, where they were replaced with a fixation cross displayed for 500 ms. After a blank period of 500 ms, a picture (width = 16 cm and height = 12 cm) with a unicolored frame (blue, red, yellow, or green; randomly varying from trial to trial; width = 3 mm) was presented with its corresponding name written below the picture (black 36-point Courier New font). The prime pictures of the second (nonresponse-bound) set were presented as well to prevent any confound with regard to familiarity. They appeared with the particular frame color instead of the picture name written below the picture. Participants were instructed to read out the name or the color (whichever was presented beneath the picture) as quickly as possible, and to learn the association between picture and name. They were informed about the random assignment of pictures and frame colors and they were instructed—in case of a picture with color label—to simply learn the association of the picture with color-naming in general but not with a single color label. Thereby, the pictures from the nonresponse-bound prime set were not paired with an unequivocal naming response. After the participants' vocal response, the picture disappeared, and the screen was cleared for 500 ms. Each picture was presented four times; that is, the learning phase comprised a total of 96 trials.

In the next phase, the learned response associations were practiced. The pictures were presented in the same manner as in the learning phase but without any labels. Participants were instructed to name the pictures with the learned names or their current frame color. Each response was registered by a voice key. The experimenter, who was sitting in front of a second screen displaying the correct responses, coded the accuracy of each response and monitored voice key triggering (to exclude accidental voice key activations). Each picture was presented five times, resulting in a total of 120 trials. If an error occurred, the picture with its particular label (name or frame color) was displayed again, and participants were required to give the correct response. If there were more than forty errors, the entire practice phase was repeated.

The main part of the experiment was the evaluative priming task. Figure 1 shows one typical trial of this task. Each trial started with a fixation period, as described previously. After a 500-ms blank screen, a target picture was presented in the middle of the screen (presentation mode was similar to the preceding phase; i.e., pictures appeared in the same size and with a colored frame). Eighty ms later (SOA = -80 ms), a prime picture (11 cm × 8 cm, without colored frame) appeared centrally on top of the target picture for 120 ms. Participants were instructed to name the large picture that appeared first as quickly and accurately as possible while ignoring the smaller picture. The target picture remained on the screen until a response was given, which was registered by a voice key and coded by the experimenter. The intertrial interval was 500 ms.

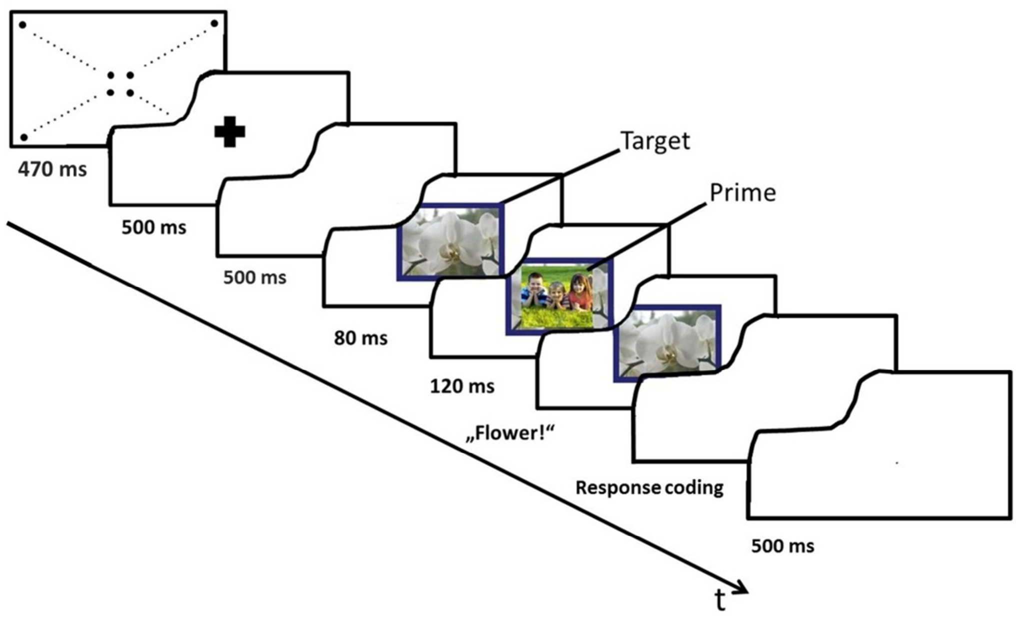

FIGURE 1.

Example trial of the evaluative priming task (naming task) in Experiment 1. In the actual experiment, pictures from the International Affective Picture System (IAPS) were used; comparable pictures were selected for illustrative purposes in Figure 1.

There were eight warm-up trials (i.e., each target appeared once), followed by the main phase comprising a total of 128 trials, with each prime-target combination featured once. The trial-sequence was randomized with the constraint that neither a target nor a prime picture was repeated in immediately successive trials.

2.1.2 Results

The average error rate across participants was 0.7 %. Mean RTs were derived from correct responses, and RTs shorter than 200 ms or longer than 1,500 ms were discarded (0.2 % of trials). Mean RTs and error rates for all conditions are shown in Table 1. Unless otherwise noted, all effects referred to as statistically significant throughout the thesis are associated with p values less than .05, two-tailed.

A 2 (prime response association: response-bound vs. nonresponse-bound) × 2 (priming condition: congruent vs. incongruent) analysis of variance (ANOVA) on mean RTs yielded no significant main effects, $F(1,30) = 1.02$, $p = .32$, mean square error (*MSE)* = 351 for the main effect of prime response association and $F < 1$ for the main effect of priming condition. But the interaction was significant, $F(1,30) = 9.95$, $p < .01$, $MSE = 340$. As expected, the S–S-based evaluative priming effect for response-bound primes was significantly below zero, $M = -11$ ms ($SD = 20$ ms), $t(30) = -3.08$, $p < .01$, $d_Z = -0.56$, whereas the S–S-based evaluative priming effect for nonresponse-bound primes was significantly positive, $M = 10$ ms ($SD = 30$ ms), $t(30) = 1.80$, $p < .05$ (one-tailed), $d_Z = 0.32$. An analogous ANOVA on error rates yielded no significant effects, all Fs < 1.

TABLE 1.

Mean RTs (in ms) as a Function of Priming Condition and Prime Type (Errors in % in Parentheses); Priming Effects for RTs (in ms; Standard errors in Brackets) (Experiment 1)

	Priming		
	Congruent	Incongruent	**S–S-based Evaluative**

			Priming Effect
Prime Type			
Nonresponse-bound	656 (0.9)	665 (0.5)	10* [5]
Response-bound	669 (0.7)	658 (0.7)	-11** [4]

Note: Priming scores are calculated by subtracting mean RTs for congruent priming from mean RTs for incongruent priming. Slight inconsistencies between the left and the right part of the table are due to rounding.

* $p < .05$ (one-tailed), ** $p < .01$

2.1.3 Discussion

The results clearly support my hypotheses. Prime pictures—presented 80 ms after target onset—that were strongly bound to a naming response led to a significant negatively signed S–S-based evaluative priming effect. This effect was not observed for prime pictures without response association. In fact, this condition yielded a positive S–S-based evaluative priming effect. The three-process model is best suited to explain this finding. A negative SOA-procedure was used to weaken target-encoding facilitation and strengthen prime-activation maintenance. This prime maintenance had an observable effect on target response only if target and prime competed for response, that is, if both were associated with a unique naming response. Therefore, only response-bound primes yielded a negatively signed S–S-based evaluative priming effect. In contrast, nonresponse-bound primes did not interfere with target naming and, hence, prolonged prime activation had no observable effect. The small positive S–S-based evaluative priming effect for nonresponse-bound primes is most likely based on residual target encoding (despite the negative SOA). Experiment 1 conceptually replicates and extends the study by Wentura and Frings (2008) who found the same interaction of priming condition (i.e., evaluative congruency or incongruency between prime and target) and prime response association. However, due to the use of a positive SOA, target-encoding facilitation presumably had a larger influence on the priming effect, yielding a positive effect in the nonresponse-bound condition and (due to additional response conflict) a null effect in the response-bound condition. As explained earlier, this result was open to an alternative explanation.

The purpose of Experiment 2a/b was to provide corroborative evidence for maintained prime activation given evaluative congruency with a manipulation of response facilitation and conflict between prime and target. For this, I examined evaluative priming in the semantic categorization task with primes and targets being evaluatively connoted exemplars from the semantic categories *persons* and *animals*. While participants were required to categorize the targets according to the semantic categories, the evaluative connotations were orthogonally varied. I used this approach for two reasons.

First, evidence for S–S-based evaluative priming effects in the semantic categorization task is even less convincing than in the naming task. As I reported earlier, some authors failed to find any evaluative priming effect (see De Houwer et al., 2002; Klinger et al., 2000, Exp. 4), while others showed conditional evaluative priming effects (Spruyt, De Houwer, et al., 2007). If target-encoding facilitation and prime maintenance are valid processes in evaluative priming designs, their effects should, however, be observable across various tasks.

Second, the semantic categorization task is even better suited for my purposes because primes that vary not only with regard to the evaluative categories but also with regard to the semantic (i.e., task-relevant) categories can be used (see Klinger et al., 2000, Exp. 4, in contrast to De Houwer et al., 2002). This means that prime and target are either associated with the same categorization response (if they share the semantic category) or opposite categorization responses (if they are from different semantic categories). This allows for the examination of S–R-based semantic priming effects (i.e., faster categorization of a target following a semantically compatible vs. incompatible prime) in addition to S–S-based evaluative priming effects. S–R-based priming effects have been reliably found with semantic categorization tasks (see Banaji & Hardin, 1996; Klinger et al., 2000).

On the basis of the theoretical assumption that a target helps to maintain the activation of an evaluatively congruent prime, I expected an evaluatively congruent prime to be activated strongly enough to interfere with the target response, yielding an S–R-based semantic priming effect. In contrast, I expected the activation of an evaluatively incongruent prime to be rather weak, inducing a reduced (or even no) response conflict and a reduced (or even no) S–R-based semantic priming effect. Thus, I predicted an interaction between semantic compatibility and evaluative congruency, that is, the S–R-based semantic priming effect should be larger in case of evaluative congruency than incongruency.

In terms of S–S-based evaluative priming effects, I expected the following: Semantic incompatibility (with regard to the task relevant semantic categories) between prime and target should be associated with response conflict. This response conflict should be larger and prolonged in case of evaluative congruency. Therefore, I predicted a negatively signed S–S-based evaluative priming effect given semantic incompatibility. By contrast, in case of semantic compatibility, prolonged prime activation should not interfere with the target response (in fact, it might even facilitate the response process). In addition, an evaluatively congruent prime might support target encoding despite its posttarget onset (see results of Experiment 1). Thus, for semantically compatible prime-target pairs, I expected either a null or a positive S–S-based evaluative priming effect.

2.2 Evaluative priming in the semantic categorization task (Experiment 2a/b)

I examined S–S-based evaluative priming in the semantic categorization task. Primes and targets were positive and negative pictures (Exp. 2a) or words (Exp. 2b) representing members from the semantic categories *persons* or *animals*. Prime and target on any particular trial were associated with either the same or opposite responses, depending on their category membership (i.e., variation of response conflict). Thus, with regard to the semantic, task-relevant variation (i.e., person vs. animal), the experimental design constituted an S–R-based semantic priming design; with regard to the evaluative variation, the design constituted an S–S-based evaluative priming design. Analogous to Experiment 1, a negative SOA-procedure was used in order to maximize the facilitative effect of evaluative congruency on prime-activation maintenance, while minimizing the same effect on target encoding.

2.2.1 Method

Participants. In Experiment 2a, 30 students (25 women; 5 men) participated; their median age was 21 years (range from 19 to 28 years). In Experiment 2b, 34 students (22 women; 12 men) participated; their median age was 22 years (range from 19 to 37 years).

Design. I employed a 2 (prime semantic) × 2 (target semantic) × 2 (prime valence) × 2 (target valence) within-participants design.

Material. The stimulus material was different in Experiment 2a and 2b.

Experiment 2a. I selected ten positive (five depicting people and five depicting animals) and ten negative (five depicting people and five depicting animals) pictures from the IAPS (Center for the Study of Emotion and Attention, 1994). IAPS numbers for all selected pictures are listed in Appendix A. Mean valences were M = 7.12 (SD = 0.73) and M = 8.09 (SD = 0.22) for positive person and animal pictures, respectively, and M = 2.70 (SD = 0.78) and M = 3.59 (SD = 0.14) for negative person and animal pictures, respectively. Ratings for positive and negative pictures differed significantly, $t(4) = 62.41$, $p < .001$, for person pictures and $t(4) = 91.11$, $p < .001$, for animal pictures. The sets of person and animal pictures also differed significantly with regard to mean valence, $t(9) = -5.22$, $p < .001$, due to significantly more positive ratings for animal pictures than for person pictures. Mean arousal values were M = 4.09 (SD = 0.64) and M = 5.59 (SD = 0.91) for positive person and animal pictures, respectively, and M = 4.34 (SD = 0.84) and M = 6.12 (SD = 0.84) for negative person and animal pictures, respectively. Arousal values were matched as closely as possible and did not differ between person and animal pictures, $t(9) = -1.51$, $p = .17$. Arousal values for positive and negative pictures were significantly different, $t(9) = -4.11$, $p < .01$, since ratings for negative pictures were more arousing than ratings for positive pictures.

Experiment 2b. All stimuli were German words. I selected ten positive and ten negative exemplar names from the categories *persons* and *animals*, respectively (most of which were also used by De Houwer et al., 2002). A list of stimuli can be found in Appendix B. Mean valences—as rated by the participants after the experiment—were M = 7.60 (SD = 0.57) and M = 7.13 (SD = 0.79) for positive person and animal words, respectively, and were M = 4.13 (SD = 0.54) and M = 4.46 (SD = 1.02) for negative person and animal words, respectively (on a scale from 1 to 9). Ratings for positive and negative words differed significantly, $t(9) = 4.09$, $p < .01$, for person words and $t(9) = 6.18$, $p < .001$, for animal words. The sets of person and animal words did not differ with regard to mean valence, $t(19) = 0.13$, $p = .90$. Word length was balanced as closely as possible.

Procedure. The experiment consisted of a learning phase and the evaluative priming task. At the beginning of every phase, instructions were presented on the screen. In the initial learning phase, participants were familiarized with the semantic categories. The procedural details were the same as in Experiment 1. Participants were instructed to categorize centrally presented images (16 cm × 12 cm) in Experiment 2a and words (black 18-point Courier New font) in Experiment 2b, as depicting a person or an animal as quickly and accurately as possible. Participants made categorization responses via the keys *c* and *m* on a computer keyboard, using their left and right index fingers. A 500-ms blank screen followed a correct response; in case of an error, the participants received feedback and were required to press the correct key to proceed ("Wrong! Continue with the correct key."). Each picture (Exp. 2a) or word (Exp. 2b), respectively, was presented once; that is, the learning phase comprised 20 trials in Experiment 2a and 40 trials in Experiment 2b in random sequences. If more than five (Exp. 2a) or ten (Exp. 2b) errors, respectively, occurred, the whole learning phase was repeated. The assignment of response keys to categories was counterbalanced across participants.

The evaluative priming task in Experiment 2a also followed the procedure of Experiment 1, except that there were no colored frames, semantic categorization responses were given via keyboard, and feedback was given in case of inaccurate categorization. Figure 2 shows one typical trial of this task in Experiment 2a. Participants were instructed to categorize the large picture that appeared first as quickly and accurately as possible according to the semantic categories of either *persons* or *animals* while ignoring the smaller picture. There were 16 warm-up trials (i.e., four per condition). In the main phase, each picture featured in each condition twice as a target and twice as a prime (i.e., 160 trials in total). The trial-sequence was randomized with the constraint that target and prime picture were always different on any given trial, and neither target nor prime picture was repeated in immediately successive trials.

In the evaluative priming task of Experiment 2b, small procedural changes were necessitated due to the use of words instead of pictures. Target words were presented at the center of the screen, while prime words appeared as two flankers just over and under the target word. The flankers appeared 50 ms after target onset, resulting in a negative SOA of -50 ms. Target and flankers together stayed on the screen for 100 ms. Participants were instructed to categorize the centrally presented word as quickly and accurately as possible according to the semantic categories *persons* and *animals*, while ignoring the words that appeared just over and under the centrally presented word. Each word was presented in each condition once as a target and once as a prime (i.e., 160 trials). Twenty warm-up trials (i.e., five trials per condition) preceded the experimental trials. After finishing Experiment 2b, participants rated the valence of all experimental stimuli.

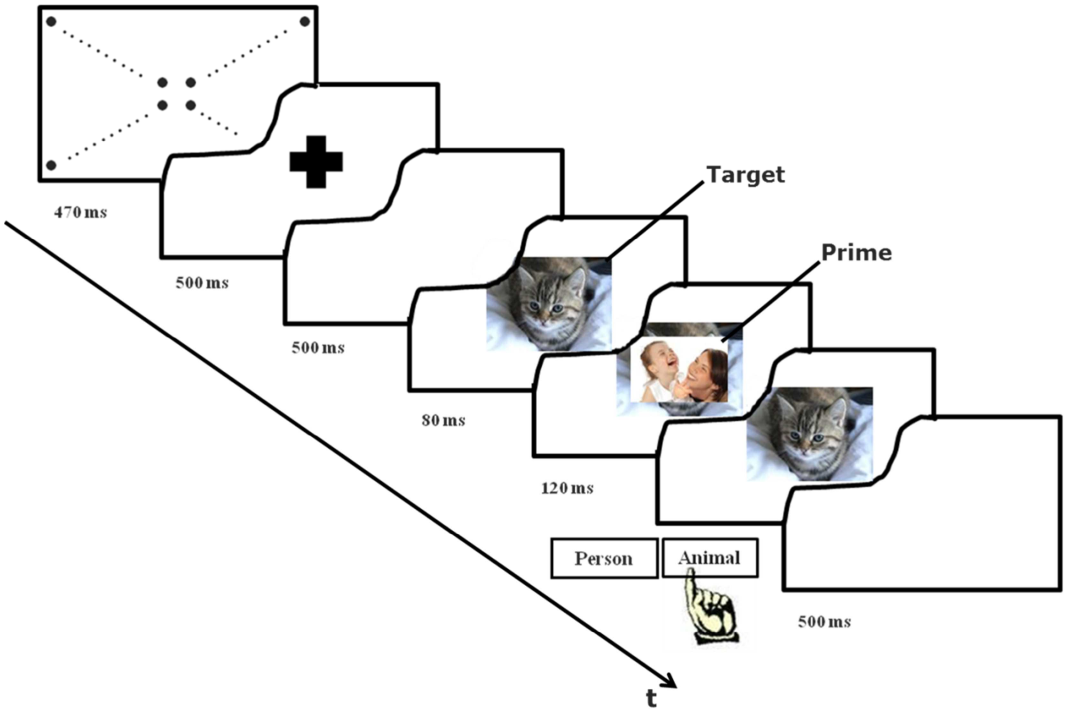

FIGURE 2.

Example trial of the evaluative priming task (semantic categorization task) in Experiment 2a. In the actual experiment, pictures from the International Affective Picture System (IAPS) were used; comparable pictures were selected for illustrative purposes in Figure 2.

2.2.2 Results

Experiment 2a. The average error rate across participants was 3.7 %. Mean RTs were derived from correct responses, and RTs shorter than 200 ms or longer than 1,500 ms were discarded (0.1 % of trials). Mean RTs and error rates for all conditions are shown in Table 2.

A 2 (semantic condition: compatible vs. incompatible) × 2 (evaluative condition: congruent vs. incongruent) ANOVA on RTs yielded a significant main effect of semantic condition, $F(1,29) = 11.71$, $p < .01$, $MSE = 393$, and a significant interaction, $F(1,29) = 4.12$, $p = .05$, $MSE = 358$. The main effect of evaluative condition was not significant, $F < 1$. The interaction can be interpreted from two different points of view. (a) It marks a significant difference in S–R-based semantic priming effects: As expected, in the case of evaluative congruency, the S–R-based semantic priming effect of $M = 19$ ms ($SD = 31$ ms) was significantly above zero, $t(29) = 3.42$, $p < .01$, $d_Z = 0.63$. In the case of evaluative incongruency, however, the S–R-based semantic priming effect of $M = 5$ ms ($SD = 23$ ms) was not significantly above zero, $t(29) = 1.27$, $p = .22$, $d_Z = 0.23$. (b) It marks a significant difference in S–S-based evaluative priming effects: As expected, semantic compatibility yielded a positive effect ($M = 7$ ms, $SD = 24$ ms) and semantic incompatibility yielded a negatively signed effect ($M = -7$ ms, $SD = 28$ ms); however, both failed to reach significance, $t(29) = 1.57$, $p = .13$, $d_Z = 0.29$, given semantic compatibility, and $t(29) = -1.40$, $p = .17$, $d_Z = -0.25$, given semantic incompatibility.

TABLE 2.

Mean RTs (in ms) as a Function of Semantic Condition and Evaluative Condition (Errors in % in Parentheses); Priming Effects for RTs (in ms; Standard errors in Brackets) (Experiment 2a)

	Valence		
	Congruent	Incongruent	**S–S-based Evaluative Priming effect**
Semantic			
Compatible	515 (2.8)	522 (2.4)	7 [4]
Incompatible	535 (5.0)	527 (4.4)	-7 [5]
S–R-based Semantic Priming effect	19** [6]	5 [4]	

Note: Priming scores (evaluative and semantic) are calculated by subtracting mean RTs for congruent/compatible priming from mean RTs for incongruent/incompatible priming. Slight inconsistencies between the left and the right part of the table are due to rounding.

** $p < .01$

An analogous ANOVA on error rates yielded a significant main effect of semantic condition, $F(1,29) = 12.80$, $p < .01$, $MSE = 0.001$, corresponding to a positive S–R-based semantic priming effect of $M = 2.1$ % ($SD = 3.2$ %), $t(29) =$

3.58, $p = .001$, $d_Z = 0.65$. Neither the main effect of evaluative condition, $F(1,29) = 1.12$, $p = .30$, $MSE = 0.001$, nor the interaction reached significance, $F < 1$.

Experiment 2b. The average error rate across participants was 5.4 %. Preliminary item analyses showed that the negative animal word *Aasgeier* (in English, *vulture*) led to outlier values in mean error rate as well as mean RTs. Moreover, some participants reported difficulties in unequivocally categorizing the word *Aasgeier* as an animal, as it is also used for a person in a figurative manner. Therefore, I discarded all trials with the target *Aasgeier*.[4] Mean RTs were derived from correct responses, and RTs shorter than 200 ms or longer than 1,500 ms were discarded (0.4 % of trials). Mean RTs and error rates for all conditions are shown in Table 3.

TABLE 3.

Mean RTs (in ms) as a Function of Semantic Condition and Evaluative Condition (Errors in % in Parentheses); Priming Effects for RTs (in ms; Standard errors in Brackets) (Experiment 2b)

	Valence		
	Congruent	Incongruent	**S–S-based Evaluative Priming effect**
Semantic			
Compatible	564 (3.9)	569 (4.0)	6 [6]
Incompatible	589 (6.9)	578 (6.6)	-11* [5]
S–R-based Semantic Priming effect	26*** [6]	9 [6]	

Note: Priming scores (evaluative and semantic) are calculated by subtracting mean RTs for congruent/compatible priming from mean RTs for incongruent/incompatible priming. Slight inconsistencies between the left and the right part of the table are due to rounding.

* $p < .05$, *** $p < .001$

A 2 (semantic condition: compatible vs. incompatible) × 2 (evaluative condition: congruent vs. incongruent) ANOVA on RTs yielded a significant main effect of semantic condition, $F(1,33) = 17.05$, $p < .001$, $MSE = 591$, but no main effect of evaluative condition, $F < 1$. Most important, the interaction was significant as well, $F(1,33) = 4.87$, $p < .05$, $MSE = 520$. As hypothesized, the S–

[4] Including the trials with the target *Aasgeier* essentially yielded the same effects in all analyses.

R-based semantic priming effect was significant in the case of evaluative congruency, *M* = 26 ms (*SD* = 34 ms), $t(33) = 4.40$, $p < .001$, $d_Z = 0.76$, but failed to reach significance in the case of evaluative incongruency, *M* = 9 ms (*SD* = 32 ms); $t(33) = 1.55$, $p = .13$, $d_Z = 0.26$. Given semantic incompatibility, I found a significant negatively signed S–S-based evaluative priming effect of *M* = -11 ms (*SD* = 26 ms), $t(33) = -2.50$, $p < .05$, $d_Z = -0.43$. Given semantic compatibility, the S–S-based evaluative priming effect was positively signed but non-significant, *M* = 6 ms (*SD* = 33 ms); $t(33) = 1.04$, $p = .30$, $d_Z = 0.18$.

An analogous ANOVA on error rates yielded a significant main effect of semantic condition, $F(1,33) = 19.35$, $p < .001$, $MSE = 0.001$, corresponding to a positive S–R-based semantic priming effect of *M* = 2.8 % (*SD* = 3.6 %), $t(33) = 4.40$, $p < .001$, $d_Z = 0.75$. Neither the main effect of evaluative condition nor the interaction reached significance, both *F*s < 1.

2.2.3 Discussion

The results from the semantic categorization task with pictures and words as prime and target stimuli confirm my theoretical rationale. The significant interaction between semantic and evaluative factors demonstrates the dependence of the S–R-based semantic priming effect on the evaluative congruency between prime and target: Only if prime and target had the same valence was there a significant S–R-based semantic priming effect. This suggests that given evaluative congruency, the target helps maintain the prime activation. If the prime is associated with the same response as the target, the response is (relatively) facilitated; if the prime is associated with the competing response, the response is (relatively) delayed. However, if prime and target are evaluatively incongruent, the S–R-based semantic priming effect breaks down, supposedly because the activation of the prime is too weak to trigger the corresponding response. Note that in case of evaluative incongruency, the target may even have inhibited the prime activation. As I did not include neutral primes, I am not able to test whether maintained prime activation given evaluative congruency, suppressed prime activation given evaluative incongruency or both raised the larger impact of evaluatively congruent compared with incongruent primes on the target response. The fact that such a reliable effect like the S–R-based priming effect (see Banaji

& Hardin, 1996; Klauer & Musch, 2002; 2003; Klinger et al., 2000) depended on the evaluative congruency between prime and target indicates the prioritized processing of the evaluative dimension.

Regarding the S–S-based evaluative priming effect, semantic incompatibility led to a significant reduction and reversion of the effect as compared with semantic compatibility. Admittedly, the pattern of S–S-based evaluative priming effects was more convincing in Experiment 2b than in Experiment 2a. (I will discuss this point later.) In Experiment 2b, incompatible prime-target pairs led to a significant negatively signed S–S-based evaluative priming effect. This suggests that the response conflict was prolonged given evaluative congruency or that it was resolved more readily given evaluative incongruency. In contrast, if prime and target were associated with the same categorization response, the prime had no distracting influence, independently of evaluative congruency or incongruency. Therefore, no S–S-based evaluative priming effect emerged for compatible prime-target pairs.

In Experiment 2a, the S–S-based evaluative priming effect given semantic incompatibility was only negatively signed but failed to reach the conventional level of significance. However, the significant *reduction* in the incompatible condition (compared to the compatible one) is the more important point here, for the following reason: Note that, even if there was no significant S–S-based evaluative priming effect in the compatible condition, the effect was positively signed in both experiments. If this positively signed effect is due to residual target-encoding facilitation by an evaluatively congruent prime (despite its presentation after target onset), this facilitative effect might exist in the incompatible condition as well, hence minimizing the negatively signed S–S-based evaluative priming effect due to prime maintenance and response conflict. The remaining question is why residual target-encoding facilitation was more pronounced in Experiment 2a than in Experiment 2b. Possibly, prime pictures are associated with a larger target-encoding facilitation than prime words; a consideration that is in line with the findings of Spruyt and colleagues (2002), as I discussed in Section 1.3.2.

Both S–R-based semantic and S–S-based evaluative priming effects support the assumption that an evaluatively congruent target helps maintain the prime activation, which in turn may yield a prolonged response conflict if prime and target are associated with competing responses.

Despite the replicated finding of a significant interaction of evaluative congruency and semantic compatibility in the S–S-based evaluative priming variant with the semantic categorization task, the cognitive processes accountable for this interaction are still unknown. Since behavioral measures like RTs and errors just indicate the end product of all cognitive processes until response (Luck, 2005), an additional measurement is necessary that provides rather on-line information about the cognitive processing of prime and target during the evaluative priming task. Thus, in Experiment 3 I replicated Experiment 2b with an additional recording of the temporally fine-grained, electrical brain activity that is evidenced by the electroencephalogram (EEG). Within the EEG, I was interested in the ERP reflecting the voltage deflections that are related to external or internal events.

3 Electrophysiological corroboration

The crux of behavioral measures is that they are not sufficiently suited to gather the cognitive processes underlying experimental effects, as they reflect the end product of all processes preceding the response execution. In contrast, the EEG provides continuous information about neural processing with a highly temporal resolution and represents, thereby, an useful and informative measurement in combination with the behavioral data. Within the EEG, the ERP can be extracted which depicts the electrical brain activity that is correlated with external or internal events. Since several ERP components (positive and negative voltage deflections) have been associated with specific information-processing operations (see, e.g., Luck, 2005; Rugg & Coles, 1995), I was able to derive clear hypotheses with regard to the ERP components expected in Experiment 3. Before I describe Experiment 3, I briefly outline the ERP technique and the ERP components that were of primary interest for my purpose.

3.1 The event-related potential (ERP) technique and relevant components

The ERP reflects the electrical brain activity within the continuous and spontaneous EEG that is associated with the cognitive processes in relation to an external (e.g., the stimulus onset in an experiment) or internal event (e.g., the semantic stimulus processing). The primary advantage of the ERP technique over behavioral measures and other neurocognitive methods (e.g., the functional magnetic resonance imaging [fMRI]) is its temporal resolution. The ERP provides a temporally precise stream of neural activity that can be used to make inferences about the cognitive processes involved in a task. The ERP consists of a sequence of components that are characterized according to their polarity, timing, scalp distribution, responsiveness to experimental variables, as well as assumed neural generators (see Donchin, Ritter, McCallum, 1978; Fabiani, Gratton, & Federmeier, 2007). For my purpose, three ERP components, namely, the N2 component, the P3 component, and the lateralized readiness potential (LRP), were of particular interest. In the following, I will briefly characterize these components. On the basis of their empirical evidence and their interpretation with cognitive processes, I will derive the hypotheses for Experiment 3.

3.1.1 The N2 component

The N2 component reflects a negative deflection that arises around 200-500 ms after stimulus onset with a maximum over fronto-central locations (see Folstein & van Petten, 2008). It has typically been associated with conflict detected and monitored by the anterior cingulate cortex (e.g., van Veen & Carter, 2002a) and has been reported in different cognitive paradigms (see Folstein & van Petten, 2008 for a review). For example, N2 amplitude differences were associated with the flanker effect in the flanker paradigm (e.g., Kopp, Rist, & Mattler, 1996; van Veen & Carter, 2002b) and the evaluative priming effect in the evaluation task (see Bartholow et al., 2009; Zhang, Lawson, Guo, & Jiang, 2006). As the N2 component is sensitive for response conflict, S–R-based evaluative priming effects in N2 amplitudes corroborate the response explanation account of S–R-based evaluative priming, as proposed by different authors (see De Houwer et al., 2002; Klauer et al., 1997; Rothermund & Wentura, 1998; Wentura, 1999; 2000).

In Experiment 3 (i.e., the replication of Experiment 2b), N2 mean amplitudes were expected to reflect semantic categorization conflicts, evidenced in S–R-based semantic priming effects. As—according to the claim by the three-process model and in line with the results in Experiment 2—the S–R-based semantic priming effect was predicted to depend on evaluative congruency, I hypothesized a significant interaction of semantic compatibility and evaluative congruency in N2 mean amplitudes. That is, in the case of evaluative congruency a significant S–R-based semantic priming effect should arise that should decrease to a null effect given evaluative incongruency.

3.1.2 The P3 component

The P3 component—supposedly generated by the locus-coeruleus norepinephrine (LC-NE; see Nieuwenhuis, Aston-Jones, & Cohen, 2005)—represents a positive deflection around 300-600 ms after stimulus onset that arises maximally over parietocentral locations (see Donchin et al., 1978; Picton, 1992; Pritchard, 1981). The P3 component has been associated with different cognitive processes (see, e.g., Duncan-Johnson & Donchin, 1982; Picton, 1992). Of relevance for the present purpose is the finding that the P3 latency has been shown to be sensitive for the effort required by categorization responses (see, e.g., Kutas, McCarthy, & Donchin, 1977; Liu, Xin, Jin, Hu, & Li, 2010; Magliero, Bashore, Coles, & Donchin, 1984; McCarthy & Donchin, 1981). The P3 latency typically increases when stimulus categorization becomes more difficult. In the flanker task, for example, slower P3 latencies have been reported in the incompatible compared with the compatible condition (see Coles, Gratton, Bashore, Eriksen, & Donchin, 1985; Gehring, Gratton, Coles, & Donchin, 1992; Smid, Mulder, & Mulder, 1990).

Thus, in Experiment 3, I expected slower P3 peak latencies given semantic incompatibility than compatibility. As—considering the rationale of the three-process model—only an evaluatively congruent prime should be activated enough (due to prime maintenance) to have the potential to interfere in the target categorization, thereby yielding categorization facilitation or conflict, I predicted a significant interaction of semantic compatibility and evaluative congruency in P3 peak latencies.

3.1.3 The lateralized-readiness potential (LRP)

The LRP represents the lateralized part of the readiness potential (see Vaughan Jr., Costa, & Ritter, 1968) and is at least partly generated in the primary motor cortex (see Coles, 1989; Miller & Hackley, 1992). The LRP is seen as an index of selective response preparation (e.g., Coles, 1989; Gratton, Coles, Sirevaag, Eriksen, & Donchin, 1988; Miller & Hackley, 1992) and arises maximally over central scalp locations contralateral to the hand that is responsible for the movement (thereby reflecting the contralateral organization of the motor cortex; see Brunia, 1988). The LRP onset indicates the beginning of side-specific response preparation (e.g., Coles, 1989). Typically, the LRP has been determined at locations near the electrode positions C3 and C4, as these locations are assumed to capture the activation of the motor cortex (see Eimer, 1998; Sommer, Leuthold, & Ulrich, 1994). Among others, several studies reported LRP effects in the flanker task with larger negativities (e.g., Kopp, Rist, & Mattler, 1996; Kopp, Mattler, Goertz, & Rist, 1996) or shorter latencies (e.g., Carrillo-de-la-Peña, Lastra-Barreira, & Galdo-Alvarez, 2006) in the response-compatible compared with the incompatible condition. Recently, evaluative priming effects in the evaluation task have been found in LRP onset latencies with shorter latencies given evaluative congruency compared with incongruency (Eder et al., 2011). Thus, LRP onset occurs earlier when prime and target elicit the same compared with the opposite response.

In Experiment 3, LRP onset latencies were analyzed with regard to categorization facilitation or conflict, respectively, between prime and target. I expected faster onset latencies in the case of semantic compatibility compared with incompatibility, resulting in a positive S–R-based semantic priming effect. In alignment with the results in Experiment 2a/b and analogous to the hypotheses for the N2 component, this priming effect was expected to depend on evaluative congruency.

3.2 ERP correlates of evaluative priming in the semantic categorization task (Experiment 3)

In Experiment 3, I replicated Experiment 2b with an additional analysis of ERP correlates. Up to now, ERP correlates of the S–S-based evaluative priming effect were not yet reported; therefore, the purpose of this experiment was to search for ERP correlates of S–S-based evaluative priming in an explorative manner. N2 mean amplitudes and LRP onset latencies were analyzed with respect to semantic compatibility between prime and target. As the semantically incompatible condition was associated with categorization conflict, while the compatible condition was associated with categorization facilitation, positive S–R-based semantic priming effects were expected to emerge in N2 mean amplitudes and LRP onset latencies. On the analogy of the results in Experiment 2a/b, this effect should depend on evaluative congruency, yielding a significant interaction of semantic compatibility and evaluative congruency. P3 peak latencies were analyzed in regard to the effort required for target categorization. This categorization effort was expected to be influenced by an interaction of semantic compatibility and evaluative congruency. Thus, a significant interaction of the semantic and evaluative factors was predicted for the three ERP components as well as for mean RTs (thereby replicating the results from Experiment 2a/b). This interaction should result in S–R-based semantic priming effects that were moderated by the evaluative dimension and S–S-based evaluative priming effects that were moderated by the semantic dimension.

3.2.1 Method

Participants. 30 participants (15 women, 15 men) completed the experiment. Their median age was 25 years (range from 19 to 32 years). 26 participants were right-handed and four participants were left-handed. None of them reported any neurological impairment.

Design, Materials, Procedure. Design, materials, and procedure were the same as in Experiment 2b with the following exceptions: As the ERP measure requires a larger amount of trials per condition, the number of stimuli used as primes and targets was increased from ten to fifteen exemplar names per category in order to avoid an increase of stimulus repetitions. A list of stimuli can be found in Appendix B. Mean valences—as rated on a scale from 1 to 9 by the participants after the experiment—were $M = 7.57$ ($SD = 0.73$) and $M = 6.76$ ($SD = 0.75$) for positive person and animal words, respectively, and $M = 2.69$ ($SD = 1.11$) and $M = 3.47$ ($SD = 1.18$) for negative person and animal words, respectively. Ratings for positive and negative words differed significantly, $t(14) = 24.43$, $p < .001$ for person and $t(14) = 17.45$, $p < .001$ for animal words. The sets of person and animal words did not differ with regard to mean valence, $t(29) = 0.07$, $p = .95$. Word length was balanced as closely as possible. All words were written in capital letters (black 18-point Courier New font).

Participants were individually tested in an electrically shielded and sound-attenuated chamber. They were seated in front of a 22’’ LCD monitor in a viewing distance of approximately 0.8 m. Instead of the fixation period that was applied in all other experiments reported in this thesis, the fixation cross appeared at the beginning of each trial for a jittered time interval (i.e., 250 ms, 500 ms, or 750 ms). Similarly, the intertrial interval was jittered (i.e., 1,250 ms, 1,500 ms, or 1,750 ms). The learning phase comprised 60 trials in a random sequence with each word displaying once. If more than 15 errors occurred, the whole learning phase was repeated. In the evaluative priming task, each word was presented in each condition once as target and once as prime, that is, the whole task comprised 240 trials. After every 60 trials, the participants were required to take a rest period and to continue the task in a self-paced manner. 16 warm-up trials (i.e., four trials per condition) preceded the experimental trials.

EEG Recording and Analyses. EEG signals were continuously recorded from 60 Ag/AgCl active scalp electrodes mounted in a preconfigured elastic cap (Brain Products) and labeled according to the extended 10-20 system (Sharbrough, Chatrian, Lesser, Lüders, Nuwer, & Picton, 1991). Signals were referenced on-line to the left-mastoid electrode. The electrode at position Fp1 and an electrode placed below the left eye monitored vertical eye movements. Electrodes placed at the outer canthi of the eyes measured horizontal eye movements. All channels were amplified with BrainAmp DC amplifiers (Brain Products). EEG signals were sampled at a rate of 500 Hz and on-line band-pass filtered (0.1-250 Hz). Impedances for all electrodes were kept below 20 kOhm (a value that corresponds to *good level* according to the default setup of the actiCAP Control Software, Brain Products). Data were recorded with the BrainVision Recorder (Brain Products) and offline data processing was performed with the Brain Vision Analyzer 2.0.1 (Brain Products). Electrodes were re-referenced off-line to averaged mastoids. Data were filtered off-line with a low-pass filter of 40 Hz (slope 24 dB) and eye movements were corrected using the independent components analysis. After forming individual epochs of 1700 ms (including a baseline of 200 ms before target onset), epochs still containing artifacts in any EEG channel (i.e., maximum amplitude in the recording epoch ± 200 μV; maximum difference between two successive sampling points 0.5 μV; maximum difference 150 μV in successive intervals of 200 ms; lowest allowed activity-change 50 μV in successive intervals of 100 ms) were rejected. Data were baseline-corrected with respect to the time interval from 200 ms before target onset to target onset. For each participant, ERPs were averaged for each condition and each response key. Grand average ERPs for each condition were computed by averaging the ERPs across participants and response keys.

Based on visual inspection, the N2 occurred in the time window from 300 to 380 ms after target onset at midline electrodes from frontal to parietal positions. The N2 was quantified as the mean amplitude in the time interval from 300 to 380 ms posttarget onset. Based on topographic voltage distributions, the priming effects in N2 mean amplitudes were determined at the CPz electrode. Based on visual inspection, the P3 arised in the time window from 380 to 680 ms after target onset and was largest at centro-parietal and parietal electrodes (particularly, at the Pz electrode). P3 latency was defined as the time interval between target onset and the time point of maximal positivity at the Pz electrode in a search window from 380 to 680 ms posttarget onset, using a computerized peak-picking procedure. Major statistical analyses on N2 mean amplitudes and P3 peak latencies comprised 2 × 2 ANOVAs involving the within-subjects factors semantic condition (compatible vs. incompatible) and evaluative condition (congruent vs. incongruent).

I determined the LRP at the C3 and C4 electrodes (see, e.g., Smulders, Kok, Kenemans, & Bashore, 1995) and applied the averaging method introduced by Coles (1989). For each participant and each condition, ERP activation at the ipsilateral side in regard to the correct response hand (i.e., activation at the C3 electrode for trials requiring left-hand responses and activation at the C4 electrode for trials requiring right-hand responses) was subtracted from ERP activation at the respective contralateral side (i.e., activation at the C4 electrode for required left-hand responses and activation at the C3 electrode for required right-hand responses). The resulting differences were averaged across hands in order to eliminate any influence of the response side and response-unspecific activation (see Coles, 1989). Grand average LRPs for each condition were obtained by averaging the LRP waveforms across participants. Grand average LRPs were low-pass filtered at 17 Hz (24 dB/octave). To determine LRP onset latencies and estimate LRP onset latency differences, the method recommended by Miller, Patterson, and Ulrich (1998) was applied. In the grand average LRPs, I specified the time point at which 50 % of the maximal negativity was reached, using a computerized peak-picking procedure. The time point at which 50 % of the peak amplitude was first exceeded and the immediately preceding time point were interpolated[5]. This value was taken as LRP onset latency. S–R-based semantic as

---

[5] The exact formula for the LRP onset latency estimate is according to Miller and colleagues (1998):

$$L = t_{i-1} + (t_i - t_{i-1}) \times \frac{c - v_{i-1}}{v_i - v_{i-1}}$$

Note: c is the 50 % LRP peak amplitude, t_i is the first time point exceeding the 50 % peak amplitude, v_i is the LRP amplitude at this time point, and t_{i-1} and v_{i-1}

well as S–S-based evaluative priming effects were calculated by subtracting the respective LRP onset latencies. Standard errors (SEM) of the priming effects were estimated applying the jackknife-based procedure (see Miller et al., 1998). Here, 30 different grand average LRPs for each condition were calculated by omitting the data of a different participant from each grand average. With this procedure, subsets of the total sample instead of individual data sets are compared, increasing the signal-to-noise ratio (Miller et al., 1998). The *t* value of every priming effect in LRP onset latencies was calculated as the quotient of the onset latency difference (based on the grand average LRPs) and the respective SEM (based on the jackknifed LRPs).

In some previous studies, the LRP has also been time-locked to the response (e.g., Eder et al., 2011). The response-locked LRP informs about the duration of the *pure* motoric response process (i.e., the process after LRP onset), while the stimulus-locked LRP indicates the duration of the cognitive processes before LRP onset (e.g., Leuthold, Sommer, & Ulrich, 1996). Since in the evaluative priming task, the required motoric responses did not vary with the evaluative or semantic factors, but—independent from the experimental condition—all responses were given via key presses, I did not expect any priming effects in the response-locked LRPs and constrained the LRP analysis on the stimulus-locked LRPs.

3.2.2 Results

Behavioral data. The average error rate across participants was 3.7 %. Mean RTs were derived from correct responses. Furthermore, trials with RTs that were 1.5 interquartile ranges below the first or above the third quartile with respect to the individual distribution (see Tukey, 1977), were shorter than 200 ms or longer than 1,500 ms were discarded (1.7 % of trials). Mean RTs and error rates for all conditions are shown in Table 4.

A 2 (semantic condition: compatible vs. incompatible) × 2 (evaluative condition: congruent vs. incongruent) ANOVA on RTs yielded a significant main effect of semantic condition, $F(1,29) = 19.77$, $p < .001$, $MSE = 329$, but no main effect of evaluative condition, $F < 0.01$. Although the interaction missed the

are the immediately preceding time point and the corresponding LRP amplitude, respectively.

conventional level of significance, $F(1,29) = 2.15$, $p = .08$ (one-tailed)[6], $MSE = 359$—as hypothesized—the S–R-based semantic priming effect was significantly positive given evaluative congruency, $M = 20$ ms ($SD = 18$ ms), $t(29) = 5.89$, $p < .001$, $d_Z = 1.07$, but was not significant given evaluative incongruency, $M = 10$ ms ($SD = 32$ ms), $t(29) = 1.64$, $p = .11$, $d_Z = 0.30$. Both S–S-based evaluative priming effects pointed to the expected direction but failed the conventional level of significance: the effect was positively signed given semantic compatibility, $M = 5$ ms ($SD = 26$ ms), $t(29) = 1.12$, $p = .27$, $d_Z = 0.20$, and negatively signed given semantic incompatibility, $M = -5$ ms ($SD = 22$ ms), $t(29) = -1.23$, $p = .23$, $d_Z = -0.22$.

An analogous ANOVA on error rates yielded a significant main effect of semantic condition, $F(1,29) = 5.51$, $p < .05$, $MSE = 0.001$, which corresponded to a positive S–R-based semantic priming effect of $M = 1.7$ % ($SD = 3.9$ %), $t(29) = 2.35$, $p < .05$, $d_Z = 0.43$. Neither the main effect of evaluative condition, $F(1,29) = 1.75$, $p = .20$, $MSE = 0$, nor the interaction reached significance, $F < 1$.

TABLE 4.

Mean RTs (in ms) as a Function of Semantic Condition and Evaluative Condition (Errors in % in Parentheses); Priming Effects for RTs (in ms; Standard errors in Brackets) (Experiment 3)

	Valence		
	Congruent	Incongruent	**S–S-based Evaluative Priming Effect**
Semantic			
Compatible	630 (2.6)	635 (3.3)	5 [5]
Incompatible	650 (4.5)	645 (4.7)	-5 [4]
S–R-based Semantic Priming Effect	20*** [3]	10 [6]	

Note: Priming scores (evaluative and semantic) are calculated by subtracting mean RTs for congruent/compatible priming from mean RTs for incongruent/incompatible priming.

*** $p < .001$

[6] Note: given the specific prediction and the equivalence of an F-test with one numerator df to a two-tailed t-test, an one-tailed test is allowed even for F-tests (see, e.g., Maxwell & Delaney, 1990).

ERP data. After the exclusion of trials due to artifact rejection and due to the application of the same exclusion criteria as applied to the behavioral data, the mean numbers of included trials were *M* = 89.7 % (*SD* = 5.9 %) in the semantically compatible and evaluatively congruent condition, *M* = 88.5 % (*SD* = 5.4 %) in the compatible and incongruent condition, *M* = 87.5 % (*SD* = 6.2 %) in the incompatible and congruent condition, and *M* = 85.6 % (*SD* = 5.1 %) in the incompatible and incongruent condition. In a 2 (semantic condition) × 2 (evaluative condition) ANOVA on the numbers of valid trials, the main effect of semantic condition, $F(1,29) = 9.28$, $p < .01$, as well as the main effect of evaluative condition, $F(1,29) = 6.22$, $p < .05$, reached significance. The interaction was not significant, $F < 1$. Both main effects resulted from more errors in semantically incompatible than compatible conditions, and more errors in the case of evaluative incongruency compared with congruency (see Table 4). Importantly, the differently large number of excluded trials in the experimental conditions did not occur due to differences in the amount of artifacts. The event-related potentials at midline electrodes are shown in Figure 3.

N2 mean amplitudes. N2 mean amplitudes at the CPz electrode for all conditions are shown in Table 5. A 2 (semantic condition: compatible vs. incompatible) × 2 (evaluative condition: congruent vs. incongruent) ANOVA on N2 mean amplitudes yielded no significant main effect, $F(1,29) = 1.67$, $p = .21$, $MSE = 3.31$, for the factor semantic condition and, $F < 1$, for the factor evaluative condition, respectively. Due to outliers in the priming effects, I analyzed the interaction effect and the priming effects in Wilcoxon rank tests. The interaction reached significance, $Z = -1.62$, $p = .05$ (one-tailed). In simple effect tests, the S–R-based semantic priming effect was significantly negative given evaluative congruency, *M* = -0.86 µV (*SD* = 2.72 µV), $Z = -2.07$, $p < .05$, $\varphi = 0.38$, but did not emerge given incongruency, *M* = 0 µV, $Z = -0.03$, $p = .98$, $\varphi = 0$. Both S–S-based evaluative priming effects missed the conventional level of significance, *M* = -0.60 µV (*SD* = 2.04 µV), $Z = -1.47$, $p = .14$, $\varphi = 0.27$ in case of semantic compatibility, and *M* = 0.26 µV (*SD* = 2.27 µV), $Z = -0.73$, $p = .47$, $\varphi = 0.13$ in case of incompatibility. Difference waveforms at the CPz electrode reflecting the S–R-based semantic priming effects are shown in Figure 4. Figure 5 displays the corresponding topographic voltage distributions.

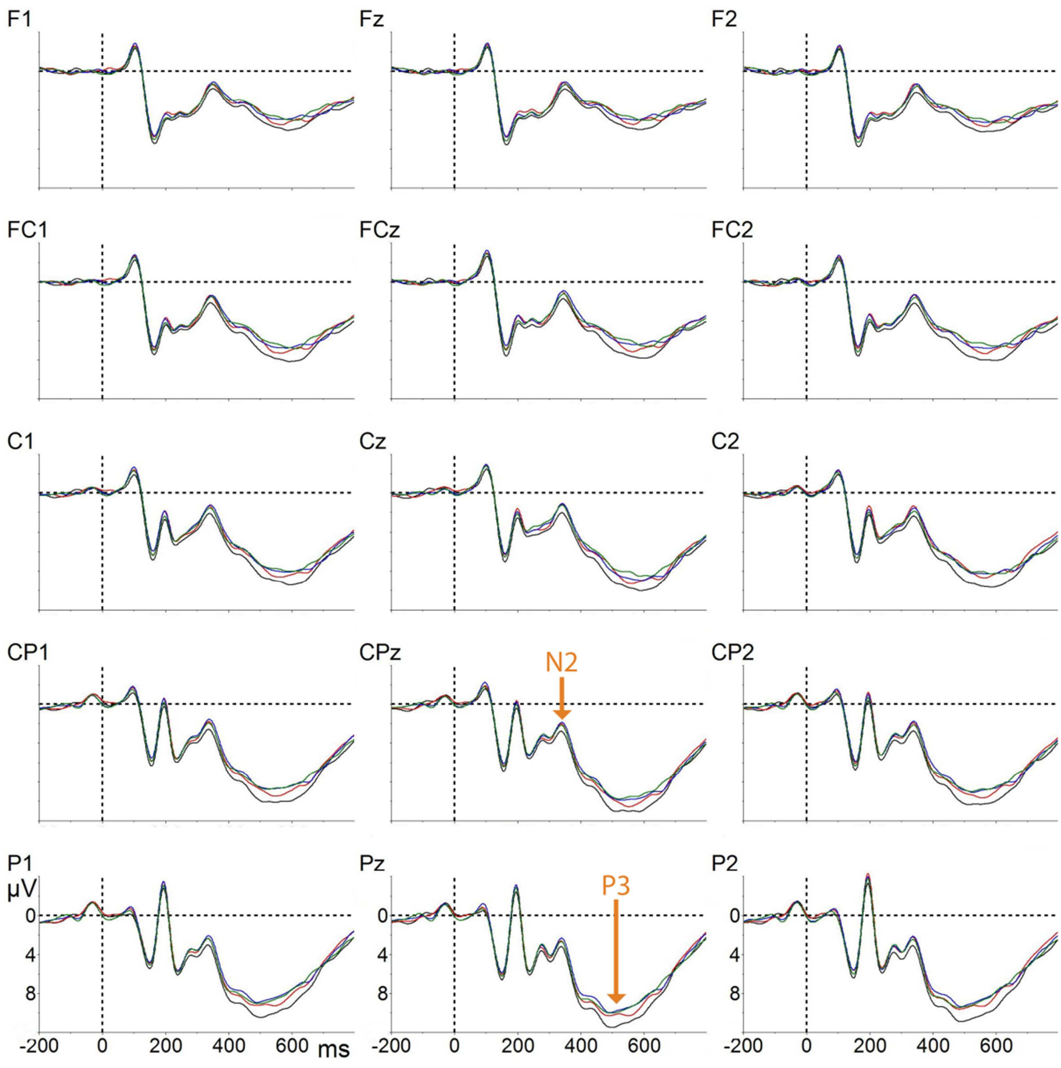

FIGURE 3.

Grand average ERP waveforms at midline electrodes from frontal to parietal positions for all experimental conditions (Experiment 3).

Note: black lines = semantically compatible and evaluatively congruent, red lines = semantically compatible and evaluatively incongruent, blue lines = semantically incompatible and evaluatively congruent, and green lines = semantically incompatible and evaluatively incongruent.

The electrode positions at which the N2 component and the P3 component, respectively, were analyzed are indicated by arrows.

TABLE 5.

N2 mean amplitudes (in µV) of the grand average ERPs at the CPz electrode within the time interval 300 – 380 ms posttarget onset as a Function of Semantic Condition and Evaluative Condition (Standard deviations in Parentheses); Priming Effects (in µV; Standard errors in Brackets) (Experiment 3)

	Valence		
	Congruent	Incongruent	**S–S-based Evaluative Priming Effect**
Semantic			
Compatible	3.68 (4.40)	3.08 (5.18)	-0.60 [0.37]
Incompatible	2.82 (4.89)	3.08 (4.65)	0.26 [0.42]
S–R-based Semantic Priming Effect	-0.86* [0.50]	0.00 [0.39]	

Note: Priming scores (evaluative and semantic) are calculated by subtracting mean amplitudes for congruent/compatible priming from mean amplitudes for incongruent/incompatible priming.

* $p < .05$

P3 peak latencies. P3 peak latencies at the Pz electrode for all conditions are shown in Table 6. A 2 (semantic condition: compatible vs. incompatible) × 2 (evaluative condition: congruent vs. incongruent) ANOVA on P3 peak latencies yielded no significant main effect, either for the factor semantic condition, $F < 1$, or the factor evaluative condition, $F(1,29) = 2.28$, $p = .14$, $MSE = 2312$. Due to outliers in the priming effects, I again analyzed the interaction effect and the priming effects in Wilcoxon rank tests. The interaction reached significance, $Z = -1.64$, $p = .05$ (one-tailed). Both S–R-based semantic priming effects were not significant, $M = 10$ ms ($SD = 63$ ms), $Z = -0.98$, $p = .33$, $\varphi = 0.18$, given evaluative congruency, and $M = -18$ ms ($SD = 60$ ms), $Z = -1.86$, $p = .06$, $\varphi = 0.34$, given incongruency. The S–S-based evaluative priming effect was significantly negative in case of semantic incompatibility, $M = -27$ ms ($SD = 74$ ms), $Z = -2.10$, $p < .05$, $\varphi = 0.38$, while it did not significantly differ from zero in case of compatibility, $M = 1$ ms ($SD = 64$ ms), $Z = -0.22$, $p = .83$, $\varphi = 0.04$.

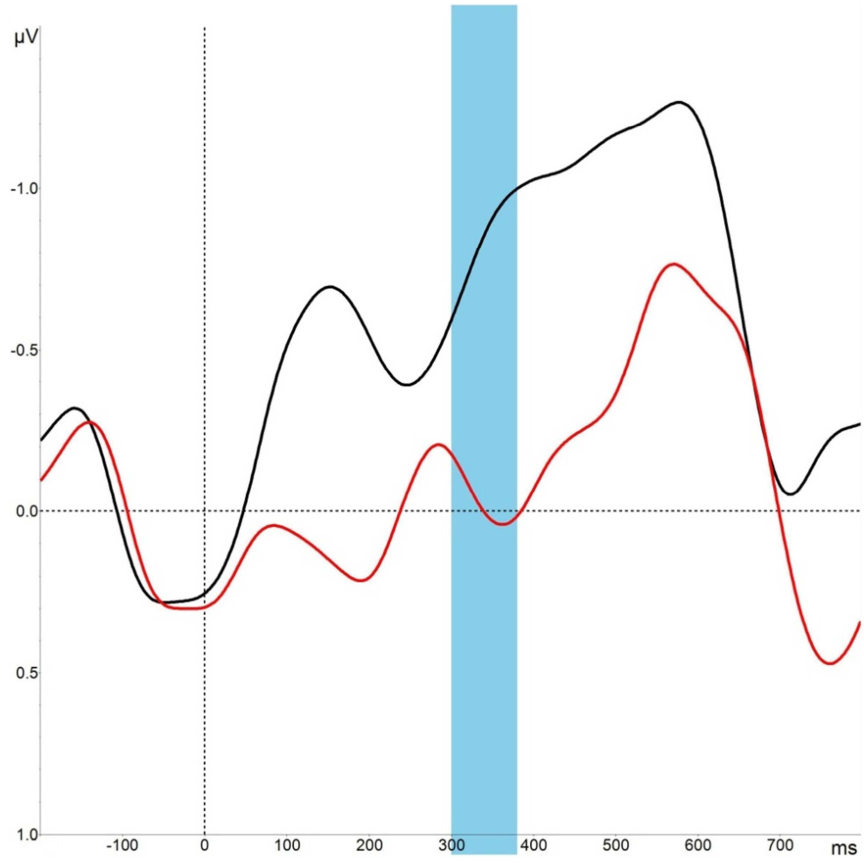

FIGURE 4.

Mean ERP difference waveforms at the CPz electrode reflecting the S–R-based semantic priming effect given evaluative congruency (black line) and incongruency (red line); N2 time interval (i.e., 300-380 ms after target onset) coloured blue.

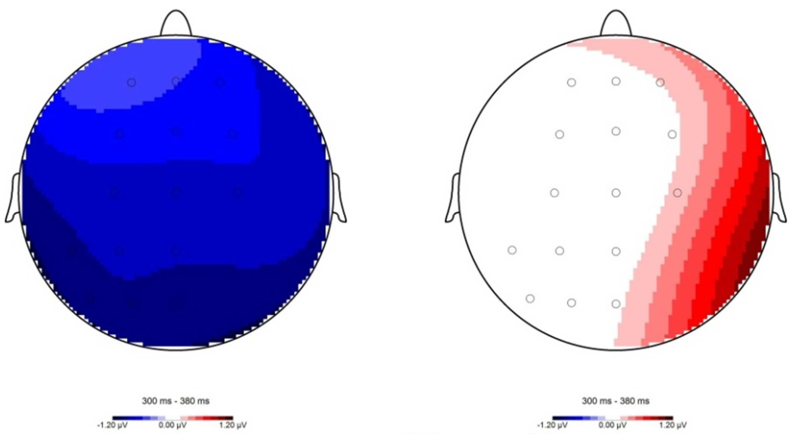

FIGURE 5.

Topographic voltage maps of mean ERP difference waveforms reflecting the S–R-based semantic priming effect given evaluative congruency (left) and incongruency (right) in the N2 time interval (i.e., 300-380 ms after target onset).

TABLE 6.

P3 peak latencies (in ms) of the grand average ERPs at the Pz electrode within the time interval 380 – 680 ms posttarget onset as a Function of Semantic condition and Evaluative condition (Standard deviations in Parentheses); Priming Effects (in ms; Standard errors in Brackets) (Experiment 3)

	Valence		
	Congruent	Incongruent	**S–S-based Evaluative Priming Effect**
Semantic			
Compatible	516 (60)	517 (63)	1 [12]
Incompatible	526 (68)	499 (61)	-27* [13]
S–R-based Semantic Priming Effect	10 [12]	-18 [11]	

Note: Priming scores (evaluative and semantic) are calculated by subtracting mean latencies for congruent/compatible priming from mean latencies for incongruent/incompatible priming.

* $p < .05$

LRP onset latencies. The LRP waveforms for all conditions are shown in Figure 6 and mean LRP onset latencies are shown in Table 7. The priming effects pointed to the expected directions, even though they were not significant in simple effect tests. The S–R-based semantic priming effect was positively signed given evaluative congruency, $M = 16$ ms ($SEM = 28$ ms), $t < 1$, while it was negatively signed given incongruency, $M = -30$ ms ($SEM = 16$ ms), $t(29) = -1.88$, $p > .05$. The S–S-based evaluative priming effect was positively signed in case of semantic compatibility, $M = 37$ ms ($SEM = 30$ ms), $t(29) = 1.23$, $p > .05$, and negatively signed in case of incompatibility, $M = -10$ ms ($SEM = 12$ ms), $t < 1$. The interaction of semantic and evaluative factors failed to be significant in a paired *t*-test, $t(29) = 1.42$, $p > .05$.

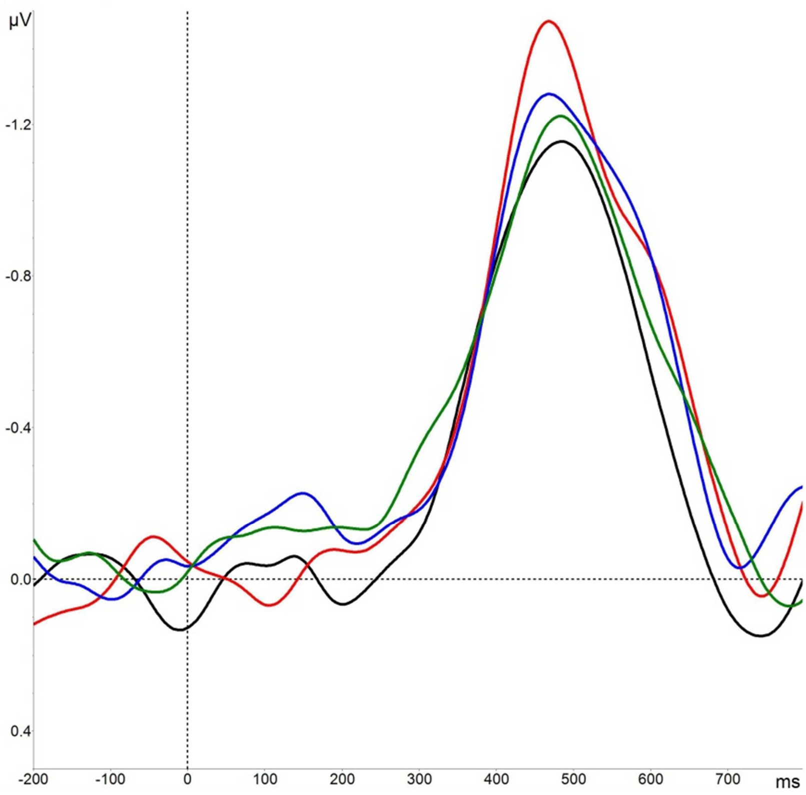

FIGURE 6.

Grand average LRP waveforms at the C3 and C4 electrodes for the experimental conditions.

Note: black lines = semantically compatible and evaluatively congruent, red lines = semantically compatible and evaluatively incongruent, blue lines = semantically incompatible and evaluatively congruent, and green lines = semantically incompatible and evaluatively incongruent.

TABLE 7.

50%-peak latencies (in ms) of the grand average LRP as a Function of Semantic condition and Evaluative condition; Priming Effects (in ms; Standard errors in Brackets) (Experiment 3)

	Valence		
	Congruent	Incongruent	**S–S-based Evaluative Priming Effect**
Semantic			
Compatible	361	398	37 [30]
Incompatible	378	368	-10 [12]
S–R-based Semantic Priming Effect	16 [28]	-30 [16]	

Note: Priming scores (evaluative and semantic) are calculated by subtracting mean latencies for congruent/compatible priming from mean latencies for incongruent/incompatible priming (see Methods for further description). Slight inconsistencies between the left and the right part of the table are due to rounding.

3.2.3 Discussion

The priming effects in mean RTs replicated the findings in the previous experiments; even though, I have to admit that the interaction of the semantic and evaluative factors missed the conventional level of significance. However, the dependence of the S–R-based semantic priming effect on evaluative congruency, which was evidenced by a significant effect in case of evaluative congruency but no effect in case of incongruency, implicates that only an evaluatively congruent prime was activated enough to interfere with the target response to an observable extent. Similarly, the semantic factor influenced the sign of the S–S-based evaluative priming effect, yielding a negatively signed effect given semantic incompatibility which, however, did not significantly differ from zero. The reason for this non-significance might be that—despite the negative SOA—an evaluatively congruent prime still facilitated target encoding, reducing the negative effect due to prime maintenance and response competition. Even more corroborated is the assumption of a residual target-encoding facilitation by the positively signed S–S-based evaluative priming effect in case of semantic compatibility.

In the ERP components, the interaction of the semantic and evaluative factors tended to the expected direction, as well, and reached significance in N2 mean amplitudes and P3 peak latencies. The S–R-based semantic priming effect in N2 mean amplitudes equaled the effect in mean RTs: Given evaluative congruency, larger N2 mean amplitudes arised in case of semantic incompatibility as compared to compatibility. In contrast, if prime and target were evaluatively incongruent, the S–R-based semantic priming effect did not differ from zero. As the N2 component has typically been associated with conflict detection or cognitive control (see Folstein & van Petten, 2008; van Veen & Carter, 2002a), the significant influence of evaluative congruency on the S–R-based semantic priming effect corroborates the assumption that the prime's potential to conflict with the target response depended on its evaluative congruency with the target. N2 mean amplitudes did not significantly differ with regard to evaluative congruency or incongruency, yielding no significant S–S-based evaluative priming effects.

In P3 peak latencies, the significance pattern of the single priming effects differed from the pattern in mean RTs and N2 mean amplitudes. While the S–R-based semantic priming effects only numerically pointed to the expected directions, the negatively signed S–S-based evaluative priming effect given semantic incompatibility reached the conventional level of significance. That is, if prime and target competed for response resources, P3 peak latencies were delayed in case of evaluative congruency as compared to incongruency. This latency difference can be interpreted in the way that evaluative congruency increased the effort required for the response conflict resolution in case of semantic incompatibility (Kutas, et al., 1977; Liu et al., 2010; Magliero et al., 1984; McCarthy & Donchin, 1981). The reason for the different significance pattern of the priming effects in P3 peak latencies compared to the priming effects in mean RTs and N2 mean amplitudes might lie in the main effect of semantic compatibility in P3 peak latencies: P3 peak latencies were delayed in the case of semantic compatibility as compared to incompatibility. Since the task required a semantic categorization of the target, participants might have tried to separate prime and target information in order to avoid confusion. Semantic compatibility might have hampered this separation, whereby the effort to categorize the target increased. I have to admit that this post-hoc interpretation is highly speculative and does not conclusively explain why the main effect of semantic compatibility emerged in P3 peak latencies only, but not in mean RTs and N2 mean amplitudes. As—so as I know—this experiment was the first study examining ERPs in an S–S-based evaluative priming paradigm, the interpretation of the single ERP components is at the very beginning and further research is essentially necessary to gain more knowledge about the ERP correlates of S–S-based evaluative priming. The priming effects in LRP onset latencies also tended to the expected directions and resembled the priming effects in mean RTs. Yet, the S–R-based semantic priming effect was not just reduced in case of evaluative incongruency, but it was even negatively signed. Due to the failure of significance, however, I refrain from interpreting the pattern of priming effects in LRP onset latencies.

It might surprise that I did not find any priming effects in the N400 component. Since effects in the N400 component have typically been reported in semantic priming studies with larger amplitudes for unrelated compared with related prime-target pairs (e.g., Anderson & Holcomb, 1995; Deacon et al., 1998;

Deacon, Hewitt, Yang, & Nagata, 2000; see Kutas & Van Petten, 1988 for a review) or in evaluative priming experiments with larger amplitudes for incongruent in comparison with congruent prime-target pairs (e.g., Eder et al., 2011; Morris, Squires, Taber, & Lodge, 2003; Zhang, Li, Gold, & Jiang, 2010; Zhang et al., 2006). In line with the spreading activation explanation of priming effects, the N400 component has been associated with the mechanism of facilitated target encoding due to the activation of a related/congruent prime (e.g., Deacon et al., 2000; Franklin, Dien, Neely, Huber, & Waterson, 2007) or the integration of semantic information in a given context (e.g., Brown & Hagoort, 1993; Brown, Hagoort, & Chwilla, 2000). As I applied a negative SOA-procedure with the aim to minimize the process of target-encoding facilitation, I did not predict any priming effects in the N400 component.

Generally, the effects in N2 mean amplitudes, P3 peak latencies, as well as LRP onset latencies resembled the pattern of priming effects in mean RTs. Thus, the ERP data provided a more fine-grained measurement of the cognitive processes involved in this particular S–S-based evaluative priming design with a negative SOA. While the effects in N2 mean amplitudes suggest that conflict detection and cognitive control were influenced by an interaction of semantic compatibility and evaluative congruency, the effects in P3 peak latencies corroborate the assumption that evaluative congruency influenced the amount of categorization effort which was necessary for semantic target categorization. The pattern of effects in LRP onset latencies implicate that an interaction of semantic compatibility and evaluative congruency influenced the prime’s influence on the target response preparation. When prime and target were associated with different key presses (as they belonged to opposite semantic categories), the target response preparation was expected to be hampered. This, however, depended on evaluative congruency between prime and target.

The experiments, reported so far, provided behavioral and electrophysiological evidence for the idea that evaluative congruency of prime and target is not associated with facilitated target encoding only, but may maintain the prime activation as well. This latter component of the mutual facilitation process was largely neglected in evaluative priming research. Based on the assumption that evaluatively congruent prime and target support their activation in a mutual manner, specific parameters, like the temporal sequence of prime and target onset, are expected to affect the relative size of facilitated target encoding and maintained prime activation due to evaluative congruency. As I was mainly interested in exploring the facilitative component of maintained prime activation given evaluative congruency, I used an experimental setting with the aim to maximize the supportive influence of an evaluatively congruent target on prime maintenance and to simultaneously minimize the facilitation of an evaluatively congruent prime on target encoding. Therefore, I applied a negative SOA-procedure.

In comparison with the mainly positive (e.g., Bargh et al., 1996; De Houwer, Hermans, & Spruyt, 2001; De Houwer & Randell, 2002; 2004; Everaert et al., 2011; Giner-Sorolla et al., 1999; Hermans et al., 1994; 2001; Spruyt & Hermans, 2008; Spruyt et al., 2009; Spruyt, De Houwer et al., 2007; Spruyt et al., 2002; Spruyt, Hermans, De Houwer, & Eelen, 2004; Spruyt, Hermans, et al., 2007) or null (see, e.g., De Houwer et al., 2002; Klauer & Musch, 2001; Klinger et al., 2000; Spruyt, Hermans, Pandelaere et al., 2004) S–S-based evaluative priming effects in previous S–S-based evaluative priming studies with a positive SOA-procedure, the effects in Experiments 1 to 3 were shifted to the negative direction, evidenced by negatively signed effects in case of response competition between prime and target. The crux of these comparisons, however, lies in the fact that they are made across different studies. As—beyond the SOA-procedure—much more experimental parameters (e.g., the stimulus material, the amount of stimuli, and the size of stimuli on the screen) may differ between the previously reported studies and my experiments, the SOA-procedure may not be primarily responsible for the differently signed S–S-based evaluative priming effects. As a consequence, I aimed to vary the relative impact of target-encoding facilitation and prime maintenance in the S–S-based evaluative priming paradigm. For this, I applied a manipulation of the SOA in the same experiment and tested the influence of this manipulation on the sign of the S–S-based evaluative priming effect (see Experiment 4).

Another critical point of the experiments, reported so far, consists of the question whether the finding of mutual facilitation by evaluative congruency characterizes a phenomenon that is specific for the evaluative dimension or whether it may be reproducible with any other shared semantic feature of prime and target. I examined this issue in Experiment 5.

4 Testing the limits

In this Section, my objective was to explore and discuss two crucial questions that stayed unanswered so far. First (Experiment 4), I more thoroughly considered the process of mutual facilitation of evaluatively congruent concepts, as it is postulated by the three-process model of evaluative priming. For this, I manipulated the relative size of the facilitative components in the evaluative priming paradigm, that is, facilitated target encoding and maintained prime activation, within the same experiment. Second (Experiment 5), I explored in how far the findings in my experiments reported until now are specific for the evaluative connotations of semantic concepts. For this, I alternated the assignment of the evaluative and semantic categories to the task-irrelevant (i.e., S–S-based) and task-relevant (i.e., S–R-based) dimension. That is, the semantic categories became task-irrelevant, while the evaluative connotations became task-relevant. By this variation, I was able to test the effect of same semantic category membership of prime and target on the evaluative categorization process.

4.1 Mutual facilitation manipulated (Experiment 4)

In Experiments 1 to 3; I applied a negative SOA-procedure in order to strengthen prime maintenance while weakening target-encoding facilitation. The usefulness of this operationalization was evidenced by the negative shift of the S–S-based evaluative priming effect, resulting in an observable negatively signed effect if the maintained prime interfered with the target response. I have to admit, however, that a direct inference from the negatively signed S–S-based evaluative priming effect to the influence by the SOA-procedure is only allowed if the SOA is manipulated within the same experiment and—ideally—within-participants. I realized such a SOA-manipulation in Experiment 4. Replicating Experiment 2a concerning design, material, and procedure, I varied the SOA across blocks, keeping all other parameters constant: While in one block a negative SOA-procedure was used (just like in Experiment 2a), in the other block a positive SOA-procedure was applied.

Comparing the study by Wentura and Frings (2008) and the present Experiment 1 (both studies examining evaluative priming in the naming task) may provide an indication which effects to expect in Experiment 4: Whereas in the former study (i.e., an experiment with positive SOA), the S–S-based evaluative priming effect was positively signed in case of no response conflict, it dropped to a null effect in case of response conflict. In the latter study (i.e., an experiment with negative SOA), the effects shifted to the negative direction: Even though, there was still some positive S–S-based evaluative priming effect in case of no response conflict, the effect was negatively signed in case of response conflict. Thus, the SOA did not moderate the interaction of evaluative congruency vs. incongruency and the presence vs. absence of response conflict. The positive SOA-procedure simply added a positive component to the S–S-based evaluative priming effect. That means—in line with the rationale of the three-process model—the amount of target-encoding facilitation was increased with a positive SOA.

Thus, for the negative SOA-block I expected to replicate the results of Experiment 2a/b, that is, a significant interaction of evaluative and semantic factors arising from maintained prime activation in case of evaluative congruency with an increased potential to interfere with the target response. In terms of the priming effects, this means a significantly more positive S–R-based semantic priming effect given evaluative congruency compared with incongruency, and a significantly more negatively signed S–S-based evaluative priming effect given semantic incompatibility compared with compatibility.

For the positive SOA-block, I expected the same interaction between evaluative and semantic factors. Due to enhanced facilitation of evaluatively congruent primes on target encoding, I predicted a positive shift of the S–S-based evaluative priming effect (compared with the negative SOA-block): In the case of semantic compatibility, I expected a positive S–S-based evaluative priming effect; in the case of semantic incompatibility, I expected this positive effect significantly decreased due to the opposite influences of response conflict and target-encoding facilitation. Concerning the S–R-based semantic priming effects, I analogously hypothesized a significantly more positive effect in the case of evaluative congruency compared with incongruency as evaluative congruency was expected to increase the prime’s potential to interfere with the target response.

Moreover, a preceding prime should have more potential to interfere with the target response than a following prime. Thus, I predicted a significantly larger S–R-based semantic priming effect averaged for evaluative congruency and incongruency in the positive SOA-block than in the negative SOA-block.

4.1.1 Method

Participants. 60 students (42 women; 18 men) participated in the experiment; their median age was 22 years (range from 18 to 30 years).

Design, Materials, and Procedure. Design, materials, and procedure were the same as in Experiment 2a with the following exceptions: The factor SOA was added, resulting in a 2 (SOA) × 2 (prime semantic) × 2 (target semantic) × 2 (prime valence) × 2 (target valence) within-participants design. The evaluative priming task consisted of two blocks (each consisting of 160 trials) that differed in SOA only. While the negative SOA-block was identical to the evaluative priming task in Experiment 2a, in the positive SOA-block, the prime appeared first for 100 ms and was followed by the target, that remained on the screen until a response was given (i.e., SOA = 100 ms). The block sequence was counterbalanced across participants.

4.1.2 Results

The average error rate across participants was 3.9 % (i.e., 3.6 % in the negative SOA-block and 4.2 % in the positive SOA-block). Mean RTs were derived from correct responses, and RTs shorter than 200 ms or longer than 1,500 ms were discarded (0.4 % of trials in the negative SOA-block and 0.3 % of trials in the positive SOA-block). Mean RTs and error rates for all conditions and both SOA-blocks are shown in Table 8.

A 2 (SOA: negative vs. positive) × 2 (semantic condition: compatible vs. incompatible) × 2 (evaluative condition: congruent vs. incongruent) ANOVA on RTs yielded a significant main effect of semantic condition, $F(1,59) = 266.12$, $p < .001$, $MSE = 603$. This effect was qualified by a significant interaction between SOA and semantic condition, $F(1,59) = 36.48$, $p < .001$, $MSE = 587$. The S–R-based semantic priming effect was significantly more positive in the positive, $M = 50$ ms ($SD = 24$ ms), as compared with the negative SOA-block, $M = 23$ ms ($SD =$

24 ms), $t(59) = 6.04$, $p < .001$, $d_Z = 0.78$. Thus, as expected, the preceding prime in the positive SOA-block exerted a larger influence on the target response than the following prime in the negative SOA-block.

TABLE 8.

Mean RTs (in ms) as a Function of Semantic Condition and Evaluative Condition (Errors in % in Parentheses), separately for the negative and the positive SOA-block; Priming Effects for RTs (in ms; Standard errors in Brackets) (Experiment 4)

negative SOA-block	*Valence* Congruent	Incongruent	**S–S-based Evaluative Priming effect**
Semantic			
Compatible	531 (2.2)	536 (2.2)	5 [3]
Incompatible	560 (5.2)	554 (4.9)	-6 [4]
S–R-based Semantic Priming effect	28*** [5]	18*** [3]	
positive SOA-block			
Semantic			
Compatible	516 (1.5)	524 (1.4)	8* [3]
Incompatible	570 (6.8)	570 (7.0)	0 [3]
S–R-based Semantic Priming effect	54*** [4]	46*** [3]	

Note: Priming scores (evaluative and semantic) are calculated by subtracting mean RTs for congruent/compatible priming from mean RTs for incongruent/incompatible priming. Slight inconsistencies between the left and the right part of the table are due to rounding.

* $p < .05$, *** $p < .001$

Most important, the predicted interaction of semantic and evaluative condition was significant as well, $F(1,59) = 7.61$, $p < .01$, $MSE = 322$. The S–S-based evaluative priming effect was significantly more positive given semantic compatibility, as compared to incompatibility and—analogously—the S–R-based semantic priming effect was significantly more positive given evaluative congruency in comparison with incongruency, $t(59) = 2.02$, $p < .05$, $d_Z = 0.26$, for the negative SOA-block and $t(59) = 1.96$, $p < .05$, $d_Z = 0.25$, for the positive SOA-block. All other effects failed the significance level, $F < 1$ for the main effect of SOA as well as the interaction of SOA, semantic, and evaluative condition, *F*(1,59) = 1.21, *p* = .28, *MSE* = 260 for the main effect of evaluative condition, and *F*(1,59) = 1.29, *p* = .26, *MSE* = 425 for the interaction of SOA and evaluative condition.

The pattern of the single priming effects in the negative SOA-block replicated the effects in Experiment 2a/b: The S–S-based evaluative priming effect was positively signed in the case of semantic compatibility, *M* = 5 ms (*SD* = 23 ms), and significantly decreased to a negatively signed effect in the case of semantic incompatibility, *M* = -6 ms (*SD* = 30 ms). Albeit, I have to concede that both effects did not significantly deviate from zero, *t*(59) = 1.54, *p* = .13, d_Z = 0.20, given semantic compatibility and *t*(59) = -1.44, *p* = .16, d_Z = -0.18, given semantic incompatibility. Even if the S–R-based semantic priming effect was significantly positive in the case of evaluative congruency, *M* = 28 ms (*SD* = 36 ms), *t*(59) = 6.16, *p* < .001, d_Z = 0.80, and incongruency, *M* = 18 ms (*SD* = 26 ms), *t*(59) = 5.31, *p* < .001, d_Z = 0.69, the significant reduction given evaluative incongruency as compared to congruency was the crucial replication.

In the positive SOA-block, the S–S-based evaluative priming effect was significantly positive in case of semantic compatibility, *M* = 8 ms (*SD* = 24 ms), *t*(59) = 2.44, *p* < .05, d_Z = 0.32, but significantly decreased to a null effect in case of semantic incompatibility, *M* = 0 ms (*SD* = 24 ms), *t* < 1. Both S–R-based semantic priming effects were significantly positive, *M* = 54 ms (*SD* = 32 ms), *t*(59) = 13.18, *p* < .001, d_Z = 1.70, in the case of evaluative congruency, and *M* = 46 ms (*SD* = 26 ms), *t*(59) = 13.81, *p* < .001, d_Z = 1.78, in the case of incongruency. Here, again, the significant difference of the effects was the most important finding.

As predicted, the priming effects were shifted to the positive direction with a positive as compared to a negative SOA-procedure: For the S–R-based semantic priming effect, this shift was significant, *M* = 27 ms (*SD* = 34 ms), *t*(59) = 6.04, *p* < .001, d_Z = 0.78, while it was not significant for the S–S-based evaluative priming effect, *M* = 4 ms (*SD* = 29 ms), *t*(59) = 1.13, *p* = .26, d_Z = 0.15.

An analogous ANOVA on error rates yielded a significant main effect of semantic condition, *F*(1,59) = 107.51, *p* < .001, *MSE* = 0.002. This effect was qualified by a significant interaction of SOA and semantic condition, *F*(1,59) =

16.12, $p < .001$, $MSE = 0.001$. The S–R-based semantic priming effect was significantly more positive in the positive SOA-block, $M = 5.5$ % ($SD = 4.7$ %), than in the negative SOA-block, $M = 2.9$ % ($SD = 3.2$ %), $t(59) = 4.02$, $p < .001$, $d_Z = 0.52$. All other effects failed to reach significance: $F(1,59) = 3.74$, $p = .06$, $MSE = 0.001$ for the main effect of SOA and $F < 1$ for the main effect of evaluative condition and any other interaction.

4.1.3 Discussion

The results of Experiment 4 clearly corroborate the hypotheses: There was a significant interaction of evaluative congruency and semantic compatibility that was, in turn, influenced by the temporal sequence of prime and target onset. As expected and in line with the claim of the three-process model, evaluative congruency was associated with facilitated target encoding as well as maintained prime activation, whereas the respective SOA determined whether the first or the second component of the mutual facilitation process predominated.

The results in the negative SOA-block replicate the findings of Experiments 2 and 3: The S–S-based evaluative priming effect decreased significantly to a negatively signed effect from the semantically compatible to the incompatible condition; just like the S–R-based semantic priming effect decreased significantly from the evaluatively congruent to the incongruent condition. I have to concede that the negatively signed S–S-based evaluative priming effect given semantic incompatibility was not significant, which may be attributed—as considered previously—to a residual effect of target-encoding facilitation by an evaluatively congruent prime (despite its posttarget onset). This post hoc explanation becomes even more plausible by the small positive S–S-based evaluative priming effect in the case of semantic compatibility, which was found in all previous experiments as well.

In the positive SOA-block, the interaction of semantic and evaluative factors was also significant. Here, however, the S–S-based evaluative priming effect was significantly positive in the semantically compatible condition and decreased significantly to a null effect in the incompatible condition. Thus, compared with the negative SOA-block (and the previous experiments), the effect was generally shifted to the positive direction; this was due to a larger facilitation of target encoding (and less prime maintenance) in the case of evaluative congruency. Independent from evaluative congruency, the preceding prime, in comparison with the following prime, had a higher potential to interfere with the target response, thus, yielding a significantly larger S–R-based semantic priming effect in the positive compared with the negative SOA-block.

The present results can easily be reconciled with the positive S–S-based evaluative priming effect reported by Spruyt, De Houwer, and colleagues (2007), that corroborated the assumption of target-encoding facilitation in the case of evaluative congruency. The three-process model's corollary that the target supports the activation maintenance of an evaluatively congruent prime is of no consequence for their results because the authors used primes that were neutral in regard to the response categories. In addition, Spruyt, De Houwer, and colleagues found a positive S–S-based evaluative priming effect only, if the evaluative dimension was attended to. I yet found valence-dependent effects, even though this precondition was not met. Clarification of this slight discrepancy can be left to future research: The assumptions derived from the present results and those of Spruyt, De Houwer, and colleagues focus on different facets of the overall process and are not contradictory.

In order to clarify the purpose of Experiment 5, it is necessary to interpret the findings of the Experiments 2, 3, and 4 at a more abstract level. In these experiments, I orthogonally varied two broad categorical dimensions A and B, and found that the S–R-based priming effect for the task-relevant dimension A was moderated by the prime-target congruency on dimension B. Up to now, I implicitly hypothesized that this moderation depends on dimension B being the evaluative dimension (in line with theoretical ideas of prioritized evaluative processing; see, e.g., Bargh, 1997; Öhmann et al., 2001; Zajonc, 1980). This was, however, not explicitly tested. Thus, I aimed to examine in Experiment 5 whether the results in the preceding experiments reflected a valence-specific phenomenon or a more general effect caused by the common categorical membership of prime and target. For this, I replicated Experiment 2a/b but changed the task-relevant dimension: Instead of a semantic categorization task, I used an evaluation task in which the evaluative dimension was (obviously) task-relevant. Thus, in terms of De Houwer's (2003) terminology, I examined S–S-based semantic priming effects with the materials embedded in an S–R-based evaluative priming design. If the evaluative dimension is crucial for the findings from the preceding experiments, I should find a clear S–R-based evaluative priming effect without any moderation by semantic congruency as well as no S–S-based semantic priming effect. By contrast, if the findings in Experiments 2 to 4 reflect a general phenomenon due to common semantic category membership, I should find a similar interaction of evaluative and semantic factors in Experiment 5. That is, I would expect a clear positive S–R-based evaluative priming effect in case of semantic congruency and no effect in case of semantic incongruency; additionally, I should find a negatively signed S–S-based semantic priming effect in case of evaluative incompatibility.

4.2 Mutual facilitation as valence-specific phenomenon (Experiment 5a/b)

I replicated Experiment 2a/b using the evaluation task with the evaluative categories (obviously) being the task-relevant dimension. Mean RT differences between evaluatively compatible and incompatible prime-target pairs were taken to reflect S–R-based evaluative priming effects; mean RT differences between semantically congruent and incongruent pairs were taken to reflect S–S-based semantic priming effects.

4.2.1 Method

Participants. In Experiment 5a, 37 students (26 women; 11 men) participated; their median age was 21 years (range from 17 to 29 years). In Experiment 5b, 31 students (25 women; 6 men) participated, their median age was 20 years (range from 19 to 27 years).

Design, Materials, and Procedure. Design, materials, and procedure were comparable to those of Experiment 2a/b with the following exceptions: I used the evaluation task instead of the semantic categorization task, meaning that participants were instructed to evaluate each picture (Exp. 5a) or word (Exp. 5b) as positive or negative, as quickly and accurately as possible. Additionally, I replaced the word *Aasgeier* (*vulture* in English) with the word *Schnake* (*crane fly* in English) in Experiment 5b (due to the ambiguity of the word *Aasgeier* with regard to the semantic categories *persons* and *animals*; see Experiment 2b). Mean valences—as rated on a scale from 1 to 9 by the participants after Experiment 5b—were *M* = 7.88 (*SD* = 0.56) and *M* = 7.19 (*SD* = 0.83) for positive person and animal words, respectively, and *M* = 1.82 (*SD* = 0.49) and *M* = 3.35 (*SD* = 1.15) for negative person and animal words, respectively. Ratings for positive and negative words differed significantly, $t(9) = 22.56$, $p < .001$, for person words and $t(9) = 9.12$, $p < .001$, for animal words. The sets of person and animal words did not differ with regard to mean valence, $t(19) = -1.19$, $p = .25$.

4.2.2 Results

Experiment 5a. The average error rate across participants was 4.3 %. Mean RTs were derived from correct responses, and RTs shorter than 200 ms or longer than 1,500 ms were discarded (0.4 % of trials). Mean RTs and error rates for all conditions are shown in Table 9.

TABLE 9.

Mean RTs (in ms) as a Function of Semantic Condition and Evaluative Condition (Errors in % in Parentheses); Priming Effects for RTs (in ms; Standard errors in Brackets) (Experiment 5a)

	Valence		
	Compatible	Incompatible	**S–R-based Evaluative Priming effect**
Semantic			
Congruent	557 (2.2)	569 (5.5)	11* [4]
Incongruent	551 (3.2)	570 (6.5)	19*** [5]
S–S-based Semantic Priming effect	-6 [4]	2 [5]	

Note: Priming scores (evaluative and semantic) are calculated by subtracting mean RTs for compatible/congruent priming from mean RTs for incompatible/incongruent priming. Slight inconsistencies between the left and the right part of the table are due to rounding.

* $p < .05$, *** $p < .001$

A 2 (evaluative condition: compatible vs. incompatible) × 2 (semantic condition: congruent vs. incongruent) ANOVA on RTs yielded a significant main effect of evaluative condition, $F(1,36) = 20.82$, $p < .001$, $MSE = 400$, but neither a main effect of semantic condition, $F < 1$, nor a significant interaction, $F(1,36) = 1.42$, $p = .24$, $MSE = 378$. The S–R-based evaluative priming effect was significantly positive both in the case of semantic congruency, *M* = 11 ms (*SD* =

27 ms), $t(36) = 2.54$, $p < .05$, $d_Z = 0.44$, and incongruency, $M = 19$ ms ($SD = 29$ ms), $t(36) = 3.96$, $p < .001$, $d_Z = 0.65$. However, there was no S–S-based semantic priming effect, either for evaluatively compatible, $M = -6$ ms ($SD = 26$ ms), $t(36) = -1.37$, $p = .18$, $d_Z = 0.22$, or incompatible prime-target pairs, $M = 2$ ms ($SD = 32$ ms), $t < 1$.

An analogous ANOVA on error rates yielded a significant main effect of evaluative condition, $F(1,36) = 49.63$, $p < .001$, $MSE = 0.001$, corresponding to a positive S–R-based evaluative priming effect of $M = 3.3$ % ($SD = 2.9$ %), $t(36) = 7.05$, $p < .001$, $d_Z = 1.16$. Neither the main effect of semantic condition, $F(1,36) = 3.35$, $p = .08$, $MSE = 0.001$, nor the interaction reached significance, $F < 1$.

Experiment 5b. The average error rate across participants was 6.6 %. Mean RTs were derived from correct responses, and RTs shorter than 200 ms or longer than 1,500 ms were discarded (0.4 % of trials).). Mean RTs and error rates for all conditions are shown in Table 10.

TABLE 10.

Mean RTs (in ms) as a Function of Semantic Condition and Evaluative Condition (Errors in % in Parentheses); Priming Effects for RTs (in ms; Standard errors in Brackets) (Experiment 5b)

	Valence		
	Compatible	Incompatible	**S–R-based Evaluative Priming effect**
Semantic			
Congruent	586 (5.2)	612 (8.0)	26*** [7]
Incongruent	589 (4.8)	618 (8.1)	28*** [6]
S–S-based Semantic Priming effect	4 [8]	6 [6]	

Note: Priming scores (evaluative and semantic) are calculated by subtracting mean RTs for compatible/congruent priming from mean RTs for incompatible/incongruent priming. Slight inconsistencies between the left and the right part of the table are due to rounding.

*** $p < .001$

A 2 (evaluative condition: compatible vs. incompatible) × 2 (semantic condition: congruent vs. incongruent) ANOVA on RTs yielded a significant main effect of evaluative condition, $F(1,30) = 31.96$, $p < .001$, $MSE = 712$, but neither a main effect of semantic condition nor a significant interaction, both *Fs* < 1. The S–R-based evaluative priming effect was significantly positive for both semantically congruent, *M* = 26 ms (*SD* = 40 ms), *t*(30) = 3.58, *p* < .001, d_Z = 0.64, and incongruent conditions, *M* = 28 ms (*SD* = 36 ms), *t*(30) = 4.38, *p* < .001, d_Z = 0.79. However, there was no S–S-based semantic priming effect, either for evaluatively compatible, *M* = 4 ms (*SD* = 42 ms), or incompatible prime-target pairs, *M* = 6 ms (*SD* = 34 ms), both *t*s < 1.

An analogous ANOVA on error rates yielded a significant main effect of evaluative condition, *F*(1,30) = 14.08, *p* = .001, *MSE* = 0.002, corresponding to a positive S–R-based evaluative priming effect of *M* = 3.1 % (*SD* = 4.5 %), *t*(30) = 3.75, *p* < .01, d_Z = 0.67. Neither the main effect of semantic condition nor the interaction reached significance, both *F*s < 1.

4.2.3 Discussion

The results indicate that the moderation of S–R-based priming effects by S–S-based congruency of prime and target is a phenomenon that is not easily reproducible by using ‘cold’ semantic categories (e.g., the categories *persons* and *animals*) for the S–S-based variation. Thus, tentatively, I decide for the assumption that the results in Experiments 1 to 4 reflect a valence-specific phenomenon. Since there was no interaction of evaluative and semantic factors, but there were significant S–R-based evaluative priming effects both in case of semantic congruency and incongruency, the semantic category had no obvious potential to affect the evaluative categorization process. In contrast—as the results from Experiments 1 to 4 suggest—the evaluative dimension is processed almost automatically (i.e., even if it is task-irrelevant) and has the potential to interfere with the current task.

Of course, I have to admit caveats. First, one might argue that the categorization of stimuli as belonging to the categories *persons* versus *animals* is not as salient as the evaluative categorization. There is clear evidence that differences in category-specific salience modulate S–S-based evaluative and semantic priming effects (see Everaert et al., 2011; Spruyt, De Houwer et al., 2007; Spruyt et al., 2009). Nummenmaa, Hyönä, and Calvo (2010, Exp. 4 and 5), however, compared the evaluative categories with the semantic categories persons and animals with regard to their a priori salience and provided some evidence for a highly salient status of the semantic categories in comparison with the evaluative categories. Categorizing the same positive and negative pictures displaying persons and animals according to either the evaluative categories or the semantic categories yielded significantly less errors and faster RTs for the semantic compared with the evaluative categorizations. Moreover, successful semantic categorizations required significantly shorter exposure durations of the pictures than successful evaluative categorizations. Thus, the findings by Nummenmaa and colleagues suggest that the person and animal categories are at least equally (or even more) accessible than the evaluative categories. Furthermore, the person and animal categories are quite distinct and frequently used categories; a fact which makes the assumption rather implausible that the semantic categories of the experimental stimuli used in my experiments are less salient than the evaluative categories. Thus, salience effects of the evaluative and semantic categories may not explain the asymmetric results in the semantic categorization task (Experiments 2 to 4) and the evaluation task (Experiment 5a/b).

Second, arbitrary members of the person and animal categories, respectively, might not have the same semantic overlap as arbitrary members of the evaluative categories, allowing for S–S-based priming effects. This asymmetry is difficult to resolve: There is no independent criterion for the choice of the ‘cold’ semantic categories than plausibility. If one argues that it is a priori implausible that, for example, *blackbird* primes *dolphin* due to semantic (i.e., categorical) relatedness, I can only argue that it is a priori equally implausible that, for example, *baby* primes *dolphin* due to evaluative congruency. I chose the semantic categories persons and animals, since these are quite salient and distinct categories, and expected to achieve a most possible comparability with the evaluative categories. Furthermore, several previous studies used the person and animal categories in direct comparison with the evaluative categories (see, e.g., Calvo & Nummenmaa, 2007, Exp. 6; De Houwer et al., 2002; Nummemnmaa et al., 2010, Exp. 4 and 5).

Thus, the asymmetric results of a significant moderation of S–R-based priming effects by the evaluative dimension in the semantic categorization task (Experiments 2 to 4) and no moderation of S–R-based priming effects by the semantic dimension in the evaluation task (Experiment 5a/b) are tentatively best explained with the valence-specificity interpretation. The reasons for this specificity remain, however, an open question: It might have something to do with the evaluative dimension being one of the most prominent dimensions structuring the semantic space (see Osgood, 1976). Or affective qualities of the evaluative dimension might play any role, increasing a prioritized processing of the evaluative features (see, e.g., Bargh, 1997; Öhmann et al., 2001; Zajonc, 1980). On the basis of salience effects on the S–S-based evaluative priming effect (see Everaert et al., 2011; Spruyt, De Houwer et al., 2007; Spruyt et al., 2009), Spruyt and colleagues (2009) concluded that the affective dimension may be processed in a favored manner due to its extraordinary relevance, but that this affective processing bias may easily be attenuated, as soon as current goals and task demands require the selective attention to other stimulus dimensions.

5 General Discussion

In the last Chapter of my thesis, I first sum up the findings of all reported experiments. Thereafter, I discuss the relevance of my findings concerning theoretical interpretations of evaluative priming and the memory representation of the evaluative connotations. In this regard, I characterize the three-process model as integrative account for evaluative priming effects in different variants of the evaluative priming paradigm and compare this model with alternative explanations of evaluative and negatively signed priming effects. Afterwards, I describe the consequential requirements for the memory representation of the evaluative connotations. Finally, I discuss considerable limitations of my studies, and end with a short conclusion of the theoretical ideas on evaluative priming and the memory representation of valence.

5.1 Résumé of results

In five experiments, I could provide evidence for the mutual facilitation of evaluatively congruent stimuli that is not easily reproducible for (nonevaluative) semantic categories. Since in prior research the facilitation of an evaluatively congruent prime on target encoding was usually taken into account for the interpretation of S–S-based evaluative priming effects, whereas the supportive impact of an evaluatively congruent target on the prime activation was largely ignored, one of my main objectives was to explore this latter effect of evaluative congruency. For this, I applied an S–S-based evaluative priming design with a negative SOA-procedure (i.e., the prime onset followed the target onset) in order to maximize the facilitative effect of evaluative congruency on prime maintenance, while minimizing the same effect on target encoding. Indeed, mean RT data of different experiments provided conclusive evidence for prolonged prime activation in case of evaluative congruency, yielding an increased response conflict for response-incompatible primes and targets. In the naming task (Experiment 1), maintained activation of evaluatively congruent primes was reflected in a negatively signed S–S-based evaluative priming effect for response-bound primes. Similarly, in the semantic categorization task (Experiments 2 to 4), prolonged prime activation by an evaluatively congruent target was indicated by the significant moderation of the S–R-based semantic priming effects by evaluative congruency (nonsignificant in Experiment 3) as well as the negatively signed S–S-based evaluative priming effects in case of semantic incompatibility (significant in Experiment 2b only).

Furthermore, the behavioral results received corroborative evidence by the ERP correlates in Experiment 3. Just like the pattern of priming effects in mean RTs indicated, a significant interaction of evaluative congruency and semantic compatibility arised in several ERP components, specifically, in N2 mean amplitudes and P3 peak latencies. The N2 component which has typically been associated with the amount of conflict between stimuli (e.g., Kopp et al., 1996; van Veen & Carter, 2002a, 2002b) featured an S–R-based semantic priming effect in mean amplitudes that significantly depended on evaluative congruency (thereby corroborating the results in mean RTs). Even though in P3 peak latencies—reflecting the effort for semantic target categorization—the same interaction of evaluative congruency and semantic compatibility significantly arised, the effect pattern differed from the pattern in mean RTs and N2 mean amplitudes. Since the single effects were shifted to the negative direction, the negatively signed S–S-based evaluative priming effect given semantic incompatibility was the only significant effect. In LRP onset latencies, the picture of both S–R-based semantic and S–S-based evaluative priming effects tended to the expected directions but did not reach the conventional level of significance.

Adding a block with a positive SOA-procedure to the negative SOA-block in order to relatively enhance the facilitative effect of evaluative congruency on target encoding and to relatively decrease the same effect on prime activation (Experiment 4) resulted in a positive shift of the S–S-based evaluative priming effect in the positive as compared to the negative SOA-block. This finding speaks for the assumption that both facilitative effects due to evaluative congruency (i.e., target-encoding facilitation and prime-activation maintenance) are potentially existent in any evaluative priming task and that the specific experimental setting determines the relative magnitude of both effects on the prime-target processing. The failure to find S–S-based semantic priming effects or any moderation of the S–R-based evaluative priming effect by semantic compatibility in the evaluation task (Experiment 5a/b) corroborates the assumption that mutual activation is a phenomenon that is not equally valid for *cold* semantic just like for evaluative categories. These asymmetric findings with regard to the S–S based priming effects in the semantic categorization and the evaluation task corroborate the assumption that the evaluative content of semantic concepts is preferentially processed (see, e.g., Bargh, 1997; Bargh et al., 1996; Murphy & Zajonc, 1993; Öhmann et al., 2001; Zajonc, 1980).

One of the main purposes of my experiments was to improve the understanding of the cognitive processes involved in evaluative priming tasks and to develop a theory that is able to account for S–R-based and S–S-based evaluative priming effects. In the next Section, I discuss the implications and requirements of my results and prior empirical findings on a conclusive theory of evaluative priming.

5.2 Integrative account on evaluative priming

One of the main objectives of the present thesis was to unify the conflicting interpretations of evaluative priming in an S–R-based and an S–S-based design. S–R-based evaluative priming effects are typically explained by response processes: an evaluatively congruent prime facilitates the evaluative categorization of the target, while evaluatively incongruent prime and target call for opposite evaluative categorizations. S–S-based evaluative priming effects are explained by processes at stimulus encoding level in that an evaluatively congruent prime is assumed to facilitate target encoding. Since both the S–R-based and the S–S-based variant of the evaluative priming paradigm differ with regard to the required target response only, while all other parameters are comparable, it is dissatisfying to accept that a process assumed to be causally responsible for the evaluative priming effect in one variant of the paradigm should not be considered for the interpretation of the evaluative priming effect in the other variant. Thus, a general theory of evaluative priming needs to provide mechanisms for all processes that are in principle involved in evaluative priming tasks.

Hence, a plausible model of evaluative priming must account for the parallel activation of two distinct evaluatively connoted concepts, as it is required by the response-based explanation of S–R-based evaluative priming. Furthermore, such a model must allow for the mutual facilitation of evaluatively congruent concepts, as it is required by the encoding facilitation explanation of S–S-based evaluative priming. In this respect, I will refer to the considerations by Wentura and Rothermund (2003; see also Wentura & Frings, 2008) with respect to the processes involved in the S–S-based evaluative priming paradigm. They first stated the idea of mutual facilitation of evaluatively congruent concepts, in that the effect of evaluative congruency between prime and target may not be limited to facilitated target encoding but may even be associated with maintained prime activation. This prime maintenance may, in turn, prolong existing response conflicts between prime and target. In the three-process model, this consideration is further elaborated with the aim to account for both S–R-based and S–S-based evaluative priming effects. Basically, the three-process model claims an interaction of mutual facilitation, parallel activation, as well as response-related processes between evaluatively congruent prime and target, whereby the relative magnitude of the single processes is expected to depend on the respective evaluative priming task.

The results in my experiments corroborate the assumptions of the three-process model. Applying a negative SOA-procedure, I could show that evaluative congruency may be even disadvantageous for the target responding, since the maintained activation of an evaluatively congruent, but response-incompatible prime intensified the existing response conflict. This was evidenced by negatively signed S–S-based evaluative priming effects given response-incompatibility (Exp. 1 and 2b) and positively signed S–R-based semantic priming effects that depended on evaluative congruency (Exp. 2, 3, and 4). Thus, my findings are best explained with the idea that mutual facilitation given evaluative congruency may effect on prime activation as well as on target encoding, while the relative magnitude of both components can be manipulated by experimental parameters (e.g., the SOA). In alignment with this explanation, a positive SOA-procedure led to a positive shift of the whole pattern of priming effects, since target-encoding facilitation by an evaluatively congruent prime was the more pronounced effect of mutual facilitation due to evaluative congruency.

As a focus of my considerations was on processes reducing and eventually reversing S–S-based evaluative priming effects, I would like to discuss two prominent theories dealing with negatively signed priming effects, in order to see whether they offer plausible alternative explanations for my results.[7]

First, I would like to characterize the psychophysical account (or evaluation window account), as it was introduced by Klauer and colleagues (2009). The authors conclusively specify mechanisms which yield positively or negatively signed evaluative priming effects with an S–R-based design. The account supposes separate counters for positive and negative valence, while the amount of activation in a counter increases when positive or negative input (e.g., stimuli, thoughts, or actions), respectively, is processed. Without additional input, the amount of activation in the respective counter decreases to zero. The current state of each valence counter and the change of the counter state over the last hundreds of milliseconds are assumed to be consciously accessible. Thus, in order to evaluatively categorize a specific stimulus, either the absolute activational state of the respective counter at a given point in time or the relative increase of activation within a certain time window can be applied. Since evaluative decisions based on absolute values largely depend on the initial state of the respective counter that may be influenced by preceding, evaluatively connoted stimuli, they are rather problematic: While a conservative criterion (i.e., high activation required) diminishes the influences of preceding stimuli but is associated with slow categorizations, a liberal criterion (i.e., little activation required) leads to rather error-prone decisions, since the current activational state largely reflects the impact of preceding stimuli. In contrast, evaluative decisions based on recent increases of activation are independent from the initial activation in the respective counter. The basic idea to explain positively as well as negatively signed S–R-based evaluative priming effects is that participants base their evaluative decision not on the absolute values of the counters at a given point in time but on the relative increase within a certain time window. With this strategy, positive effects would be expected if the activation increase was considered within the period from prime onset until target evaluation (i.e., with an evaluation window that includes the prime event), whereas negatively signed effects would be expected if the increase was considered only from target onset onwards (i.e., with an evaluation window that excludes the prime event).

[7] I refrain from discussing theories that focus on negative *masked* priming effects (e.g., Dagenbach, Carr, & Barnhardt, 1990; Kahan, 2000).

The following simple example demonstrates this logic (see Klauer et al., 2009): Assume the positive counter has an (arbitrary) activation level of c = 15 at prime onset. If the prime is neutral, activation stays at c = 15 until target onset; if the prime is positive, it rises to c = 20 until target onset. A positive target lets activation in the positive counter further increase by Δc = 10 until the end of the decision window. If the onset of the decision window is at prime onset, the (decision-relevant) relative increase within the window is I = (25-15)/15 = 0.67 in case of a neutral prime and I = (30-15)/15 = 1.00 in case of a positive prime. Thus, the relative increase of activation in the positive counter is higher with a positive than a neutral prime. Consequently, a positive target evaluation is facilitated by a positive as compared to a neutral prime, resulting in a positive S–R-based evaluative priming effect. If, however, the onset of the decision window is at target onset, the (decision-relevant) relative increase within the window is I = (25-15)/15 = 0.67 in case of a neutral prime and I = (30-20)/20 = 0.50 in case of a positive prime. Thus, a positive target evaluation is facilitated by a neutral as compared to a positive prime, resulting in a negatively signed S–R-based evaluative priming effect. In order to broaden the scope of the psychophysical account, Klauer and Dittrich (2010) reported corroborative evidence for the applicability of the main assumptions to masked arrow priming. Thus, they could show that the account is not restricted to evaluative priming but applies for a wide range of different S–R-based priming paradigms.

Since in Experiments 2 to 4 with the negative SOA-procedure I used a fixed temporal stimulus sequence, which made target and prime onset completely predictable, an evaluation window from target onset seems to be most plausible. In alignment with the rationale of the psychophysical account, the appearance of a person target, for example, should increase the activation in the person-category counter that would either be additionally boosted (in case of a person prime) or not (in case of an animal prime). This would result in a positive S–R-based semantic priming effect. There are two obvious possibilities to account for the conditional S–R-based semantic priming effects of Experiments 2 to 4 within this framework. First, I can return to my assumption that the impact of the prime (here: on the counter of the respective semantic category) depends on its activation, and that an evaluatively congruent prime is activated to a larger extent as compared to an incongruent one, since it is supported by the target activation.

In this case, the psychophysical account would provide a more sophisticated mechanism of maintained prime activation due to evaluative congruency and resulting response interference, as it is suggested in the three-process model. That means, both accounts would be compatible. An alternative theory would arise if one would assume that the window on- and offset of the semantic category counter is a consequence of evaluative congruency. In case of evaluative congruency, the counter window would include the prime stimulus (thereby causing an S–R-based priming effect), whereas the detection of evaluative incongruency would be a signal to close the counter window (thereby delimiting the impact of the prime on target response and resulting in no S–R-based priming effect). However, beyond the *ad hoc* character of this assumption, differences in the offset of the counter window between evaluatively congruent and incongruent conditions should be associated with differences in general response speed. I did, however, not observe such RT differences.

As mentioned previously, an application of the psychophysical account (Klauer et al., 2009) to the results in the naming task (Experiment 1) seems to be even more problematic. First, a response-relevant activation counter would be necessary for each single target concept. Second, whether the prime information would be in- or excluded from the target response process would be influenced by the response binding of the prime: while a response-bound prime would be a signal to close the decision-relevant window, a nonresponse-bound prime would be taken into account during the target response preparation. Third, an evaluatively congruent prime would support the activation increase in the activation counter for target naming to a larger extent than an incongruent prime. While the last condition may illustrate a more elaborated specification of the encoding facilitation explanation of S–S-based evaluative priming effects, the first two conditions are not empirically corroborated.

A further prominent account that deals with negatively signed priming effects is the ROUSE theory, as it was introduced by Huber, Shiffrin, Lyle, and Ruys (2001). ROUSE stands for Responding Optimally with Unknown Sources of Evidence. The theory describes mechanisms which mainly explain positively and negatively signed, perceptual priming effects (i.e., prime and target are perceptually similar or identical). The theory assumes that participants attempt to correct for possible source confusion between prime and target events. Therefore, if some activated features are attributed to the prime event, they receive less weight in the target analysis (i.e., they are *discounted*). As a consequence, positive priming effects are the result of too little discounting, whereas negatively signed effects are the result of too much discounting.

In order to apply this principle to my findings in the experiments with the semantic categorization task (i.e., Experiments 2 to 4), it is necessary to assume *ad hoc* that evaluative congruency vs. incongruency moderates the discounting of the prime's response-relevant features (i.e., the semantic category). According to that, if prime and target are evaluatively congruent, there is too little discounting of the prime's features (including the semantic category) and the prime either triggers the target-compatible or incompatible response, resulting in a positive S–R-based semantic priming effect. In contrast, if prime and target are evaluatively incongruent, there is adequate discounting of the prime's features, resulting in no (or a smaller) S–R-based semantic priming effect. The problem with this application is the *ad hoc* character of the assumptions as well as its implicit inconsistency: The congruency or incongruency of one feature of the prime with the corresponding feature of the target (i.e., the evaluative category) determines whether another feature of the prime (i.e., the task-relevant semantic category) is insufficiently or optimally discounted. However, this interaction does not hold if the evaluative categories are task-relevant, since no moderating influence of semantic congruency on the S–R-based evaluative priming effect emerged (see Experiment 5a/b). Furthermore, the results of Experiment 1 are not easily explainable with the assumptions of the ROUSE theory (Huber et al., 2001): It would be necessary to claim that (a) manipulating the response-binding of the prime pictures moderates the discounting process on a trial-by-trial basis and (b) too little (in case of nonresponse-bound primes) or too much (in case of response-bound primes) discounting of the prime's evaluative features affects target naming.

In summation, I do not see how both theories, the psychophysical account (Klauer et al., 2009) and the ROUSE theory (Huber et al., 2001), that are well suited to explain the occurrence of negatively signed priming effects, may explain the results in the present S–S-based evaluative priming studies.

Recently, Giesen and Rothermund (2011) tested the moderating influence of evaluative matching between target and distractor on binding processes of stimulus and response in a variant of the negative priming paradigm. Sequentially presented prime and probe displays each consisted of simultaneously appearing, evaluatively connoted target and distractor. RT analyses of the probe display led to a significant three-way interaction: mean responses were facilitated if the response as well as the distractor repeated from the prime to the probe display and if—in addition—target and distractor in the prime display were evaluatively congruent. If, however, target and distractor in the prime display were of opposite valence, the two-way interaction of response relation and distractor relation failed to be significant. The authors interpreted their results in the sense that evaluative congruency in the prime display enabled the binding of the distractor, the target, and the corresponding response to a specific episodic memory structure, so that in case of response repetition additional distractor repetition yielded response facilitation. Such an integration of the target and the distractor information did not emerge if they were evaluatively incongruent.

The main theoretical assumption, that is, a match of two concepts with regard to a specific feature supports the binding of these concepts, reminds on the general idea of compound cue theories (see McKoon & Ratcliff, 1989; 1992; Ratcliff & McKoon, 1994, 1995). Developed to account for priming effects in recognition tasks (i.e., the target is categorized as *old* or *new*) and lexical decision tasks, these theories assume that currently activated concepts join together in short-term memory and form a compound. This compound is passively matched against information in long-term memory, while the result of this matching process determines a certain value of familiarity of the compound. Thus, in a specific trial of a priming task, the compound serves as a cue to search for the long-term memory entry of the target. The more familiar the compound, the more accessible is the long-term memory entry corresponding to the target. Since the familiarity of the compound positively correlates with the associative relation of prime and target that, in turn, depends on the frequency of prime-target co-occurrence, semantic priming effects beyond associative relatedness are hardly explainable with compound cue models (see Lucas, 2000).

Consequently, the interpretation of S–S-based evaluative priming effects might also pose a problem for compound cue theories, since evaluative congruency between semantic concepts does not *per se* be associated with a frequent co-occurrence of these concepts. This may be even implausible, since the amount of evaluatively connoted stimuli is probably by far too high (see Neumann et al., 2003; Zajonc, 1980). Even if one would assume that a compound formed by evaluatively congruent prime and target is highly familiar and facilitates the search for the long-term memory entry associated with the target, an application of the compound cue account to the present findings is still problematic. Given evaluative congruency, the target response is not generally facilitated; instead, target response facilitation or interference depends on the prime-target response relation. Such response-related processes between prime and target are, however, not considered by the compound cue theories. Therefore, I do not see how these models could account for the reported interaction of evaluative congruency and response-compatibility in S–S-based evaluative priming tasks.

Since a further objective of my experiments was to elaborate the requirements of evaluative priming phenomena on memory models with a prioritized, representational status of the evaluative connotations, in the following Section I discuss the implications of my results on the representation of valence in the semantic memory.

5.3 Implications on the memory representation of valence

As mentioned previously, the evaluative priming paradigm is an implicit measure to explore the processing of the evaluative features of prime and target stimuli, whereby it provides information about the representation of the evaluative connotations in the semantic memory. For this, it is crucial to remind that evaluative priming effects caused by stimulus-response compatibility are interpreted in a largely different way than evaluative priming effects within an S–S-based priming design. In principle, these diverging interpretations pose no severe problem, since the evaluative content is just differently processed in the evaluation task compared with any nonevaluative task (e.g., naming or semantic categorization task). However, a problem arises when the different interpretations of evaluative priming effects implicate conflicting memory representations of the evaluative connotations. While the response-based explanation of S–R-based evaluative priming requires a parallel activation of prime and target responses, the encoding facilitation explanation of S–S-based evaluative priming requires the facilitative encoding of one concept due to the pre-activation of the shared, evaluative features. The three-process model and the findings in my experiments suggest specific implications for a model of the memory representation of valence. First, a plausible model should provide a mechanism for mutual facilitation of evaluatively congruent stimuli (as it is necessary to explain S–S-based evaluative priming effects), thereby, it should enable target-encoding facilitation as well as prime-activation maintenance. Second, parallel activation of target and prime representations (including unshared features) should be possible in order to allow for S–R-based evaluative priming effects.

Regarding the dominating encoding facilitation theories of evaluative priming—as characterized earlier—illustrates a dilemma. On the one hand, parallel distributed memory models (e.g., Masson, 1995) provide the most elegant implementation of facilitated encoding of evaluatively congruent concepts: Each semantic concept is represented by a specific pattern of activation across processing units, including units that code for the evaluative connotations (see Spruyt et al., 2002; Wentura, 1999; 2000). Priming is explained by the ease of the transition between activation vectors that share part of their pattern (e.g., the evaluative category). Parallel activation of related concepts is implemented by overlapping activation units that correspond to the shared semantic features. Since, however, the response-based account of S–R-based evaluative priming demands the parallel activation of prime and target response features—even if these features are not shared in case of response-incompatibility—the parallel distributed memory model does not provide a conclusive mechanism for S–R-based evaluative priming.

On the other hand, traditional semantic network models (e.g., Bower, 1991) are still well suited to implement the boundary conditions for the memory representation of valence to account for evaluative priming effects; since these models provide a mechanism for both spreading of activation between evaluatively congruent concepts and parallel activation of several semantic concepts. However, as noted earlier, such semantic network models are burdened with other problems. Most importantly, if the activation is widely distributed among many evaluatively congruent concepts, each single concept is activated to a very low extent that, in turn, highly decreases the probability of observable priming effects (see Anderson, 1974). Thus, a spreading activation account needs constraints with regard to the amount of activation to prevent a collapse of the system.

To overcome this dilemma, it might be of help to broaden the considerations about a plausible model for the memory representation of valence to research areas beyond the field of priming research. In this context, it is interesting to note that the research on working memory *per se* deals with the question of how different semantic concepts can be kept active for cognitive processing at the same time; this concern corresponds to the parallel activation of prime and target concepts, as it is crucial for the interpretation of S–R-based evaluative priming effects. A prominent perspective on working memory is to regard its contents as the activated part of the long-term memory (see Cowan, 1999; Oberauer, 2002). In his embedded-processes model of working memory, Cowan characterizes the focus of attention as the structure within the activated part of the long-term memory that is able to keep around three to five unrelated long-term memory entries in a highly accessible state at the same time. In a comparable way, Oberauer (2002) defines the working memory as a framework with three embedded components. Besides the activated part of the long-term memory, he determines the region of direct access that can hold a limited number of information units available for cognitive processing; thus, this region nearly corresponds to the focus of attention in Cowan's model. The focus of attention in Oberauer's model is able to keep only the currently selected object activated. However, Oberauer and Bialkova (2009) reported that the number of simultaneously activated elements in the focus of attention can be increased from one to two by a process of ad-hoc chunking. As a consequence, not the single elements but just the chunk is activated in the focus of attention.

To account for parallel activation of more than one concept at once, working memory models with an organizational structure of parallel distributed models were considered, while the activation units that belong to the same concept are assumed to fire synchronously (e.g., Raffone & van Leeuwen, 2001; Raffone & Wolters, 2001; Vogel, Woodman, & Luck, 2001; Wolters & Raffone, 2008). Since—as a result—the activation patterns of simultaneously activated, distinct semantic concepts can unambiguously and completely emerge, synchronous firing may provide an elegant mechanism for the parallel activation of several concepts within the distributed memory model of priming (Masson, 1991, 1995). With this amendment, the distributed memory model is able to account for S–R-based evaluative priming.

In order to provide an explanation for S–S-based evaluative priming as well, such working memory models need the implementation of a mechanism that enables feature overlap of simultaneously maintained concepts, as it is assumed for evaluatively congruent prime and target. In this context, Raffone and van Leeuwen (2003) considered that the activation units which belong to different, simultaneously activated patterns may alternate their synchronizations between the rhythms of the respective activation patterns. Referring to the objective of evaluative priming, such alternations in synchronism are specifically crucial for the evaluative features of evaluatively congruent prime and target.

What is yet to be solved, however, is the question of how mutual facilitation of overlapping (e.g., evaluatively congruent) concepts can be enabled in these sophisticated models. In this regard, the question arises whether there is an empirical link between priming and working memory studies. Indeed, not at first sight, but at the second: In several working memory studies, similarity of to-be-remembered items was associated with detrimental effects, that is, rather the opposite of mutual facilitation was observed. It is, for example, well known that phonological similarity of sequentially presented words typically leads to impaired serial recall compared to the recall of phonologically dissimilar words (e.g., Baddeley, 1966; Henson, Norris, Page, & Baddeley, 1996). Oberauer (2009; see also Oberauer & Kliegl, 2006, 2010) explained this impaired performance for similar in comparison to dissimilar test items with a mechanism called feature overwriting. Feature overwriting means that different, currently held items in working memory, which share certain features, compete for these features, while only one item can gain this competition. It is important to note that Oberauer (2009; see also Oberauer & Kliegl, 2006) suggests that each feature unit is able to fire only once per phase and, thereby, belong to only one of all currently activated elements in working memory at the same time.

In this regard, it is yet interesting to see that, even though phonological similarity of the to be remembered items was detrimental for serial recall, it was beneficial for the recall of the single items, irrespective of the specific positions in the list (see Watkins, Watkins, & Crowder, 1974). Furthermore, no detrimental effects of semantic similarity (i.e., the to-be-remembered words belong to the same semantic category) were found (e.g., Cowles, Garnham, & Simner, 2010). Some studies even reported improved recall for semantically related words as compared to unrelated ones (see Cowles et al., 2010; Poirier & Saint-Aubin, 1995; Saint-Aubin, Ouellette, & Poirier, 2005). Of course, beneficial similarity effects can be explained with easier retrieval of the memory representations in case of semantic similarity because a shared category or a common theme can provide an additional retrieval cue (e.g., Poirier & Saint-Aubin, 1995; Saint-Aubin & Poirier, 1999) or because the elements from the same semantic category are bound to chunks (McElree, 1998). However, such advantageous effects of semantic similarity were also interpreted as reflecting the mechanism of spreading activation (e.g., Stuart & Hulme, 2000). Thus, working memory studies provide some evidence that semantic overlap of simultaneously activated patterns is associated with benefits (in terms of mutual facilitation) rather than costs (in terms of interference). These findings go in line with the assumptions of the three-process model.

Thus, developing a model of the memory representations of the evaluative connotations that accounts for both S–R-based and S–S-based evaluative priming effects, one might think about an amendment of parallel distributed models of priming that allows for parallel activation of several concepts, even in their non-overlapping parts. Such a model should have implemented a mechanism of synchronous firing of all features belonging to one concept (thereby allowing for parallel activation of several concepts) as well as a mechanism of feature overlap of related concepts (thereby allowing for mutual facilitation of evaluatively congruent concepts). A theoretical combination of priming and working memory models seems to be a fruitful way to arrive at an explanation model of evaluative priming effects that allows for parallel activation of several (at least two) concepts as well as mutual facilitation of evaluatively congruent concepts.

In the next Section, I aim to discuss some considerable limitations of the experiments reported in this thesis that are important to keep in mind while interpreting the present findings.

5.4 Limitations of the present experiments

One might wonder that I used rather few stimuli as primes and targets in my experiments. The stimulus set sizes in evaluative priming studies are in general much smaller in comparison with the set sizes in semantic priming studies (see Klauer & Musch, 2003). One reason for this may lie in the rather limited number of clearly valenced stimuli. Klauer and Musch (2001) examined evaluative priming in the naming task with different set sizes of prime and target stimuli and did not report significant influences of the stimulus set size; however—as discussed earlier—they failed to find any significant priming effects in this series of experiments.

I have to admit that the magnitude and the robustness of S–S-based evaluative priming effects in my experiments were rather weak. Regarding the effect sizes of S–S-based evaluative priming effects in prior studies, the effect seems to be rather small and was associated with medium (see, e.g., Glaser & Banaji, 1999; Hermans et al., 1994; Spruyt, De Houwer et al., 2007; Spruyt et al., 2002) or even small (see, e.g., Everaert et al., 2011; De Houwer & Randell, 2004; Spruyt & Hermans, 2008) effect sizes. Only Bargh and colleagues (1996) reported large effect sizes for the positive evaluative priming effect with the naming task (but see Klauer & Musch 2001, for a failure to replicate).

One of the main and most important findings in my experiments was the prolonged response conflict between response-incompatible prime and target given evaluative congruency as compared to incongruency. Applying the rationale of the three-process model, I interpreted this result in the way that the activation of an evaluatively congruent prime is supported by the target, leading to a parallel activation of prime and target, and—as a direct consequence—resulting in a larger interference of the target response by a response-incompatible prime. Following this logic, an evaluatively incongruent prime is not sufficiently activated and does, thereby, not have the potential to disturb the target response. I must, however, admit that the finding of an increased target response interference given evaluative congruency as compared to incongruency also allows for an alternative interpretation. Taking the idea of distributed concept representation—as suggested in the distributed memory model by Masson (1991, 1995)—into account and applying this idea to my experiments, the activation of the target was necessarily accompanied by the activation of an evaluatively congruent prime because the activation units corresponding to the evaluative connotations of prime and target overlapped. According to the rationale of the distributed memory model, however, the parallel activation of evaluatively congruent prime and target is restricted to their overlapping parts. The non-overlapping features, by contrast, may impede each other and mutually inhibit the formation of the complete activation pattern of either the prime or the target concept. Since, thus, also the response-related features of response-incompatible prime and target may impede each other, an increased response conflict given evaluative congruency in comparison with incongruency may occur.

Both interpretations, that is, the parallel activation of the prime and the target concept in case of evaluative congruency (as suggested by the three-process model) versus a parallel activation that is restricted to the overlapping, evaluative features of the prime and the target pattern with a mutual interference of the remaining prime and target features (as implemented by Masson's [1991, 1995] distributed memory model), are compatible with the finding of increased target response interference by an evaluatively congruent compared with an incongruent prime. In order to test the explanation derived from the three-process model against the alternative interpretation, it is necessary to examine the representational status of the prime concept in case of evaluative congruency. An elegant and reasonable operationalization would be to employ prime and target stimuli from (at least) three response categories with a specific analysis of the erroneous target responses. If—in case of response-incompatibility and evaluative congruency—the response associated with the prime would interfere with the target response more frequently than expected by chance, one could conclude that evaluatively congruent prime and target representations are simultaneously activated and that the prime activation is maintained by an evaluatively congruent target. Thus, such a finding would corroborate the interpretation according to the three-process model. Otherwise, if the erroneous target responses would equally often arise due to all available responses without a significantly more frequent interference by the prime-associated response, the increased target response conflict given evaluative congruency would be caused by a mutual inhibition of the activation patterns corresponding to the prime and the target concept, impeding the formation of the entire target activation pattern. Such a result would rather corroborate an interpretation in line with the explanation of priming effects by the distributed memory model.

Since I examined evaluative priming in sequential priming tasks with one target and a single prime per trial, my considerations concerning the interaction of evaluatively congruent concepts and the representation of the evaluative connotations in the semantic memory are restricted to two concepts. It may be interesting and a matter of future research to broaden the applicability of the three-process model on priming task settings with more than two stimuli. The memory models with mechanisms of synchronously firing activation patterns and activation units that alternate their rhythm between patterns should in principle allow for the simultaneous activation of more than two concepts, as well. Furthermore, I did not explore in how far the three-process model is able to account for S–S-based evaluative priming effects with nonconsciously perceptible primes. For this, similar S–S-based evaluative priming studies should be examined with masked prime presentations.

5.5 Conclusions

The main purpose of the present thesis was to introduce and experimentally test a theory of evaluative priming that accounts for evaluative priming effects in the S–R-based as well as the S–S-based variant of the paradigm. I would like to emphasize that both variants of the evaluative priming paradigm originated from largely different traditions. While the S–R-based evaluative priming variant illustrates an evaluative modification of the response priming paradigm, the S–S-based variant is structurally rather comparable with the semantic priming paradigm. Thus, the implications of evaluative priming effects on (a) the cognitive processes involved in the evaluative priming task and (b) the memory representations of the evaluative connotations of semantic concepts largely differ. With the three-process model, I aimed to propose an integrative explanation for both S–R-based and S–S-based evaluative priming effects. Thus, this model provides implementations of mutual facilitation of (at least two) evaluatively congruent concepts, parallel activation of (at least two) concepts as well as response-related interactions between the currently activated concepts.

6 References

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

Anderson, J. R. (1974). Retrieval of propositional information from long-term memory. *Cognitive Psychology, 6,* 451-474. doi:10.1016/0010-0285(74)90021-8

Anderson, J. R. (1983). A spreading activation theory of memory. *Journal of verbal learning and verbal behavior*, *22,* 261-295. doi:10.1016/S0022-5371(83)90201-3

Anderson, J. E., & Holcomb, P. J. (1995). Auditory and visual semantic priming using different stimulus onset asynchronies: An event-related brain potential study. *Psychophysiology, 32,* 177-190. doi:10.1111/j.1469-8986.1995.tb03310.x

Baddeley, A. D. (1966). Short-term memory for word sequences as a function of acoustic, semantic and formal similarity. *The Quarterly Journal of Experimental Psychology*, *18*, 362-365. doi:10.1080/14640746608400055.

Balota, D. A., & Lorch, R. F. (1986). Depth of automatic spreading activation: Mediated priming effects in pronunciation but not in lexical decision. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12*, 336-345. doi:10.1037/0278-7393.12.3.336

Banaji, M. R., & Hardin, C. D. (1996). Automatic stereotyping. *Psychological Science*, *7*, 136-141. doi:10.1111/j.1467-9280.1996.tb00346.x

Banse, R. (2001). Affective priming with liked and disliked persons: Prime visibility determines congruency and incongruency effects. *Cognition & Emotion*, *15*, 501-520. doi:10.1080/02699930126251

Bargh, J. A. (1997). The automaticity of everyday life. In R. S. Wyer (Eds.), *The automaticity of everyday life. Advances in social cognition, Vol. X.* (pp. 1-61). Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.

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

Bargh, J. A., & Chartrand, T. L. (2000). The mind in the middle: A practical guide to priming and automaticity research. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 253-285). Cambridge, UK: Cambridge University Press.

Bartholow, B. D., Riordan, M. A., Saults, J. S., & Lust, S. A. (2009). Psychophysiological evidence of response conflict and strategic control of responses in affective priming. *Journal of Experimental Social Psychology, 45*, 655-666. doi:10.1016/j.jesp.2009.02.015

Berkowitz, L., Jaffee, S., Jo, F., & Troccoli, B. T. (2000). On the correction of feeling-induced judgmental biases. In J. P. Forgas (Ed.), *Feeling and thinking: The role of affect in social cognition* (pp. 131-152). New York: Cambridge University Press.

Berner, M. P., & Maier, M. A. (2004). The direction of affective priming as a function of trait anxiety when naming target words with regular and irregular pronunciation. *Experimental Psychology, 51*, 180-190. doi:10.1027/1618-3169.51.3.180

Besner, D., & Stolz, J. A. (1999). What kind of attention modulates the Stroop effect? *Psychonomic Bulletin & Review*, *6*, 99-104. doi:10.3758/BF03210834

Botvinick, M., Nystrom, L. E., Fissell, K., Carter, C. S., & Cohen, J. D. (1999). Conflict monitoring versus selection-for-action in anterior cingulate cortex. *Nature*, *402*, 179-181. doi:10.1038/46035

Bower, G. H. (1981). Mood and memory. *American Psychologist*, *36*, 129-148. doi:10.1037/0003-066X.36.2.129

Bower, G. H. (1987). Commentary on mood and memory. *Behaviour Research and Therapy*, *25*, 443-455. doi:10.1016/0005-7967(87)90052-0

Bower, G. H. (1991). Mood congruity of social judgments. In J. P. Forgas (Ed.), *Emotion and social judgments* (pp. 31-53). Elmsford, NY, US: Pergamon Press.

Bower, G. H., & Forgas, J. P. (2001). Mood and social memory. In J. P. Forgas (Ed.), *Handbook of affect and social cognition* (pp. 95-120). Mahwah, NJ, US: Lawrence Erlbaum Associates.

Bower, G. H., & Mayer, J. D. (1991). In search of mood-dependent retrieval. *Journal of Social Behavior & Personality, 4,* 121-156.

Bower, G. H., Monteiro, K. P., & Gilligan, S. G. (1978). Emotional mood as a context for learning and recall. *Journal of verbal learning and verbal behavior, 17,* 573-585. doi:10.1016/j.bbr.2011.03.031

Brown, C., & Hagoort, P. (1993). The processing nature of the N400: evidence from masked priming. *Journal of Cognitive Neuroscience, 5,* 34-44. doi:10.1162/jocn.1993.5.1.34

Brown, C., Hagoort, P., & Chwilla, D. (2000). An event-related brain potential analysis of visual word-priming effects. *Brain and Language, 72,* 158-190. doi:10.1006/brln.1999.2284

Brunia, C. H. M. (1988). Movement and stimulus preceding negativity. *Biological Psychology, 26,* 165-178. doi:10.1016/0301-0511(88)90018-X

Calvo, M. G., & Nummenmaa, L. (2007). Processing of unattended emotional visual scenes. *Journal of Experimental Psychology: General, 136*, 347-369. doi:10.1037/0096-3445.136.3.347

Carrillo-de-la-Peña, M. T., Lastra-Barreira, C., & Galdo-Alvarez, S. (2006). Limb (hand vs. foot) and response conflict have similar effects on event-related potentials (ERPs) recorded during motor imagery and overt execution. *European Journal of Neuroscience, 24,* 635-643. doi:10.1111/j.1460-9568.2006.04926.x

Center for the Study of Emotion and Attention (1994). *The International Affective Picture System* [photographic slides]. Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.

Chaiken, S., & Bargh, J. A. (1993). Occurrence versus moderation of the automatic attitude activation effect: Reply to Fazio. *Journal of Personality and Social Psychology, 64*, 759-765. doi:10.1037/0022-3514.64.5.759

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.

Chartrand, T. L., van Baaren, R. B., & Bargh, J. A. (2006). Linking automatic evaluation to mood and information processing style: Consequences for experienced affect, impression formation, and stereotyping. *Journal of Experimental Psychology: General, 135*, 70-77. doi:10.1037/0096-3445.135.1.70

Coles, M. G. H. (1989). Modern mind-brain reading: Psychophysiology, physiology, and cognition. *Psychophysiology, 26,* 251-269. doi:10.1111/j.1469-8986.1989.tb01916.x

Coles, M. G. H., Gratton, G., Bashore, T. R., Eriksen, C. W., & Donchin, E. (1985). A psychophysiological investigation of the continuous flow model of human information processing. *Journal of Experimental Psychology: Human Perception and Performance, 11*, 529-553. doi:10.1037/0096-1523.11.5.529

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

Cowan, N. (1999). An embedded-processes model of working memory. In A. Miyake & P. Shah (Eds.), *Models of Working Memory: Mechanisms of Active Maintenance and Executive Control* (pp. 62-101). Cambridge, UK: Cambridge University Press.

Cowles, H. W., Garnham, A., & Simner, J. (2010). Conceptual similarity effects on working memory in sentence contexts: Testing a theory of anaphora. *Quarterly Journal of Experimental Psychology, 63,* 1218-1232. doi:10.1080/17470210903359198

Dagenbach, D., Carr, T. H., & Barnhardt, T. M. (1990). Inhibitory semantic priming of lexical decisions due to failure to retrieve weakly activated codes. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *16*, 328-340. doi:10.1037/0278-7393.16.2.328

Deacon, D., Hewitt, S., & Tamny, T. (1998). Event-related potential indices of semantic priming following an unrelated intervening item. *Cognitive Brain Research, 6*, 219-225. doi:10.1016/S0926-6410(97)00019-0

Deacon, D., Hewitt, S., Yang, C.-M., & Nagata, M. (2000). Event-related potential indices of semantic priming using masked and unmasked words: Evidence that the N400 does not reflect a post-lexical process. *Cognitive Brain Research, 9,* 137-146. doi:10.1016/S0926-6410(99)00050-6

Degner, J. (2009). On the (un-)controllability of affective priming: Strategic manipulation is feasible but can possibly be prevented. *Cognition & Emotion, 23,* 327-354. doi:10.1080/02699930801993924

De Houwer, J. (2003). On the role of stimulus-response and stimulus-stimulus compatibility in the Stroop effect. *Memory & Cognition, 31,* 353-359. doi:10.3758/BF03194393

De Houwer, J., Crombez, G., Baeyens, F., & Hermans, D. (2001). On the generality of the affective Simon effect. *Cognition & Emotion, 15,* 189-206. doi:10.1080/02699930125883

De Houwer, J., & Eelen, P. (1998). An affective variant of the Simon paradigm. *Cognition & Emotion, 12,* 45-62. doi:10.1080/026999398379772

De Houwer, J., & Hermans, D. (1994). Differences in the affective processing of words and pictures. *Cognition & Emotion, 8,* 1-20. doi:10.1080/02699939408408925

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 & Emotion, 18*, 251-264. doi:10.1080/02699930341000022

De Houwer, J., Teige-Mocigemba, S., Spruyt, A., & Moors, A. (2009). Implicit measures: A normative analysis and review. *Psychological Bulletin, 135*, 347-368. doi:10.1037/a0014211

Donchin, E., Ritter, W., & McCallum, W. C. (1978). Cognitive psychophysiology: The endogenous components of the ERP. In E. Callaway, P. Tueting, & S. Koslow (Eds.), *Event-related brain potentials in man* (pp. 349-411). New York, NY, US: Academic Press.

Draine, S. C., & Greenwald, A. G. (1998). Replicable unconscious semantic priming. *Journal of Experimental Psychology: General, 127*, 286-303. doi:10.1037/0096-3445.127.3.286

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

Duncan-Johnson, C. C., & Donchin, E. (1982). The P300 component of the event-related brain potential as an index of information processing. *Biological Psychology, 14*, 1-52. doi:10.1016/0301-0511(82)90016-3

Dunton, B. C., & Fazio, R. H. (1997). An individual difference measure of motivation to control prejudiced reactions. *Personality and Social Psychology Bulletin, 23,* 316-326. doi:10.1177/0146167297233009

Duscherer, K., Holender, D., & Molenaar, E. (2008). Revisiting the affective Simon effect. *Cognition & Emotion, 22*, 193-217. doi:10.1080/02699930701339228

Eder, A. B., & Klauer, K. C. (2009). A common-coding account of the bidirectional evaluation-behavior link. *Journal of Experimental Psychology: General, 138*, 218-235. doi:10.1037/a0015220

Eder, A. B., Leuthold, H., Rothermund, K., & Schweinberger, S. R. (2011). Automatic response activation in sequential affective priming: an ERP study. *Social Cognitive and Affective Neuroscience*. doi:10.1093/scan/nsr033

Eder, A. B., Müsseler, J., & Hommel, B. (2011). The structure of affective action representations: Temporal binding of affective response codes. *Psychological Research, 76,* 111-118, doi:10.1007/s00426-011-0327-6

Eimer, M. (1998). The lateralized readiness potential as an on-line measure of central response activation processes. *Behavior Research Methods, Instruments, and Computers, 30*, 146-156. doi:10.3758/BF03209424

Eriksen, B. A., & Eriksen, C. W. (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. *Perception and Psychophysics, 16,* 143-149. doi:10.3758/BF03203267

Everaert, T., Spruyt, A., & De Houwer, J. (2011). On the (un)conditionality of automatic attitude activation: The valence proportion effect. *Canadian Journal of Experimental Psychology, 65,* 125-132. doi:10.1037/a0022316

Fabiani, M., Gratton, G., & Federmeier, K. D. (2007). Event-related brain potentials: Methods, theory, and applications. In J. T. Cacioppo, L. G. Tassinary, & G. G. Berntson (Eds.), *Handbook of psychophysiology* (pp. 85-119). New York, NY, US: Cambridge University Press.

Fazio, R. H. (1989). On the power and functionality of attitudes: The role of attitude accessibility. In A. R. Pratkanis, S. J. Breckler, & A. G. Grennwald (Eds.), *Attitude structure and function* (pp. 153-179). Hillsdale, NJ: Lawrence Erlbaum Associates.

Fazio, R. H. (2001). On the automatic activation of associated evaluations: An overview. *Cognition & Emotion, 15,* 115-141. doi:10.1080/02699930125908

Fazio, R. H., & Olson, M. A. (2003). Implicit measures in social cognition research: Their meaning and use. *Annual Review of Psychology, 54*, 297-327. doi:10.1146/annurev.psych.54.101601.145225

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

Ferguson, M. J., & Bargh, J. A. (2003). The constructive nature of automatic evaluation. In J. Musch & K. C. Klauer (Eds.), *The Psychology of Evaluation: Affective Processes in Cognition & Emotion* (pp. 169-188). Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.

Ferguson, M. J., Bargh, J. A., & Nayak, D. A. (2005). After-affects: How automatic evaluations influence the interpretation of subsequent, unrelated stimuli. *Journal of Experimental Social Psychology, 41,* 182-191. doi:10.1016/j.jesp.2004.05.008

Fiedler, K. (1991). On the task, the measures and the mood in research on affect and social cognition. In J. P. Forgas (Ed.), *Emotion and social judgments* (pp. 83-104). Oxford, MA: Pergamon Press.

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

Folstein, J. R., & van Petten, C. (2008). Influence of cognitive control and mismatch on the N2 component of the ERP: A review. *Psychophysiology, 45*, 152-170. doi:10.1111/j.1469-8986.2007.00602.x

Forgas, J. P., & Bower, G. H. (1987). Mood effects on person-perception judgments. *Journal of Personality and Social Psychology, 53*, 53-60. doi:10.1037/0022-3514.53.1.53

Franklin, M. S., Dien, J., Neely, J. H., Huber, E., & Waterson, L. D. (2007). Semantic priming modulates the N400, N300, and N400RP. *Clinical Neurophysiology, 118,* 1053-1068. doi:10.1016/j.clinph.2007.01.012

Frijda, N. H. (1986). The emotions. Cambridge: Cambridge University Press.

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

Frost, R., Katz, L., & Bentin, S. (1987). Strategies for visual word recognition and orthographical depth: A multilingual comparison. *Journal of Experimental Psychology: Human Perception and Performance, 13,* 104-115. doi:10.1037/0096-1523.13.1.104

Gehring, W. J., Gratton, G., Coles, M. G. H., & Donchin, E. (1992). Probability effects on stimulus evaluation and response processes. *Journal of Experimental Psychology: Human Perception and Performance*, *18,* 198-216. doi:10.1037/0096-1523.18.1.198

Giesen, C., & Rothermund, K. (2011). Affective matching moderates S-R binding. *Cognition & Emotion, 25*, 342-250. doi:10.1080/02699931.2010.482765

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. (2003). Reverse priming: Implications for the (un)conditionality of automatic evaluation. In J. Musch & K. C. Klauer (Eds.), *The Psychology of Evaluation: Affective Processes in Cognition & Emotion* (pp. 87-108). Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.

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

Glaser, W. R. (1992). Picture naming. *Cognition, 42,* 61-105. doi:10.1016/0010-0277(92)90040-O

Glaser, W. R., & Glaser, M. O. (1989). Context effects in Stroop-like word and picture processing. *Journal of Experimental Psychology: General, 118,* 13-42. doi:10.1037/0096-3445.118.1.13

Gratton, G., Coles, M. G. H., Sirevaag, E. J., Eriksen, C. W., & Donchin, E. (1988). Pre- and poststimulus activation of response channels: A psychophysiological analysis. *Journal of Experimental Psychology: Human Perception and Performance, 14,* 331-344. doi:10.1037/0096-1523.14.3.331

Greenwald, A. G., Draine, S. C., & Abrams, R. L. (1996). Three cognitive markers of unconscious semantic activation. *Science, 273,* 1699-1702. doi:10.1126/science.273.5282.1699

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

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology, 74,* 1464-1480. doi:10.1037/0022-3514.74.6.1464

Greenwald, A. G., & Rosenberg, K. E. (1978). Sequential effects of distracting stimuli in a selective attention reaction time task. In J. Requin (Ed.), *Attention and performance, Vol. VII* (pp. 487-504). Hillsdale, NJ: Lawrence Erlbaum Associates.

Henson, R. N. A., Norris, D. G., Page, M. P. A., & Baddeley, A. D. (1996). Unchained memory: Error patterns rule out chaining models of immediate serial recall. *The Quarterly Journal of Experimental Psychology, 49A,* 80-115. doi:10.1080/713755612

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., De Houwer, J., & Eelen, P. (2001). A time course analysis of the affective priming effect. *Cognition & Emotion*, *15*, 143-165. doi:10.1080/02699930125768

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. doi:10.1080/02699930302276

Hill, A. B., & Kemp-Wheeler, S. M. (1989). The influence of context on lexical decision times for emotionally aversive words. *Current Psychology: Research and Reviews*, *8*, 219-227. doi:10.1007/BF02686750

Huber, D. E., Shiffrin, R. M., Lyle, K. B., & Ruys, K. I. (2001). Perception and preference in short-term word priming. *Psychological Review*, *108*, 149-182. doi:10.1037/0033-295X.108.1.149

Kahan, T. A. (2000). Negative priming from masked words: Retrospective prime clarification or center-surround inhibition? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *26*, 1392-1410. doi:10.1037/0278-7393.26.6.1392

Kemp-Wheeler, S. M., & Hill, A. B. (1992). Semantic and emotional priming below objective detection threshold. *Cognition & Emotion*, *6*, 113-128. doi:10.1080/02699939208411062

Klauer, K. C., & Dittrich, K. (2010). From sunshine to double arrows: An evaluation window account of negative compatibility effects. *Journal of Experimental Psychology: General*, *139*, 490-519. doi:10.1037/a0019746

Klauer, K. C., & Musch, J. (2001). Does sunshine prime loyal? Affective priming in the naming task. *The Quarterly Journal of Experimental Psychology*, *54A*, 727-751. doi:10.1080/713755986

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. (2003). Affective priming: Findings and theories. In J. Musch & K. C. Klauer (Eds.), *The Psychology of Evaluation: Affective Processes in Cognition & Emotion* (pp. 7-49). Mahwah, NJ, US: Lawrence Erlbaum Associates.

Klauer, K. C., Roßnagel, C., & Musch, J. (1997). List-context effects in evaluative priming. *Journal of Experimental Psychology: Learning, Memory, and 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. (2007). Controllability and resource dependence in automatic evaluation. *Journal of Experimental Social Psychology, 43,* 648-655. doi:10.1016/j.jesp.2006.06.003

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

Kopp, B., Mattler, U., Goertz, R., & Rist, F. (1996). N2, P3 and the lateralized readiness potential in a nogo task involving selective response priming. *Electroencephalography and Clinical Neurophysiology, 99*, 19-27. doi:10.1016/0921-884X(96)95617-9

Kopp, B., Rist, F., & Mattler, U. (1996). N200 in the flanker task as a neurobehavioral tool for investigating executive control. *Psychophysiology, 33,* 282-294. doi:10.1111/j.1469-8986.1996.tb00425.x

Kutas, M., McCarthy, G., & Donchin, E. (1977). Augmenting mental chronometry: The P300 as a measure of stimulus evaluation time. *Science, 197,* 792-795. doi:10.1126/science.887923

Kutas, M., & Van Petten, C. (1988). Event-related brain potential studies of language. *Advances in Psychophysiology, 3,* 139-187.

Leuthold, H., Sommer, W., & Ulrich, R. (1996). Partial advance information and response preparation: Inferences from the lateralized readiness potential.

Journal of Experimental Psychology: General, 125, 307-323. doi:10.1037/0096-3445.125.3.307

Liu, B., Xin, S., Jin, Z., Hu, Y., & Li, Y. (2010). Emotional facilitation effect in the picture-word interference task: An ERP study. *Brain and Cognition, 72,* 289-299. doi:10.1016/j.bandc.2009.09.013

Lucas, M. (2000). Semantic priming without association: A meta-analytic review. *Psychonomic Bulletin & Review, 7,* 618-630. doi:10.3758/BF03212999

Luck, S. J. (2005). *An introduction to the event-related potential technique.* Cambridge, Massachusetts: MIT Press.

MacLeod, C. M. (1991). Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin, 109,* 163-203. doi:10.1037/0033-2909.109.2.163

Magliero, A., Bashore, T. R., Coles, M. G. H., & Donchin, E. (1984). On the dependence of P300 latency of stimulus evaluation processes. *Psychophysiology, 21*, 171-186. doi:10.1111/j.1469-8986.1984.tb00201.x

Maier, M. A., Berner, M. P., & Pekrun, R. (2003). Directionality of affective priming: Effects of trait anxiety and activation level. *Experimental Psychology, 50,* 116-123. doi:10.1026//1618-3169.50.2.116

Masson, M. E. J. (1991). A distributed memory model of context effects in word identification. In D. Besner & G. W. Humphreys (Eds.), *Basic processes in reading: Visual word recognition* (pp. 233-263). Hillsdale, NJ: Lawrence Erlbaum Associates.

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

Maxwell, S. E., & Delaney, H.D. (1990). *Designing experiments and analyzing data: A model comparison perspective.* Mahwah, NJ: Lawrence Erlbaum Associates.

McCarthy, G., & Donchin, E. (1981). A metric for thought: A comparison of P300 latency and reaction time. *Science, 211,* 77-80. doi:10.1126/science.7444452

McElree, B. (1998). Attended and non-attended states in working memory: Accessing categorized structures. *Journal of Memory and Language, 38*, 225-252. doi: 10.1006/jmla.1997.2545

McKoon, G., & Ratcliff, R. (1989). Assessing the occurrence of elaborative inference with recognition: Compatibility checking vs. compound cue theory. *Journal of Memory & Language, 28,* 547-563. doi:10.1016/0749-596X(89)90012-0

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. (1992). Priming and constraints it places on theories of memory and retrieval. *Psychological Review, 99,* 650-662. doi:10.1037/0033-295X.99.4.650

McNamara, T. P. (2005). *Semantic priming: Perspectives from memory and word recognition. Essays in cognitive psychology*. New York, NY, US: Psychology Press.

McRae, K., de Sa, V. R., & Seidenberg, M. S. (1997). On the nature and scope of featural representations of word meaning. *Journal of Experimental Psychology: General*, *126,* 99-130. doi:10.1037/0096-3445.126.2.99

Miller, J., & Hackley, S. A. (1992). Electrophysiological evidence for temporal overlap among contingent mental processes. *Journal of Experimental Psychology: General, 121,* 195-209. doi:10.1037/0096-3445.121.2.195

Miller, J., Patterson, T., and Ulrich, R. (1998). Jackknife-based method for measuring LRP onset latency differences. *Psychophysiology, 35,* 99-115. doi:10.1111/1469-8986.3510099

Morris, J. P., Squires, N. K., Taber, C. S., & Lodge, M. (2003). Activation of political attitudes: A psychophysiological examination of the hot cognition hypothesis. *Political Psychology, 24,* 727-745. doi:10.1046/j.1467-9221.2003.00349.x

Murphy, S. T., & Zajonc, R. B. (1993). Affect, cognition, and awareness: Affective priming with optimal and suboptimal stimulus exposures. *Journal of Personality and Social Psychology, 64,* 723-739. doi:10.1037/0022-3514.64.5.723

Musch, J., & Klauer, K. C. (2001). Locational uncertainty moderates affective congruency effects in the evaluative decision task. *Cognition & Emotion, 15*, 167-188. doi:10.1080/0269993004200042

Neely, J. H. (1991). Semantic priming effects in visual word recognition: A selective review of current findings and theories. In D. Besner & G. W. Humphreys (Eds.), *Basic processes in reading. Visual word recognition* (pp. 264-336). Hillsdale, NJ: Lawrence Erlbaum Associates.

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 & Emotion* (pp. 371-391). Mahwah, NJ, US: Lawrence Erlbaum Associates.

Nieuwenhuis, S., Aston-Jones, G., & Cohen, J. D. (2005). Decision making, the P3, and the locus coeruleus--norepinephrine system. *Psychological Bulletin, 131,* 510-532. doi:10.1037/0033-2909.131.4.510

Nummenmaa, L., Hyönä, J., & Calvo, M. G. (2010). Semantic categorization precedes affective evaluation of visual scenes. *Journal of Experimental Psychology: General*, *139,* 222-246. doi:10.1037/a0018858

Oberauer, K. (2002). Access to information in working memory: Exploring the focus of attention. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28,* 411-421. doi:10.1037/0278-7393.28.3.411

Oberauer, K. (2009). Interference between storage and processing in working memory: Feature overwriting, not similarity-based competition. *Memory & Cognition*, *37,* 346-357. doi:10.3758/MC.37.3.346

Oberauer, K., & Bialkova, S. (2009). Accessing information in working memory: Can the focus of attention grasp two elements at the same time? *Journal of Experimental Psychology: General, 138,* 64-87. doi:10.1037/a0014738

Oberauer, K., & Kliegl, R. (2006). A formal model of capacity limits in working memory. *Journal of Memory and Language, 55*, 601-626. doi:10.1016/j.jml.2006.08.009

Oberauer, K., & Kliegl, R. (2010). Interferenz im Arbeitsgedächtnis: Ein formales Modell. *Psychologische Rundschau, 61,* 33-42. doi:10.1026/0033-3042/a000008

Osgood, C. E. (1976). *Focus on meaning: I. Explorations in semantic space.* Oxford, England: Mouton.

Öhmann, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General, 130,* 466-478. doi:10.1037/0096-3445.130.3.466

Picton, T. W. (1992). The P300 wave of the human event-related potential. *Journal of Clinical Neurophysiology, 9,* 456-479.

Poirier, M., & Saint-Aubin, J. (1995). Memory for related and unrelated words: Further evidence on the influence of semantic factors in immediate serial recall. *The Quarterly Journal of Experimental Psychology, 48A,* 384-404. doi:10.1080/14640749508401396

Pratto, F., & John, O. P. (1991). Automatic vigilance: The attention-grabbing power of negative social information. *Journal of Personality and Social Psychology, 61,* 380-391. doi:10.1037/0022-3514.61.3.380

Pritchard, W. S. (1981). Psychophysiology of P300. *Psychological Bulletin, 89,* 506-540. doi:10.1037/0033-2909.89.3.506

Raffone, A., & van Leeuwen, C. (2001). Activation and coherence in memory processes: Revisiting the parallel distributed processing approach to retrieval. *Connection Science, 13,* 349-382. doi:10.1080/09540090110109173

Raffone, A., & van Leeuwen, C. (2003). Dynamic synchronization and chaos in an associative neural network with multiple active memories. *Chaos, 13,* 1090-1104. doi:10.1063/1.1602211

Raffone, A., & Wolters, G. (2001). A cortical mechanism for binding in visual working memory. *Journal of Cognitive Neuroscience, 13,* 766-785. doi:10.1162/08989290152541430

Ratcliff, R., & McKoon, G. (1995). Sequential effects in lexical decision: Tests of compound-cue retrieval theory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21,* 1380-1388. doi: 10.1037/0278-7393.21.5.1380

Rosenbaum, D. A., & Kornblum, S. (1982). A priming method for investigating the selection of motor responses. *Acta Psychologica, 1,* 223-243. doi:10.1016/0001-6918(82)90036-1

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.

Rugg, M. D., & Coles, M. G. H. (1995). *Electrophysiology of Mind.* London: Oxford University Press.

Saint-Aubin, J., Ouellette, D., & Poirier, M. (2005). Semantic similarity and immediate serial recall: Is there an effect on all trials? *Psychonomic Bulletin & Review, 12,* 171-177. doi:10.3758/BF03196364

Saint-Aubin, J., & Poirier, M. (1999). Semantic similarity and immediate serial recall: Is there a detrimental effect on order information? *The Quarterly Journal Of Experimental Psychology, 52A,* 367-394. doi:10.1080/713755814

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

Shaffer, W. O., & LaBerge, D. (1979). Automatic semantic processing of unattended words. *Journal of Verbal Learning and Verbal Behavior, 18,* 413-426. doi:10.1016/S0022-5371(79)90228-7

Sharbrough, F., Chatrian, G.-E., Lesser, R. P., Lüders, H., Nuwer, M., & Picton, T. W. (1991). American electroencephalographic society guidelines for standard electrode position nomenclature. *Journal of Clinical Neurophysiology, 8,* 200-202. doi:10.1097/00004691-199104000-00007

Shelton, J. R., & Martin, R. C. (1992). How semantic is automatic semantic priming? *Journal of Experimental Psychology: Learning, Memory, & Cognition, 18,* 1191-1210. doi:10.1037/0278-7393.18.6.1191

Smid, H. G. O. M., Mulder, G., & Mulder, L. J. M. (1990). Selective response activation can begin before stimulus recognition is complete: A psychophysiological and error analysis of continuous flow. *Acta Psychologica, 74*, 169-201. doi:10.1016/0001-6918(90)90005-Z

Smith, S. M., & Petty, R. E. (1995). Personality moderators of mood congruency effects on cognition: The role of self-esteem and negative mood regulation. *Journal of Personality and Social Psychology, 68,* 1092-1107. doi:10.1037/0022-3514.68.6.1092

Smulders, F. T. Y., Kok, A., Kenemans, J. L., & Bashore, T. R. (1995). The temporal selectivity of additive factor effects on the reaction process revealed in ERP component latencies. *Acta Psychologica, 90,* 97-109. doi:10.1016/0001-6918(95)00032-P

Solarz, A. K. (1960). Latency of instrumental responses as a function of compatibility with the meaning of eliciting verbal signs. *Journal of Experimental Psychology, 59*, 239-245. doi:10.1037/h0047274

Sommer, W., Leuthold, H., & Ulrich, R. (1994). The lateralized readiness potential preceding brief isometric force pulses of different peak force and rate of force production. *Psychophysiology, 31*, 503-512. doi: 10.1111/j.1469-8986.1994.tb01054.x

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., De Houwer, J., Hermans, D., & Eelen, P. (2007). Affective priming of nonaffective semantic categorization responses. *Experimental Psychology*, *54*, 44-53. doi:10.1027/1618-3169.54.1.44

Spruyt, A., & Hermans, D. (2008). Affective priming of naming responses does not depend on stimulus repetition. *Canadian Journal of Experimental Psychology*, *62*, 237-241. doi:10.1037/1196-1961.62.4.237

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*, 227-256. 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

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18*, 643–662. doi:10.1037/0096-3445.121.1.15

Stuart, G., & Hulme, C. (2000). The effects of word co-occurance on short-term memory: Associative links in long-term memory affect short-term memory performance. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *26*, 796-802. doi:0.1037/0278-7393.26.3.796

Teige-Mocigemba, S., & Klauer, K. C. (2008). ‘Automatic‘ evaluation? Strategic effects on affective priming. *Journal of Experimental Social Psychology, 44,* 1414-1417. doi:10.1016/j.jesp.2008.04.004

Tukey, J. W. (1977). *Exploratory data analysis*. Reading, MA: Addison-Wesley.

Tzelgov, J., Henik, A., Sneg, R., & Baruch, O. (1996). Unintentional word reading via the phonological route: The Stroop effect with cross-script homophones. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*, 336-349. doi:10.1037/0278-7393.22.2.336

van Veen, V., & Carter, C. S. (2002a). The anterior cingulate as a conflict monitor: fMRI and ERP studies. *Physiology and Behavior*, *77*, 477-482. doi:10.1016/S0031-9384(02)00930-7

van Veen, V., & Carter, C. S. (2002b). The timing of action-monitoring processes in the anterior cingulate cortex. *Journal of Cognitive Neuroscience, 14,* 593-602. doi:10.1162/08989290260045837

Vaughan Jr., H. G., Costa, L. D., & Ritter, W. (1968). Topography of the human motor potential. *Electroencephalography and Clinical Neurophysiology, 25,* 1-10. doi:10.1016/0013-4694(68)90080-1

Vogel, E. K., Woodman, G. F., & Luck, S. J. (2001). Storage of features, conjunctions, and objects in visual working memory. *Journal of Experimental Psychology: Human Perception and Performance*, *27*, 92-114. doi:10.1037/0096-1523.27.1.92

Vorberg, D., Mattler, U., Heinecke, A., Schmidt, T., & Schwarzbach, J. (2003). Different time courses for visual perception and action priming. *Proceedings of the National Academy of Sciences*, *100,* 6275-6280. doi:10.1073/pnas.0931489100

Watkins, M. J., Watkins, O. C., & Crowder, R. G. (1974). The modality effect in free and serial recall as a function of phonological similarity. *Journal of Verbal Learning and Verbal Behavior, 13,* 430-447. doi:10.1016/S0022-5371(74)80021-6

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. (2000). Dissociative affective and associative priming effects in the lexical decision task: Yes versus no responses to word targets reveal evaluative judgment tendencies. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *26*, 456-469. doi:10.1037/0278-7393.26.2.456

Wentura, D., & Degner, J. (2010). A practical guide to sequential priming and related tasks. In B. Gawronski & B. K. Payne (Eds.), *Handbook of implicit social cognition: Measurement, theory, and applications* (pp. 95-116). New York, NY, US: Guilford Press.

Wentura, D., & Frings, C. (2008). Response-bound primes diminish affective priming in the naming task. *Cognition & Emotion*, *22*, 374-384. doi:10.1080/02699930701446064

Wentura, D., & Rothermund, K. (2003). The “meddling-in” of affective information: A general model of automatic evaluation effects. In J. Musch & K. C. Klauer (Eds.), *The Psychology of Evaluation: Affective Processes in Cognition & Emotion* (pp. 51-86). Mahwah, NJ, US: Lawrence Erlbaum Associates.

Williams, J. M. G., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin, 120,* 3-24. doi:10.1037/0033-2909.120.1.3

Wittenbrink, B. (2007). Measuring attitudes through priming. In B. Wittenbrink & N. Schwarz (Eds.), *Implicit measures of attitudes: Procedures and controversies* (pp. 17-59). New York, NY: Guilford Press.

Wolters, G., & Raffone, A. (2008). Coherence and recurrency: Maintenance, control and integration in working memory. *Cognitive Processing, 9*, 1-17. doi:10.1007/s10339-007-0185-8

Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *American Psychologist, 35*, 151-175. doi:10.1037/0003-066X.35.2.151

Zhang, Q., Lawson, A., Guo, C., & Jiang, Y. (2006). Electrophysiological correlates of visual affective priming. *Brain Research Bulletin, 71*, 316-323. doi:10.1016/j.brainresbull.2006.09.023

Zhang, Q., Li, X., Gold, B. T., & Jiang, Y. (2010). Neural correlates of cross-domain affective priming. *Brain Research, 1329,* 142-151. doi:10.1016/j.brainres.2010.03.021

7 Appendix

Appendix A: Pictorial material used in Experiments 1, 2a, 4, and 5a

Appendix B: Word material used in Experiments 2b, 3, and 5b

Appendix A

IAPS pictures used in Experiment 1

IAPs numbers for target pictures

Positive: 1440, 1710, 2070, 5010

Negative: 1220, 1280, 6190, 9440

IAPs numbers for prime pictures

Positive: 2091, 2092, 2360, 2391, 4700, 5621, 5910, 8120

Negative: 2810, 2900, 6313, 9220, 9404, 9421, 9570, 9810

IAPS pictures used in Experiments 2a, 4, and 5a

IAPS numbers for pictures displaying persons

Positive: 2010, 2030, 2340, 2360, 4700

Negative: 2120, 2900, 6313, 9404, 9800

IAPS numbers for pictures displaying animals

Positive: 1440, 1460, 1610, 1710, 1920

Negative: 1050, 1220, 1280, 1300, 1930.

Appendix B

Exemplar Names from the Persons and Animals Categories Used as Primes and Targets

Experiments 2b and 5b											
Persons						Animals					
Positive			Negative			Positive			Negative		
English	German	Word length	English	German	Word length	English	German	Word length	English	German	Word length
baby	Baby	4	snob	Snob	4	pony	Pony	4	worm	Wurm	4
hero	Held	4	nazi	Nazi	4	chick	Küken	5	midge	Mücke	5
clown	Clown	5	enemy	Feind	5	blackbird	Amsel	5	rat	Ratte	5
genius	Genie	5	tyrant	Tyrann	6	puppy	Welpe	5	marten	Marder	6
friend	Freund	6	liar	Lügner	6	swan	Schwan	6	spider	Spinne	6
mother	Mutter	6	sadist	Sadist	6	parrot	Papagei	7	snake	Schlange	7
helper	Helfer	6	egoist	Egoist	6	dolphin	Delphin	7	lizard	Eidechse	8
partner	Partner	7	bragger	Angeber	7	bunny	Häschen	7	scorpion	Skorpion	8
girl	Mädchen	7	fraudster	Betrüger	8	swallow	Schwalbe	8	cockroach	Kakerlake	9
optimist	Optimist	8	tight-arse	Geizhals	8	kitten	Kätzchen	8	vulture	Aasgeier (Exp. 2b)	8
									crane fly	Schnake (Exp. 5b)	7
Mean		5.8			6			6.2			6.6 (Exp. 2b) 6.5 (Exp. 5b)
Standard Deviation		1.3			1.4			1.4			1.7 (Exp. 2b) 1.6 (Exp. 5b)

Experiment 3

Persons						Animals					
Positive			Negative			Positive			Negative		
English	German	Word length	English	German	Word length	English	German	Word length	English	German	Word length
hero	HELD	4	snob	SNOB	4	pony	PONY	4	moth	MOTTE	5
guest	GAST	4	nazi	NAZI	4	chick	KÜKEN	5	midge	MÜCKE	5
genius	GENIE	5	enemy	FEIND	5	blackbird	AMSEL	5	rat	RATTE	5
bride	BRAUT	5	idiot	IDIOT	5	bird	VOGEL	5	bug	KÄFER	5
father	VATER	5	tyrant	TYRANN	6	puppy	WELPE	5	vulture	GEIER	5
buddy	KUMPEL	6	liar	LÜGNER	6	stork	STORCH	6	wasp	WESPE	5
mother	MUTTER	6	sadist	SADIST	6	swan	SCHWAN	6	tick	ZECKE	5
helper	HELFER	6	egoist	EGOIST	6	parrot	PAPAGEI	7	fly	FLIEGE	6
role model	VORBILD	7	bragger	ANGEBER	7	dolphin	DELPHIN	7	marten	MARDER	6
partner	PARTNER	7	grumbler	NÖRGLER	7	little monkey	ÄFFCHEN	7	spider	SPINNE	6
expert	EXPERTE	7	racist	RASSIST	7	bunny	HÄSCHEN	7	crane fly	SCHNAKE	7
friend	FREUNDIN	8	bitch	SCHLAMPE	8	swallow	SCHWALBE	8	mosquito	MOSKITO	7
optimist	OPTIMIST	8	betrayer	VERRÄTER	8	kitten	KÄTZCHEN	8	snake	SCHLANGE	8
sportsman	SPORTLER	8	fraudster	BETRÜGER	8	giant panda	PANDABÄR	8	hornet	HORNISSE	8
tourist	URLAUBER	8	coward	FEIGLING	8	flamingo	FLAMINGO	8	scorpion	SKORPION	8
Mean		6.3			6.3			6.4			6.1
Standard Deviation		1.4			1.4			1.4			1.2

Curriculum Vitae

Persönliche Informationen

Melanie Schmitz

Geburtsdatum: 08. Dezember 1983

Nationalität: Deutsch

Schul- und Hochschulausbildung

Oktober 2008

Diplom in Psychologie, Johannes Gutenberg Universität Mainz

2003-2008

Studium der Psychologie, Johannes Gutenberg Universität Mainz

2003

Allgemeine Hochschulreife, Gymnasium am Stefansberg Merzig

Berufliche Erfahrungen

seit Oktober 2011

Wissenschaftliche Mitarbeiterin in der Abteilung Allgemeine Psychologie und Methodenlehre des Instituts für Psychologie, Universität des Saarlandes

Oktober 2008 – Oktober 2011

Promotionsstipendiatin im internationalen Graduiertenkolleg *Adaptive Minds* (IRTG 1457) am Institut für Psychologie, Universität des Saarlandes

April 2007 – Januar 2008

Wissenschaftliche Hilfskraft am Institut für Sozialforschung und Sozialwirtschaft e.V. Saarbrücken

Juni 2006 – August 2007

Wissenschaftliche Hilfskraft in der Abteilung Allgemeine Experimentelle Psychologie des Psychologischen Instituts der Johannes Gutenberg Universität Mainz