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Contrast Effects in Spontaneous Evaluations: A Psychophysical Account

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In the affective-priming paradigm, target stimuli are preceded by evaluatively polarized prime stimuli and then are to be classified as either good or bad as fast as possible. The typical and robust finding is assimilation: Primes facilitate the processing of evaluatively consistent targets relative to evaluatively inconsistent targets. Nevertheless, contrast effects have repeatedly been observed. The authors propose a new psychophysical account of normal (assimilative) and reversed (contrastive) priming effects and test new predictions derived from it in 5 studies: In Studies 1 and 2, the authors' account is shown to provide a better explanation of contrastive effects in a priming paradigm with two primes than the traditional attentional account does. Furthermore, as predicted by the new account, contrast effects emerge at an intermediate stimulus-onset asynchrony (SOA, Study 3) and even with short SOAs when target onset takes participants by surprise (Study 4). Finally, the use of extremely valenced primes triggers corrective efforts (Study 5) as predicted. Implications for priming measures of evaluative associations are discussed.

Keywords: affective priming, attitudes, assimilation, contrast, implicit attitudes

Spontaneous evaluations play an important role in determining human behavior. It is rare that an object or event is completely neutral rather than endowed with a certain valence (Osgood, Suci, & Tannenbaum, 1957, chap. 3); even unfamiliar objects can be quickly and consistently evaluated (Duckworth, Bargh, Garcia, & Chaiken, 2002). Objects that are spontaneously liked tend to be approached, whereas disliked objects are avoided or rejected (Chen & Bargh, 1999). Spontaneous evaluations color other judgments (Cooper, 1981; Murphy & Zajonc, 1993) and influence social interactions (Curtis & Miller, 1986), consumer choices, and many other aspects of everyday life (Fazio & Towles-Schwen, 1999). Emotion theories often consider spontaneous evaluations a core element of emotions (e.g., Ortony, Clore, & Collins, 1988; Scherer, 1988). For these and other reasons, social psychologists have long been interested in studying spontaneous evaluations (Bargh, 1997). In particular, the evaluative-conditioning paradigm (e.g., De Houwer, Baeyens, & Field, 2005) exemplifies how attitudes can be acquired through the transfer of spontaneous evaluations of unconditioned stimuli to previously neutral stimuli; the evaluative-priming paradigm (Fazio, Sanbonmatsu, Powell, & Kardes, 1986) exemplifies how spontaneous evaluations bias the evaluation of subsequently encountered stimuli, events, and behavioral choices.

In Fazio et al.'s (1986) evaluative-priming paradigm, participants classified target words as either good or bad as fast as possible, a task that we refer to as the evaluative-decision task in the following. Targets were preceded by evaluatively polarized prime words. Evaluative decisions on targets were faster and more accurate when target words (e.g., *peace*) were preceded by primes of the same valence (e.g., *sun*) rather than by primes of the opposite valence (e.g., *cancer*). This evaluative-priming effect has since been replicated many times using different materials and many procedural variations (see Fazio & Olson, 2003; Klauer & Musch, 2003, for overviews). Evaluative priming has been studied as a prime example of automaticity of social cognitive processes. Furthermore, it has been useful as a tool to measure attitudes and prejudices unobtrusively and to predict behavior (e.g., Spruyt, Hermans, De Houwer, Vanderkerckhove, & Eelen, 2007; Wittenbrink, 2007).

Although the typical and robust finding is assimilation (i.e., target processing is facilitated by evaluatively consistent primes relative to evaluatively inconsistent primes), a number of contrast effects have been reported over the years. These comprise reversed priming effects as well as contrastive effects of evaluative contexts on normal priming effects.

Contrast effects are of immediate relevance for priming measures of implicit attitudes and prejudices; priming measures are compromised where contrastive effects unexpectedly underlie observed priming effects. Understanding the scope and nature of conditions that lead to contrast instead of assimilation is therefore fundamentally important for the interpretation of priming measures. Perhaps the most satisfactory way to characterize these conditions is by means of a theory that accounts both for contrast and assimilation.

Contrast effects are also theoretically provocative because they pose problems for theoretical accounts of evaluative priming. For example, in one view activation spreads from valenced primes to concepts related in valence, causing priming effects in spontaneous evaluations. Spread of activation can explain only assimilation, not contrast.

Finally, contrast effects in evaluative priming have been important pieces of evidence in current debates in social psychology. For instance, Rothermund (2003) interpreted contrastive effects of

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success and failure feedback on target evaluations as evidence for the influence of motivational states on attentional processes subserving self-regulation and promoting evolutionary adaptiveness (Derryberry, 1993). Eder (2006; Eder & Klauer, 2007) interpreted contrastive effects of positively and negatively connoted actions on target evaluations as evidence in the debate about whether or not positive and negative stimulus evaluations are bidirectionally linked with broad behavioral and motivational structures of approach and avoidance, respectively (e.g., Chen & Bargh, 1999; Neumann, Förster, & Strack, 2003). Klauer, Mierke, and Musch (2003) interpreted a contrastive effect pattern in masked evaluative priming as subtle evidence for the bidimensionality and against the unidimensionality of attitudes (Cacioppo & Berntson, 1994). As will be seen, the present account bears on these different lines of social psychological research in that it proposes an alternative and more general interpretation of these and related contrast effects.

In the following, we briefly review the contrast effects reported in the literature as well as theoretical ideas that have been forwarded to account for subsets of them. A new psychophysical account of normal and reversed priming effects is then developed and empirically assessed in five studies.

A List of Contrast Effects

The contrast effects reviewed next tend to be small compared to assimilative priming effects. Moreover, the evidence for some of the effects is based on only one or two experiments, awaiting replication. Others turned out to be not as consistently replicable as one might hope for. Still others present unresolved puzzles. Yet, taken together, the diverse findings suggest that contrast effects do occur under certain circumstances.

Long Stimulus-Onset Asynchrony (SOA)

When the SOA between prime and target is long, reversed priming effects are sometimes observed. For instance, Klauer, Roßnagel, and Musch (1997; Experiment 2) found a reversed priming effect at an SOA of 1,200 ms in one of three conditions. Similarly, Spruyt, Hermans, De Houwer, Vandromme, and Eelen (2007) reported a reversed priming effect at an SOA of 1,000 ms in one of six conditions (see also Murphy & Zajonc, 1993). The most frequent finding, however, has been that priming effects are absent at long SOAs (Klauer & Musch, 2003). In addition, participants' strategies are likely to play a role at long SOAs (see also Neely, 1977).

Two Primes

Gawronski, Deutsch, and Seidel (2005; Gawronski & Deutsch, 2006) presented three evaluatively polarized words in close succession. The first two words were primes, presented for 133 ms each; the third word was the target word for which a speeded evaluative decision was required. The first prime interacted with the (normal) priming effect of the second prime, so that a larger priming effect was observed when first and second prime were evaluatively inconsistent than when both were consistent. An equivalent way to couch the effect is to say that the first prime engendered a reversed priming effect additive to the second prime's normal priming effect. The effect has been replicated by Fockenberg, Koole, and Semin (in press).

Action Valence Blindness

Eder (2006; Eder & Klauer, 2007) had participants plan actions with an evaluative connotation, such as approach and avoidance movements or the pressing of a key labeled *positive* or *negative*. Once participants signaled their readiness to execute the action and then executed the action, an evaluatively polarized target word was briefly shown. Participants were to decide whether the target was positive or negative. In a series of experiments, target identification was consistently impaired when action valence and target valence matched rather than mismatched.

Contrast Effects of Success and Failure Feedback

In a series of experiments by Rothermund (2003), target words were to be evaluated as positive or negative as fast as possible, followed by an immediate success or failure feedback, depending upon the speed of response. Processing of the subsequent target word was facilitated when feedback and target were evaluatively inconsistent (e.g., a success feedback followed by a negative target) relative to when both were consistent; however, that effect was present only when target valence had shifted from the previous trial to the current trial.

Negative Priming

Wentura (1999a) adapted the so-called negative-priming paradigm (e.g., Milliken, Joordens, Merikle, & Seiffert, 1998) to evaluative priming in two studies. Across pairs of trials, he found a contrast effect of prime valence in the first trial on target evaluation in the second trial, in which the prime was always neutral. The effect was, however, restricted to trial pairs with differently valenced targets.

Positivity Proportion Effect

Klauer et al. (2003) manipulated the proportion of positive relative to negative target words in masked evaluative priming. In a series of experiments, they found that primes of the less frequent valence produced larger priming effects than primes of the more frequent valence did, suggesting that the less frequent valence was accentuated via contrast with the more frequent valence. For example, in the context of many positive targets, negative primes were more powerful as primes than they were in a context with many negative targets.

Emphasis on Accuracy

Wentura (1999b), cited from Wentura and Rothermund (2003), manipulated the emphasis put on speed versus accuracy in the evaluative-priming paradigm. He found that a focus on accuracy reduced and in part reversed the normal priming effect observed under speed instructions. Glaser (2003) similarly found priming effects for strong primes reduced, although not reversed, when accuracy was emphasized.

Consistency Proportion Effect

As the proportion of evaluatively inconsistent prime–target pairs that are presented is increased, priming effects in the evaluative-decision task decrease (Klauer et al., 1997; Spruyt, Hermans, De Houwer, Vandromme, & Eelen, 2007). Klauer and Teige-Mocigemba (2007, Experiment 1) explicitly alerted participants to the fact that they would see a high proportion of inconsistent pairs. Participants were motivated to use this fact to optimize their performance. Priming effects were found to be eliminated and in part reversed despite the use of a short SOA (275 ms).

Extreme Primes, Anxiety, and the Pronunciation Task

In a series of experiments, Glaser and Banaji (1999) used the pronunciation task, in which target words have to be pronounced as fast as possible, and found reversed evaluative-priming effects for extremely valenced primes. Maier, Berner, and Pekrun (2003) and Berner and Maier (2004) similarly reported reversed priming effects in the pronunciation task for extreme primes in subgroups of participants selected for high anxiety. Maier et al. (Experiment 2), however, observed a reversed priming effect only for moderately valenced primes in a subgroup of moderately anxious participants.

Masked Priming

Banse (2001), using pictures of liked and disliked others as primes, found reversed priming effects when primes were masked and normal priming effects when primes were visible. Priming effects in masked priming were reversed, however, for only the negative primes but pointed in the normal direction for positive primes. Hermans, Spruyt, De Houwer, and Eelen (2003), using pictures as primes, also reported reversed priming effects in the second of two blocks of priming trials in masked priming (see also Wentura, 1999b).

High Frequency Targets

Chan, Ybarra, and Schwarz (2006) compared priming effects for targets with low and high frequency of occurrence in a single study. Whereas a normal priming effect emerged for low frequency targets, a reversed effect was observed for high frequency targets.

Theoretical Ideas

Given the diversity of the paradigms in which contrast effects were found, it seems likely that a number of different mechanisms are at work that cause contrast effects. Let us briefly review the mechanisms that have been proposed in the literature to account for different subsets of the above contrast phenomena.

Glaser (2003) argued that extreme primes trigger a nonconscious attempt to correct for the prime influence that overcompensates, causing reversed priming effects for extreme primes. Although spread of activation is usually seen as causing facilitation, Berner and Maier (2004) suggested that activation turns into inhibition once a certain level of activation is exceeded, as might be the case for extreme primes and highly anxious participants in their view. Hermans et al. (2003), on the other hand, argued that activation might turn into inhibition for the weakest primes. They suggested that reversed effects in masked priming might reflect the operation of a center-surround mechanism, as proposed by Dagenbach and Carr (1994). In this view, weakly activated concepts (such as concepts represented by masked primes) inhibit the activation of related concepts, leading to reversed effects.

Wentura and Rothermund (2003) suggested a temporal-discrimination account that draws on Milliken et al.'s (1998) account of negative priming by temporal discrimination and on Houghton and Tipper's (1999) model of selective attention. Roughly, when accuracy is emphasized over speed or when target identity must be determined, as in the pronunciation task, participants discriminate between information stemming from the prime and target-derived information to make sure that they accurately respond on the basis of the target rather than the prime. Discriminating between prime and target is more difficult when both match rather than mismatch in valence, causing reversed priming. In contrast, when speed is emphasized over accuracy, participants respond on the basis of activated valence irrespective of source, causing normal, assimilative priming.

Gawronski et al. (2005), Klauer et al. (2003), and Rothermund (2003) have suggested attentional mechanisms that differ in detail but roughly concur that a frequently or recently activated valence increases the salience of the opposite valence when it is encountered subsequently. Fockenberg et al. (in press) argued that temporally close primes and targets are absorbed into an initial perceptual compound, termed the *perceptual snapshot*, causing assimilative priming. If the combined evidence in the snapshot is ambiguous, as when prime and target are evaluatively inconsistent, contrastive processing of stimuli outside the perceptual snapshot occurs. In this perceptual-snapshot account, contrastive processing of a stimulus means correcting for its influence, and it can lead to reversed priming, especially for primes preceding the target by longer amounts of time. "This is because participants had more time to correct for distal forward primes, and the prime activation might have already sufficiently faded to allow for overcorrection" (Fockenberg et al., in press).

A Psychophysical Account

The purpose of the present article is to propose a new integrative account of contrast effects and normal priming effects in many of the domains just reviewed. The account is inspired by Hochhaus and Johnston's (1996) psychophysical account of so-called repetition blindness, also used by Eder (2006) to account for action valence blindness.

Assume that there are separate nodes or counters for positive and negative valence (Cacioppo & Berntson, 1994) that accumulate activation from positive and negative stimulus events, respectively. The system thereby keeps an ongoing tally of the amount of activation of the features *positive* and *negative*, as activated by encountered positive and negative stimuli, thoughts, actions, and so forth. It is reasonable to assume that the activation decays over time so that without additional activation, both counters slowly drift back toward a neutral state of zero activation. The decision maker has access to the current counter states as well as to the recent history of how the counter states have changed over the last hundreds of milliseconds or so.

In evaluating a target, one strategy is to focus on the target and to monitor how the valence counters react. Once an asymptote has been reached, the counter values can be read off to determine direction and strength of the target evaluation. In speeded evaluative decisions, there is, however, frequently not enough time to wait until an asymptotic state has materialized; at the same time, it is risky and error-prone to respond on the basis of early counter states. The initial and early states of the counters largely reflect the recency and frequency of which events of the respective valence were encountered prior to target onset. Assume instead that a decision is based on detecting increases in the two counters over a short temporal interval. This is a reasonable strategy because (a) increases are independent of the initial state of the counter and (b) an evaluatively polarized target will correctly lead to a high rate of increase in the counter of the appropriate valence and to little increase or, if both counters are negatively correlated, to a decrease in the counter of the opposite valence. Two assumptions are needed to explain normal and reversed priming effects through this mechanism.

> Assumption 1: We assume that it is difficult to synchronize the interval over which increases are detected with other mental representations, such as how the stream of events impinging on the system is segmented into stimuli of different identities. After initial target detection and some target processing, decision makers access some of the available recent history of the counter states recorded for an evaluation window that most often begins some time before target onset and always extends to some time afterwards.

This synchronization problem is akin to the well-known binding problem discussed in cognitive psychology (e.g., Treisman, 1996); that is, the problem of binding activated features together for a representation of a specific object. The difficulty arises because the valence counters per se do not contain a record of the sources that feed activation into them. According to Assumption 1, the evaluation window therefore regularly extends to some time before target onset. This implies that some of the rate of increase in the evaluation window is due to extraneous sources of valence activation, such as primes preceding the target with a short SOA, primes that still drive the counter states when the target is encountered. Assumption 1 thereby explains normal priming effects. Assumption 2 is psychophysical in nature.

> Assumption 2: Detecting an increase in one of the counters becomes more difficult as the initial level of that counter increases. Thus, as in the famous Weber-Fechner law (Fechner, 1860), detecting an increase of one unit is easier departing from a zero state of activation than detecting an increase of the same size departing from a counter state of one unit. This means that detecting increases becomes more difficult, slower, and less accurate in proportion to the initial activation of the counter.

Assumption 2 thereby predicts a contrast effect relative to the state of the counter at the beginning of the evaluation window. For example, detecting an increase in the counter for positive valence is impaired if the counter state is already high at the beginning of the evaluation window.

These ideas are illustrated in Figure 1. Activations of the counter for positive valence are shown for a trial with positive context and a trial with neutral context, given a positive target. The context (e.g., a prime word) sets on at t_0, followed by the target at t_1. We believe that the temporal positioning of window onset is to some extent malleable, as explained later. Two evaluation windows are shown in Figure 1, an inclusive window, which includes prime-derived activation and begins at t_0, and an exclusive window, which excludes prime-derived activation and begins at t_1; both end at t_2. One way to formalize the psychophysical Assumption 2 is to say that participants base their decision on the increase ΔA in the evaluation window relative to the initial counter state A, that is, on the Weber fraction $\Delta A/A$. As can be seen in the figure, this leads to an assimilative context effect for the inclusive window and to contrast effects for the exclusive window.[1]

In a sense, the present model is thereby analogous to the inclusion–exclusion model (Schwarz & Bless, 2007) of assimilation and contrast in social judgments. Assimilation (i.e., normal priming) should occur when primes are included in the evaluation window; contrast (i.e., reversed priming) should occur for stimuli that have contributed to the initial counter states but no longer drive changes in the counter states within the evaluation window itself. That is, contrast is engendered by stimuli that occurred recently but are effectively excluded from the evaluation window.

The temporal positioning of the evaluation window thereby determines whether assimilation or contrast will be observed. Assumptions 3 and 4 outline conditions that govern window onset.

> Assumption 3: When the stream of events is clearly and repetitively segmented (e.g., by presenting a clearly patterned sequence of stimuli in each trial), the last stimulus before the target will come to be used as a kind of "go" signal for an early and preparatory start in setting up the evaluation window.

For a typical sequential priming paradigm, Assumption 3 states that participants capitalize on the repetitive sequence of prime and target. For primes preceding targets with a short SOA, this results in evaluation windows with onsets that are locked to the prime and that therefore include much of the prime information, leading to normal priming effects. It is reasonable to assume, however, that close coupling of window onset and prime onset is confined to short SOAs. As SOA increases, there will come a point at which this synchronization breaks down and beyond which the distance between prime onset and window onset gradually increases. In particular, at long SOAs, window onset will occur much later than will prime onset, at a point in time at which most of the prime-derived activation is likely to have decayed.

Assumption 3 is consistent with, and in part motivated by, studies that have manipulated SOA (Fockenberg, Koole, & Semin, 2006; Hermans, De Houwer, & Eelen, 2001; Klauer et al., 1997; Spruyt, Hermans, De Houwer, Vandromme, & Eelen, 2007). According to these studies, evaluative priming is observed most reliably at short SOAs below 300 ms, whereas priming effects are typically absent or occasionally reversed at long SOAs, in line with

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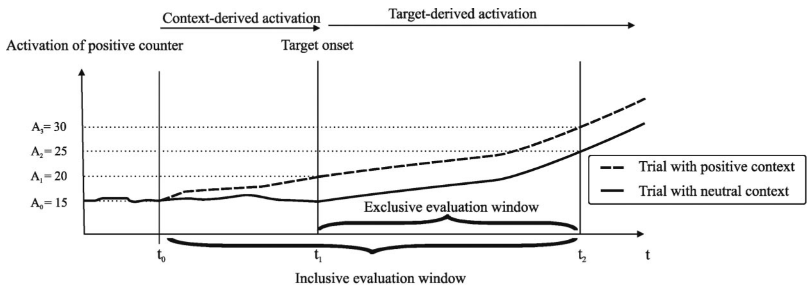
[1] The psychophysical account describes effects of the prime on central processes of semantic categorization of targets as good or bad that precede response selection. One way to model the categorization formally is to assume that each valence counter drives a noisy diffusion process (Ratcliff, 1978), with mean drift rate proportional to $\Delta A/A$, and that an evaluative decision is made as soon as an upper threshold is exceeded. For the unambiguously valenced targets used in evaluative priming, this leads to faster and more accurate categorizations the larger the quantity $\Delta A/A$ is for the appropriate counter. Categorization is followed by response selection, which is often conceived as a separate processing stage. Response selection is not only a function of the relevant categorization but can also be biased by interfering response tendencies stemming from irrelevant sources. Performance differences in categorizing as a function of $\Delta A/A$ are thus only one factor affecting the resulting response latencies and accuracy. Note that it is not necessary to commit to strong assumptions regarding the sequential versus overlapping, cascading nature of categorization and response selection to derive the predictions that are considered in this article.



	Positive context	Neutral context	Context effect
Inclusive evaluation window (from t_0 to t_2):	$\frac{\Delta A}{A_0} = \frac{30-15}{15} = 1.00$	$\frac{\Delta A}{A_0} = \frac{25-15}{15} = 0.67$	0.33 (Assimilation)
Exclusive evaluation window (from t_1 to t_2):	$\frac{\Delta A}{A_1} = \frac{30-20}{20} = 0.50$	$\frac{\Delta A}{A_0} = \frac{25-15}{15} = 0.67$	-0.17 (Contrast)

Figure 1. Activation of the counter for positive valence given a positive target for a trial with positive context and a trial with neutral context. The context (e.g., a prime word) sets on at t_0, followed by the target at t_1. Two evaluation windows are shown: An inclusive window begins at t_0 and an exclusive window at t_1. The trajectory of activation for the trial with positive context is represented by the broken line, the trajectory for the trial with neutral context by the continuous line. Participants base their decision on the increase ΔA in activation that accrues during the evaluation window relative to the initial counter state A.

Assumption 3. Moreover, Assumption 3 accounts for the hitherto unexplained finding that there is an effect of SOA on overall response latency: The longer the SOA, the shorter the mean response latency, suggesting that primes indeed trigger some amount of preparatory target-relevant processing, such as setting up an evaluation window even before target onset. The role of SOA will be discussed in more detail in Study 3.

Another implication of Assumption 3 is that an additional stimulus presented shortly before the prime should likely fall outside the evaluation window, giving rise to contrast. For example, in Gawronski et al.'s (2005) paradigm, two primes and a target were shown one after the other, in close succession. Assumptions 1 and 3 imply that the evaluation window for the target will include much of the valence activation generated by the second prime, leading to a normal priming effect for that prime. According to Assumption 3, however, the evaluation window is likely to exclude the first prime. If so, the first prime's valence exerts an influence only indirectly via the initial state of the counters at the beginning of the evaluation window. Assumption 2 thereby implies a reversed priming effect for the first prime in that paradigm. In fact, the contrast effect reported by Gawronski et al. can be recoded as a reversed priming effect of the first prime as elaborated below.

According to Assumption 3, the evaluation window can become locked to primes preceding targets by a short SOA. It may be that this reflects an unintentional tuning to rapid and repetitive sequences of events, but we assume that decision makers also have some amount of strategic control over the evaluation window's temporal parameters as postulated in Assumption 4.

> Assumption 4: When participants are alerted to a possibly distorting prime influence (e.g., when primes are extreme, perceived as misleading, or when the instructions put an emphasis on accuracy), participants make an effort to adopt a more exclusive evaluation window.

Scope of the Psychophysical Account

We have presented the psychophysical account in terms of evaluative categorization, but it applies to any situation in which stimuli have to be categorized into a pair of categories, making it relevant for many different social psychological and cognitive lines of research. For example, automatic processes in gender stereotyping have frequently been studied through the use of the so-called gender-priming paradigm (e.g., Banaji & Hardin, 1996; Blair & Banaji, 1996). In that paradigm, target words, such as first names or gender-related pronouns (e.g., she), have to be quickly classified as male or female. They are preceded by prime words related to gender. We believe that the psychophysical account also holds for gender priming, suggesting in particular that contrast effects like those observed in evaluative priming can also be produced in gender priming (Fockenberg et al., in press; Versace & Allain, 2001).

More generally, both evaluative priming and gender priming are instances of category priming, in which the categorization of target words with respect to a pair of categories is typically facilitated by primes that are members of, or related to, the same category as the target and impaired by primes that are members of, or related to, the other category. Many lines of social psychological research rely heavily on category priming, with the tacit assumption that category-priming effects must be assimilative and cannot be contrastive. The following are just a few examples of these lines of research: research on the weapon-identification task (e.g., Payne, 2001) and related research on the so-called shooter bias (e.g., Correll, Park, Judd, & Wittenbrink, 2002), research on automatic evaluation (e.g., Bargh & Chartrand, 2000), and many studies on automatic stereotyping and prejudice (e.g., Fazio & Olson, 2003).

It is beyond the scope of the present article to spell out the empirical and theoretical implications of the psychophysical account for these and other relevant social psychological and cognitive literatures; instead, the focus of the present article is on evaluative priming. Nevertheless, in Study 2, we found it useful for theoretical reasons to employ a nonevaluative categorization task in testing the psychophysical account.

Finally, the psychophysical account can be extended to tasks in which object identity must be determined (e.g., to the pronunciation task and related naming tasks; Glaser & Banaji, 1999) rather than only category membership. We briefly discuss such extensions in the General Discussion.

Outlook

Studies 1 and 2 aim at discriminating between the psychophysical account and the attentional account that was described above. Like the psychophysical account, the attentional account explains several of the above contrast phenomena, in particular the effects of success and failure feedback (Rothermund, 2003), the positivity proportion effect (Klauer et al., 2003), and the effects seen in Gawronski et al.'s (2005) paradigm with two primes.

Both accounts, the attentional account and the psychophysical account, make similar predictions for the contrast phenomena for which they compete. Nevertheless, a clear empirical discrimination between the two accounts is possible in Gawronski et al.'s (2005) paradigm with two primes. Studies 1 and 2 test opposing predictions of the two accounts in that paradigm. This also gives us an opportunity to test predictions made by Fockenberg et al.'s (in press) perceptual-snapshot account.

In Studies 3 to 5, we put Assumptions 3 and 4 of the psychophysical account to more targeted tests. These studies also bear on the interpretation of priming measures of attitudes and prejudice. Furthermore, Study 3 tests opposing predictions of the psychophysical account and the temporal-discrimination account (Wentura & Rothermund, 2003); Study 4 tests opposing predictions of the psychophysical account and the perceptual-snapshot account (Fockenberg et al., in press). Both the temporal-discrimination account and the perceptual-snapshot account compete with the psychophysical account in being able to explain assimilative priming effects along with more than one of the above-listed reversed priming effects.

Study 1: Discriminating Between the Attentional and Psychophysical Accounts

The attentional account and the psychophysical account make opposing predictions for the case of a neutral second prime in the paradigm with two primes. According to Gawronski et al. (2005), perceiving a valenced stimulus leads to an attentional bias, enhancing the salience of the opposite valence when it is subsequently encountered. The salience of Prime 2 valence is therefore enhanced when Prime 2 is preceded by an evaluatively inconsistent rather than consistent Prime 1. This leads to a larger Prime 2 priming effect given a mismatching Prime 1 rather than a matching Prime 1. This contrast effect can also be construed as a reversed priming effect engendered by Prime 1 on target processing.[2]

According to this attentional account, the first prime does not in itself exert an attentional effect on target processing; rather, its effect is mediated by a modulation of the salience of the second prime's valence. Thus, when the second prime is neutral and does not have a valence in the first place, a contrast effect should not emerge. This leads to two predictions:

> Prediction 1: Prime 1 should engender a normal assimilative priming effect on target processing in trials with a neutral Prime 2. Because a neutral Prime 2 still acts as a backward mask for Prime 1, the priming effect might however be small, given that masking primes reduces the effect (e.g., Klauer, Musch, & Eder, 2005).
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> Prediction 2: Prime 1 priming effects should therefore differ significantly between trials with neutral Prime 2 (assimilative priming effect) and trials with valenced Prime 2 (reversed priming effect).

In contrast, according to the psychophysical account, the first prime directly exerts a reversed priming effect on target categorization that is not mediated by, and hence is independent of, second prime valence. This leads to the following two predictions:

> Prediction 1′: There should be a significant reversed Prime 1 priming effect on target processing in trials with neutral Prime 2.
>
> Prediction 2′: Prime 1 priming effects should not differ for trials with neutral Prime 2 and trials with valenced Prime 2.

In their Experiment 2, Gawronski et al. (2005) included trials with neutral second (and first) prime, but results were inconclusive. There was no significant Prime 1 priming effect in trials with neutral second primes; that is neither Prediction 1 nor Prediction 1′ can be confirmed. Predictions 2 and 2′ were not tested, perhaps because the a priori unlikely possibility of a reversed Prime 1 priming effect in trials with neutral Prime 2 was not foreseen. Thus, we do not know whether Prime 1 priming effects differ in trials with neutral Prime 2 and in trials with valenced Prime 2, as predicted by the attentional account.

The present study employed a statistically more powerful design to permit informative tests of these crucial predictions. Departing from Gawronski et al. (2005), we used neutral words matched in length and frequency to the valenced primes, whereas Gawronski et al. used the letter string "XXXXXX" as their neutral prime. There is considerable debate about what constitutes an appropriate neutral baseline in priming studies, but we felt that the use of the XXXXXX string might disrupt the flow of processing that occurs when only words are used, as in trials with valenced rather than neutral primes. Perhaps more importantly, XXXXXX and valenced words differ on many dimensions other than valence (e.g., meaningfulness, familiarity, number of repetitions across trials, effectiveness as backward mask) that can be better controlled for when neutral words are used.

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[2] Note that the interaction of (a) Prime 1–Prime 2 consistency and (b) Prime 2–target consistency (i.e., with the Prime 2 priming effect) is logically the same effect as the main effect of Prime 1–target consistency (i.e., as the Prime 1 priming effect).

Method

Participants. Participants were 106 University of Freiburg students with different majors; mean age was 24 years, ranging from 18 to 44 years. They received a monetary gratification of €3.50 (approximately $5.00) for participating. Five of them were extreme outliers according to Tukey's criterion (i.e., above the third quartile plus three times the interquartile distance; Clark-Carter, 2004, chap. 9) in regard to mean response latencies ($M = 618$ ms, $SD = 126$ ms) and/or error rates ($M = 3.5\%$, $SD = 4.3\%$), as they had mean response latencies above 1,098 ms and/or mean error rates above 16%. These participants were excluded from the analyses.

Materials. The positive and negative words were the same as those used by Gawronski et al. (2005; Experiment 2).[3] In particular, targets were sampled from 12 positive and 12 negative adjectives, whereas valenced primes were sampled from two sets of 12 positive nouns and two sets of 12 negative nouns (see Appendix), matched for valence and word length. Each set was assigned to one of the two prime positions (first versus second), and (positive or negative) primes for that position were sampled from it exclusively. The assignment of sets to prime positions was counterbalanced across participants.

We selected 12 neutral words (e.g., *format*) that were matched to the valenced primes in word length ($M = 5.75$ and $M = 5.75$ letters for valenced and neutral primes, respectively) and log frequency ($M = 1.28$ and $M = 1.28$ for valenced and neutral primes, respectively; Celex, 1995; see Appendix). Valence norms for the words were available from German word norms (Hager & Hasselhorn, 1994). On a scale from -5 to 5, the neutral primes never deviated from the neutral 0 point by more than 0.23 points ($M = 0.13$, $SD = 0.07$) in either the negative or the positive direction, whereas the valenced primes always deviated by more than 1.37 points ($M = 2.71$, $SD = 0.77$). Not surprisingly, the difference between neutral and valenced primes in evaluative polarization was significant, $t(58) = 22.91$, $p < .01$. Mean valence ratings were -2.81 ($SD = 0.74$), 0.07 ($SD = 0.13$), and 2.61 ($SD = 0.80$) for negative, neutral, and positive words, respectively.

Procedure. The procedures closely followed Gawronski et al.'s (2005) Experiment 2. There were 384 experimental priming trials, presented in four blocks of 96 trials each. Prime 1 valence (negative vs. positive), Prime 2 valence (negative, neutral, positive), and target valence (negative vs. positive) were crossed orthogonally defining 12 possible valence combinations. In each block, each of the 12 combinations was represented eight times, with primes and targets sampled randomly from the above-described stimulus sets.

These experimental priming trials were preceded by a practice block of 24 trials, in which each of the 12 valence combinations occurred twice. The practice block was otherwise constructed as the experimental blocks were.

Each trial began with the presentation of a blank screen for 700 ms, followed by a fixation cross for 700 ms. The fixation cross was then replaced by the first prime for 130 ms, followed by the second prime for 130 ms. After a blank screen was shown for 40 ms, the target word was presented. Participants' task was to categorize the target as positive or negative as quickly as possible by pressing one of two response keys. As in the other studies reported in this article, participants used the interior keys of two computer mice positioned to the left and right of them to respond (Voss, Leonhart, & Stahl, 2007).

Results and Discussion

The analyses are based on correct response latencies; mean response latency was 607 ms, and mean error rate was 2.8%. All analyses were conducted twice for this and the subsequent study (Study 2) in the paradigm with two primes: once with a predetermined cutoff value of 1,000 ms (as adopted by Gawronski et al., 2005) and once with response latencies excluded that were outliers in the individual's latency distribution according to Tukey's criterion (i.e., latencies that were below the first quartile minus 1.5 times the interquartile range or above the third quartile plus 1.5 times the interquartile range; Clark-Carter, 2004, chap. 9). The two analyses revealed the same pattern of significant and nonsignificant results both in Study 1 and in Study 2. For consistency with other recent articles from our group, we present the analyses based on the Tukey criterion in this and all subsequent studies. In Study 1, the criterion led to the exclusion of 5.4% of the trials.

Consider first trials without neutral words. Response latencies from these trials were submitted to a 2 (Prime 1 valence) × 2 (Prime 2 valence) × 2 (target valence) analysis of variance with repeated measures. A significant interaction of Prime 2 valence and target valence, $F(1, 100) = 16.52$, $p < .01$, $\eta_p^2 = .14$, revealed a significant Prime 2 priming effect of 8.13 ms ($SD = 20.09$ ms). A significant interaction of Prime 1 valence and target valence, $F(1, 100) = 7.31$, $p < .01$, $\eta_p^2 = .07$, revealed a small but significant reversed Prime 1 priming effect of -3.56 ms ($SD = 13.52$ ms).[4] Less importantly, negative target words were responded to more slowly than positive target words were ($M_{\text{negative}} = 590$ ms, $M_{\text{positive}} = 572$ ms), $F(1, 100) = 49.97$, $p < .01$, $\eta_p^2 = .33$, and there was a tendency for slower responses following negative second primes relative to positive second primes ($M_{\text{negative}} = 582$ ms, $M_{\text{positive}} = 579$ ms), $F(1, 100) = 3.87$, $p = .052$, $\eta_p^2 = .04$ (all other Fs < 1).

Regarding Predictions 1 and 1′, in trials with neutral Prime 2, the Prime 1 priming effect was reversed; that is, a contrast effect resulted ($M = -5.01$ ms, $SD = 21.81$ ms) and it was significantly different from 0, $t(100) = -2.31$, $p = .02$. Regarding Predictions 2 and 2′, the Prime 1 priming effect did not differ significantly between trials with neutral second primes and trials with valenced second primes, $t(100) = -0.55$, $p = .59$.

Results were clear-cut. Predictions 1 and 2 of the attentional account had to be rejected, whereas Predictions 1′ and 2′ of the

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[3] In a pilot study ($N = 54$) using the same procedures and materials but no neutral words, we replicated Gawronski et al.'s (2005) basic contrast effect.

[4] Numerically, the Prime 1 effect of -3.56 ms corresponds to an effect of twice that size in the coding scheme preferred by Gawronski et al. (2005), that is, when it is expressed as the difference in Prime 2 priming effects between trials with inconsistent Prime 1 and trials with consistent Prime 1.

psychophysical account could be upheld. Thus, Prime 1 engendered a contrast effect on target processing independent of, and additive to, the effects of Prime 2 on target processing.

According to Fockenberg et al.'s (in press) account, in terms of a perceptual snapshot, Prime 2 and target are included in the assimilative snapshot, consistent with the normal priming effect exerted by Prime 2. When Prime 2 and target are evaluatively inconsistent, but not when they are consistent, Prime 1 is assumed to be processed contrastively, causing a contrast effect of Prime 1 on target evaluation. In this account, the Prime 1 priming effect is moderated by consistency of Prime 2 and target. However, in an analysis of the trials with nonneutral Prime 2, the interaction between consistency of Prime 2 and target on the one hand and consistency of Prime 1 and target on the other hand did not approach significance ($F < 1$), indicating that Prime 2–target consistency did not moderate the Prime 1 priming effect.

One problem with neutral primes is that evaluations are attached to almost any stimulus, including meaningless stimuli, relatively readily and reliably (e.g., Arnold, 1960; Lazarus, 1966; Martin & Levey, 1978). For example, Gawronski et al.'s (2005) XXXXXX prime may have been slightly unpleasant for many participants, whereas some of the neutral words used in the present study may have been slightly positive or negative for many participants. To the extent to which neutral primes are not really neutral, the logic of experiments with ostensibly neutral primes is of course put into question. The neutral words used here were selected to bear as little valence as possible, so it is perhaps implausible that the results can be questioned on these grounds. Nevertheless, the goal of Study 2 was to implement a situation in which neutral primes were even more strictly neutral.

Study 2: Extension and Conceptual Replication

In Study 2, the same procedures as in Study 1 were employed, but we used a nonevaluative task and different materials. Participants saw names of plants (e.g., *rose*) and animals (e.g., *camel*) as targets, and their task was to categorize targets as plant or animal as quickly as possible. Evaluative priming of evaluative decisions is an instance of category priming, and as elaborated at the beginning of this article, the psychophysical account is general enough to encompass any kind of category priming. In fact, Gawronski and Deutsch (2006, Experiment 3) expected and found a contrast effect in the paradigm with two primes when they presented names of animate objects instead of positive words and names of inanimate objects instead of negative words and asked participants to decide as quickly as possible whether the target referred to an animate or an inanimate object. They explained the contrast effect by means of the attentional account applied to the salience of the animacy categories. Similarly, Fockenberg et al. (in press) reported contrast effects in a paradigm with multiple primes and a nonevaluative task (i.e., the gender decision task). Following the lead of these authors, moving to a similar nonevaluative task (i.e., discriminating between plants and animals) allowed us to use neutral words that are more uncontroversially neutral with respect to the task-relevant features (i.e., features signaling membership in one of the two task categories, plant or animal). Neutral words (e.g., *dice*) were inanimate objects.

Method

Participants. Participants were 65 University of Freiburg students with different majors; mean age was 23 years, ranging from 18 to 45 years. They received a monetary gratification of €3.50 for participating. Two participants were extreme outliers according to Tukey, one with mean latency of 1,544 ms in the total sample's distribution of mean response latencies ($M = 632$ ms, $SD = 155$ ms), one with an error rate of 28% in the distribution of error rates ($M = 3.7\%$, $SD = 4.2\%$). These participants were excluded from the analyses.

Materials. Three sets of 12 plant names and three sets of 12 animal names were selected, as well as a set of 12 neutral nouns that were neither plants nor animals (see Appendix). All sets were matched with respect to word length and log frequency. One set of plant names and one set of animal names were reserved for targets; the other two sets were used for primes and counterbalanced over prime position (first vs. second) across participants.

Procedures. Procedures were the same as in Study 1, with positive words replaced by names of plants and negative words by names of animals. Participants' task was to categorize target words as plant or animal as quickly as possible.

Results and Discussion

Correct response latencies were preprocessed as in Study 1, leaving out 5.9% of the trials; mean response latency was 617 ms, and mean error rate was 3.4%. Consider first trials without neutral words. Response latencies from these trials were submitted to a 2 (Prime 1 category: plant vs. animal) × 2 (Prime 2 category) × 2 (target category) analysis of variance with repeated measures. A significant interaction of Prime 2 category and target category, $F(1, 62) = 112.29$, $p < .01$, $\eta_p^2 = .64$, revealed a significant Prime 2 priming effect of 23.73 ms ($SD = 17.77$ ms). A significant interaction of Prime 1 category and target category, $F(1, 62) = 13.01$, $p < .01$, $\eta_p^2 = .17$, revealed a small but significant reversed Prime 1 priming effect of -6.34 ms ($SD = 13.95$ ms). Less importantly, plant names were responded to more slowly when they appeared as targets than animal names were ($M_{\text{plant}} = 591$ ms, $M_{\text{animal}} = 569$ ms), $F(1, 62) = 35.10$, $p < .01$, $\eta_p^2 = .36$ (all other Fs ≤ 1.67, ps $\geq .20$).

Regarding Predictions 1 and 1′, in trials with neutral Prime 2, the Prime 1 priming effect was reversed, that is, a contrast effect ($M = -4.96$ ms, $SD = 16.91$ ms), and was significantly different from 0, $t(62) = -2.33$, $p = .02$. Regarding Predictions 2 and 2′, the Prime 1 priming effect did not differ significantly between trials with neutral second primes and trials with nonneutral second primes, $t(62) = 0.48$, $p = .64$.

Results were again clear-cut. Predictions 1 and 2 of the attentional account had to be rejected, whereas Predictions 1′ and 2′ of the psychophysical account could be upheld. Thus, Prime 1 engendered a contrast effect on target processing independent of, and additive to, the effects of Prime 2 on target processing even though neutral primes were now more uncontroversially neutral with respect to the task-relevant features.[5]

Like in Study 1, the interaction of Prime 1–target consistency and Prime 2–target consistency predicted by the perceptual-snapshot account (Fockenberg et al., in press) was not significant, $F(1, 62) = 1.67$, $p = .20$, $\eta_p^2 = .03$.

Study 3: Contrast Effects in the Paradigm With One Prime

In Studies 1 and 2, contrast effects were demonstrated in the paradigm with two primes. First primes elicited contrast even when second primes were neutral. These contrast effects are predicted by the psychophysical account, but they are difficult to reconcile with the attentional account.

In Study 3, we tested a central temporal implication of the psychophysical account, namely that contrast effects can be demonstrated in the traditional priming paradigm with one prime (i.e., when second primes are left out altogether) at SOAs of intermediate length. Based on the psychophysical account, three factors are conducive to contrast effects: (a) the use of an intermediate SOA, (b) that intermediate SOA being presented in trial-wise mixture with additional SOA levels, and (c) motivation to respond accurately. We discuss these factors in order.

1. According to Assumption 3, at short SOAs, the onset of the evaluation window is locked to the prime. As SOA is increased beyond a certain point, this synchronization will, however, break down, and the distance between prime onset and window onset will gradually increase. In consequence, as SOA is increased, primes should move from being included in the evaluation window to being excluded. As soon as an SOA is reached at which the prime is effectively excluded, contrast effects should result. As SOA further increases, priming effects should, however, again return to a zero baseline because prime-derived activation has likely decayed prior to window onset at long SOAs. In other words, assimilative priming effects should decrease, gradually turn into contrast effects, and eventually revert to 0 as SOA is increased. At an intermediate range of SOA values, contrast effects are thus expected to occur.

A few studies have manipulated SOA in several steps (Fockenberg et al., 2006; Hermans et al., 2001; Klauer et al., 1997; Spruyt, Hermans, De Houwer, Vandromme, & Eelen, 2007). Perhaps inspired by Neely's (1977) classic study, most of these have focused on relatively short SOAs (such as 0 ms, 100 ms, and 200 ms) along with one long SOA (above 1,000 ms), and there has been little systematic exploration of intermediate SOAs between these extremes.[6]

In addition, there is some variability across studies for the SOAs at which assimilative priming effects are reported, suggesting that unidentified procedural variables shape the range of SOA values at which normal priming effects are observed (see also Hermans et al., 2001, Experiment 3).[7] By analogy, the exact range of intermediate SOAs at which contrast may be obtained is likely to depend upon procedural details, and individual-differences variables may also play a role (Hutchison, 2007).

In most of our studies, normal priming effects have been observed consistently for only short SOAs up to and sometimes including 300 ms. For example, Klauer et al. (1997; Study 1) found priming at SOAs of 0 ms and 100 ms, weaker effects at 200 ms, and no effects at 300 ms, 600 ms, and 1,200 ms. This led us to assume that in our case, the critical range of SOA values at which contrast should be seen would be positioned between 300 ms and 600 ms. We therefore implemented three SOA levels: 140 ms, 280 ms, and 420 ms, expecting assimilative priming at 140 ms, little priming at 280 ms, and contrastive priming at 420 ms.

2. Another feature that we manipulated was how these different SOAs were administered. For one half of the participants, SOA level was blocked as is the usual procedure, a condition that we refer to as the *blocked SOA* group. In a second group, the trials with different SOAs were presented in random order, a condition that we refer to as the *random SOA* group. There were two reasons for this manipulation: (a) to render the prime less useful as a "go" signal and (b) to discourage strategic use of the prime.

a. If prime-target SOA changes unpredictably from trial to trial, the prime should be less useful as a "go" signal for initializing preparatory target-relevant processing, per Assumption 3. As a consequence, the onset of the evaluation window is likely to be less closely synchronized with the prime and is likely to occur later for random SOAs than it is for blocked SOAs. This should lead to somewhat more exclusive evaluation windows in the random SOA group, enhancing the chance to observe contrast effects.

b. As SOA is increased, the potential for strategic use of the prime increases. Depending upon expectancies brought to the experiment or formed online (Klauer & Teige-Mocigemba, 2007; Neely, 1977; Teige-Mocigemba & Klauer, in press), primes might be used to predict target valence. Strategic use of the prime should, however, be more difficult if the prime-target SOA is unpredictable.

3. We believe that participants have some control over the temporal positioning of the evaluation window. As per Assumption 4, participants motivated to respond accurately should adopt somewhat more exclusive evaluation windows. In Study 3, participants were therefore paid contingent upon the number of correct responses to targets made within an 800 ms response window,

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[5] One of us felt that the neutral prime *Gelenk* [joint] (see Appendix) was not entirely neutral inasmuch as one interpretation of the word is in terms of a body part of animals. We re-ran all analyses excluding trials with that stimulus and found that the pattern of results, including all significances and nonsignificances, remained unchanged.

[6] It is encouraging to note, however, that a few priming studies using nonevaluative categorization tasks (as in Study 2) found contrast effects that depended on the use of intermediate SOAs. For example, Versace and Allain (2001) had participants judge the grammatical gender (feminine vs. masculine) of (French) nouns used as primes and targets. They found a reversed priming effect for primes at an SOA of 600 ms but not at an SOA of 25 ms. Similarly, Eimer and Schlaghecken (1998) reported a contrast effect of masked primes in a left–right decision task in which primes and targets were arrows pointing either left or right. Later research has revealed that normal assimilative priming effects emerge at short SOAs in this task and that contrast depends on the use of sufficiently long SOAs (Jaśkowski & Verleger, 2007).

[7] For example, one article reported assimilative priming effects for an SOA as long as 500 ms (Greenwald, Klinger, & Liu, 1989), and many studies found such effects with an SOA of 300 ms (for an overview, see Klauer & Musch, 2003), whereas in other studies, reliable priming effects were observed only at short SOAs (i.e., below but not above 300 ms; Hermans et al., 2001; Klauer et al., 1997).

pushing participants to respond both accurately and quickly, a procedure that we also employed in the subsequent studies.

Method

Participants. Participants were 80 University of Freiburg students with different majors. One of these students was erroneously accepted as participant as she had already taken part in a previous experiment in the present series. That person was excluded. Mean age of the remaining 79 participants was 23 years, ranging from 18 to 42 years. Two participants were extreme outliers according to Tukey, one with an error rate of 49%, the other one with an error rate of 29% in the total sample's distribution of error rates ($M = 7.84\%$, $SD = 7.31\%$). These participants were excluded from the analyses.

Materials. Targets and primes were sampled from a set of 70 strongly polarized positive adjectives and a set of 70 strongly polarized negative adjectives that have been used in previous priming studies (e.g., Klauer & Teige-Mocigemba, 2007).

Design. We manipulated prime valence, target valence, and SOA (140 ms, 280 ms, and 420 ms) within participants and SOA administration (blocked vs. random) across participants.

There were three experimental blocks and one practice block. Each block comprised 72 trials plus 8 warm-up trials. Within each experimental block, prime valence, target valence, and SOA (in the random SOA group) were crossed orthogonally. In the blocked SOA group, SOA was constant across the trials of each experimental block. In this group, each of the three experimental blocks was assigned one of the three SOA levels, and order of blocks was randomized across participants.

Procedure. A trial of one of the experimental blocks began with the presentation of a fixation cross for 500 ms, followed by the prime. Prime duration was 100 ms. After the SOA assigned to the trial, the target appeared. It was taken off the screen upon the participant's response or 800 ms after target onset, whichever occurred first. Intertrial interval was 500 ms. Participants were asked to respond correctly as fast as possible while the target was on screen.

Participants' payment was contingent on performance: In the experimental blocks, they earned 2 euro cents (approximately 3¢) for each correct response made during the 800 ms target presentation.

Practice block trials differed from those of the experimental blocks in that no prime was presented. Thus, the target followed the fixation cross immediately. In addition, the word *Fehler!* [Error!] appeared printed in red for 200 ms upon a wrong response. Trial-wise error feedback was discontinued for the experimental blocks. End-of-block feedback reported percent correct responses and median response latency in the last block.

Results

Correct response latencies were preprocessed as in Study 1, leaving out 3.2% of the trials; mean response latency was 567 ms, and mean error rate was 7.02%.

Priming effects are shown in Figure 2 as a function of group (blocked SOA vs. random SOA) and SOA (140 ms, 280 ms, and 420 ms). Mean response latencies and percent correct scores for these conditions are shown in Table 1 separately for evaluatively consistent prime–target pairs and for inconsistent prime–target pairs, along with the priming effects.[8] As can be seen in Figure 2, priming effects decreased as SOA increased. They were assimilative at the 140 ms SOA, decreased at the 280 ms SOA, and reversed at the 420 ms SOA.

Response latencies were submitted to an analysis of variance with factors prime–target consistency (consistent vs. inconsistent), SOA, and group (blocked vs. random), with repeated measures on the first two factors. There was a pronounced main effect of SOA, $F(2, 150) = 91.65$, $p < .01$, $\eta_p^2 = .55$, indicating that mean latency decreased as SOA increased. Between the 140 ms SOA and the 280 ms SOA, mean latency dropped by 29 ms; the additional benefit due to the 420 ms SOA was 6 ms. As already discussed at the beginning of this article, the SOA effect suggests that the prime was used as a go signal to initialize preparatory target-relevant processing (see Assumption 3).

The SOA effect was moderated by group, $F(2, 150) = 3.43$, $p = .04$, $\eta_p^2 = .04$. The interaction of SOA and group reflected the fact that mean response latency dropped by 36 ms between the 140 ms SOA and the 280 ms SOA in the random SOA group but by only 23 ms in the blocked SOA group. Both groups profited almost equally by an additional 6 ms benefit due to the 420 ms SOA.

The interaction is consistent with the assumption that the prime was more effective as a go signal in the blocked SOA group than it was in the random SOA group. If participants in the blocked SOA group can already profit from primes at the 140 ms SOA by preparing for target processing, whereas participants in the random SOA group require longer SOAs to draw such benefit from the prime, a larger benefit of lengthening SOA is expected for the random SOA group than is expected for the blocked SOA group. In addition, as can be seen in Table 1, mean latency was larger in each condition (defined by SOA and prime–target consistency) of the random SOA group than it was in the blocked SOA group, a finding that is also in line with the assumption that random SOAs render primes less useful as a go signal than blocked SOAs do. But the main effect of group was not significant, $F(1, 75) = 1.04$, $p = .31$, $\eta_p^2 = .01$.

More importantly, there was no main effect of prime–target consistency ($F < 1$), but consistency interacted, as expected, with SOA, $F(1, 150) = 8.00$, $p < .01$, $\eta_p^2 = .10$. Priming effects and individual t tests were computed for the 140 ms, 280 ms, and 420 ms SOA. They were, in order, $M_{140\ \text{ms}} = 9$ ms, $SD = 25$ ms, $t(76) = 3.07$, $p < .01$; $M_{280\ \text{ms}} = 1$ ms, $SD = 27$ ms, $t < 1$; $M_{420\ \text{ms}} = -7$ ms, $SD = 28$ ms, $t(76) = -2.13$, $p = .04$. Note in particular that there was a significant contrast effect at the 420 ms SOA as predicted.

As can be seen in Figure 2, priming effects were smaller in the random SOA group than in the blocked SOA group at each SOA level, in line with the assumption that random SOAs lead to the adoption of somewhat more exclusive evaluation windows than blocked SOAs do. But the interaction of consistency and group did not reach significance, $F(1, 150) = 1.18$, $p = .60$, $\eta_p^2 = .004$, nor

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[8] Fewer trials were presented per cell of the within-participants design than were presented in Studies 1 and 2. To compensate, we aggregate over prime valence and target valence and code prime–target consistency. This allows us to maintain a nominal cell size of 36 trials for each participant's mean per cell of the analyses of variance reported in Study 3. For the same reason, we coded prime–target consistency in the subsequent studies.

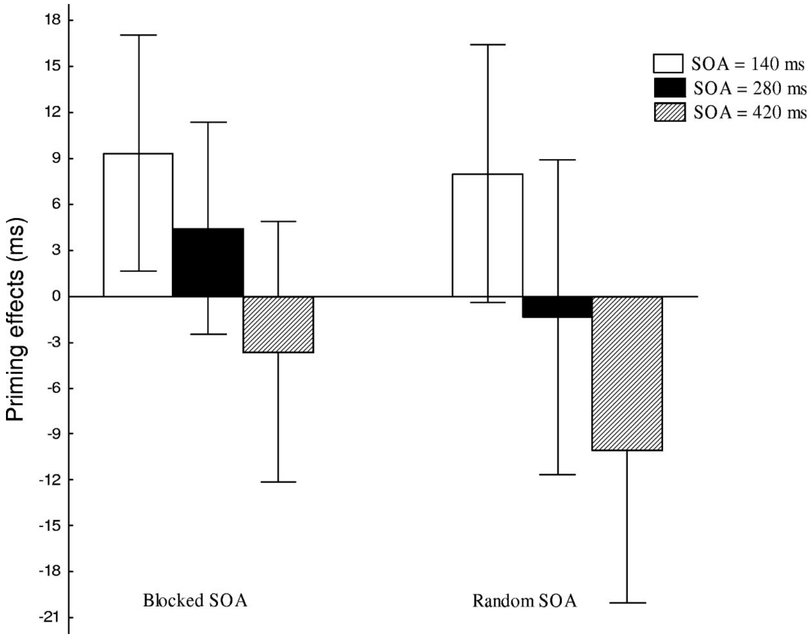

Figure 2. Priming effects in Study 3 as a function of stimulus-onset asynchrony (SOA) administration (blocked vs. random) and SOA. Error bars show the 95% confidence intervals.

was the three-way interaction of consistency, group, and SOA significant ($F < 1$).

As expected, the contrast effect observed at the 420 ms SOA, which was significant across both groups, was more pronounced in the group with random SOAs than in the group with blocked SOAs. As can be read off the confidence intervals depicted in Figure 2, it was in fact individually significant in the group with random SOAs ($M = -10.05$ ms, $SD = 30.79$ ms), $t(38) = -2.04$, $p = .049$, but not in the group with blocked SOAs ($M = -3.66$ ms, $SD = 25.83$ ms, $|t| < 1$).

Table 1
Mean Correct Response Latencies (ms) and Accuracy (%) in Study 3

	Inc.		Con.		
Group and SOA (in ms)	*M*	*SD*	*M*	*SD*	PE
			Latency		
Blocked SOA					
140	581	53	572	61	9.32
280	556	54	551	59	4.42
420	546	57	550	60	−3.66
Random SOA					
140	603	68	595	78	7.97
280	563	61	565	69	−1.38
420	553	69	563	78	−10.05
			Accuracy		
Blocked SOA					
140	93	6.2	95	5.3	1.29
280	94	5.5	93	4.5	−1.31
420	93	6.5	93	4.6	−0.34
Random SOA					
140	93	7.1	93	5.0	−0.22
280	92	6.6	93	5.4	1.23
420	93	5.8	92	5.8	−1.01

Note. SOA = stimulus-onset asynchrony; Inc. = inconsistent prime–target pairs; Con. = consistent pairs; PE = priming effect (negative values indicate contrast).

Error rates in Study 3 were slightly higher than in the previous studies, but different materials, procedures, and participants were employed in Study 3, making direct comparisons difficult. In any event, an analysis of variance of the accuracy data with the above factors did not reveal any significant effects in the accuracy data (all Fs ≤ 2.48, ps $\geq .09$).

Discussion

In Study 3, we tested another new prediction of the psychophysical account, namely that it should be possible to find contrast in the traditional paradigm with one prime under certain conditions. Based on Assumptions 3 and 4, we hypothesized that conditions conducive to contrast were the use of an intermediate SOA, that intermediate SOA being randomly intermixed with other SOA levels, and payoff-induced motivation to respond accurately. Study 3 implemented these conditions and found the predicted contrast effect.

The perceptual-snapshot account (Fockenberg et al., in press) can also account for the predicted shift from normal priming to reversed priming as SOA is increased. This is because primes are less likely to be absorbed in the assimilative perceptual snapshot, and activation of primes outside the snapshot is more likely to decay to levels allowing for overcorrection as SOA is increased. But for the same reason, the temporal-discrimination account cannot explain the SOA effect. According to Wentura and Rothermund (2003, pp. 78–79), reversed priming can occur when accuracy is emphasized and when prime and target initially induce a balanced activation of their respective valences, as is the case when prime and target follow each other with short SOA.[9] Contrast effects should, however, diminish in size as prime activation decays, that is, as SOA is increased. Note, however, that the temporal-discrimination account is part of a larger framework that comprises a number of interacting systems responsible for stimulus perception, selection of response schemata, goal maintenance, task supervision, and affective vigilance, respectively. As acknowledged by Wentura and Rothermund, it is difficult to derive specific predictions from their model because it has not been implemented in a computer simulation yet. This makes it difficult to put the temporal-discrimination account to a stringent empirical test.

According to the temporal-discrimination account as currently stated, the contrast effect should have been prominent already at the shortest SOA, and it should have diminished in size, if anything, as SOA was increased. However, a normal priming effect was in fact observed at the shortest SOA, and a contrast effect emerged only at the longest SOA employed in the present study.

Given that evaluative priming effects are considered to be increasingly susceptible to strategic control as SOA is increased (Klauer & Teige-Mocigemba, 2007), the present study is open in principle to the alternative explanation that the effects observed at the longest SOA reflect the strategic use of participants' expectancies. One purpose of the random SOA condition was, however, to make strategic use of a prime of any kind more difficult. Indirect evidence for the tenability of this reasoning stems from the findings suggesting that the prime was indeed a less helpful cue for initializing preparatory target-relevant processing in the random SOA group than it was in the blocked SOA group. But contrast effects were, if anything, even stronger in the random SOA group than they were in the blocked SOA group, rendering it implausible that they reflected the use of participants' strategies.

Study 4: Reversed Priming With Short SOA?

A central tenet of Assumption 3 is that evaluative priming is to some extent created by certain features of traditional sequential priming paradigms rather than revealed by them. According to Assumption 3, participants tune in to the repetitive, clearly structured stimulus presentation that is typical of these paradigms to prepare target evaluation prior to target onset, leading to assimilation in spontaneous evaluations. In less predictable environments, on the other hand, such advance preparation may be impossible so that participants cannot initialize evaluation windows prior to target onset. This suggests the intriguing possibility that contrast may be a more pervasive phenomenon in everyday life than has been suggested by our and others' work in the laboratory.

Study 4 was designed to test this tenet of Assumption 3. Participants saw short streams of valenced words, words that succeeded each other with an SOA of 200 ms. Note that an SOA of 200 ms is reliably associated with assimilative priming effects according to the priming literature (e.g., Klauer & Musch, 2003). The streams differed in length from two words to nine words, and stream length varied randomly from trial to trial. Participants were to evaluate the last word of each stream, and our interest was on the effect of the penultimate word (the prime) on the evaluation of the last word (the target).

Because stream length varies randomly, participants cannot be sure of the temporal position of prime and target prior to the stream's end. This should effectively block the use of the prime as a go signal for setting up the target's evaluation window. Accordingly, it is a bit difficult to predict how the evaluation window will be positioned temporally within streams. One strategy is to wait until the target appears on screen, identifiable as the last item to appear, and to set up the evaluation window then, that is, coinciding with the stream's end. Another possibility is to bet on a stream of average length and to position the evaluation window somewhat prior to the average stream length in order to be prepared for the expected target onset, implying that the evaluation window has to be reset effortfully if the stream is longer than expected.

We reasoned, however, that most participants would be caught by surprise by the shortest streams and would not have opened the evaluation window for such streams prior to target onset. The prediction was therefore that a contrast effect should emerge for the shortest streams. In view of the short SOA (200 ms) and the overwhelming evidence for assimilative evaluative priming effects given short SOAs (Klauer & Musch, 2003), it is perhaps fair to say that this prediction is quite bold.

Method

Participants. Participants were 120 University of Freiburg students with different majors. Mean age was 24 years, ranging from 19 to 43 years.

Materials. Words were sampled from a set of 65 strongly polarized positive adjectives and a set of 65 strongly polarized negative adjectives that have been used in previous priming studies (e.g., Klauer & Teige-Mocigemba, 2007).

Design. We manipulated prime valence, target valence, and stream length (from two to nine words in steps of one) within participants. There were three experimental blocks and one practice block. Each block comprised 64 trials plus 8 warm-up trials. Each trial consisted of a stream of words, of which the penultimate word was designated the prime and the last word the target. Within each block, prime valence, target valence, and stream length were crossed orthogonally. Words for each stream were sampled randomly from the above word sets without repetition of words within streams. In determining trial sequence, streams were classified as below or above median length (5.5 words) and as either consistent or inconsistent with respect to the evaluative connotations of prime and target. Trial sequence was randomized with the constraint that streams with the same classification in terms of length and consistency did not occur more than three times in a row.

Procedure. Each trial presented a number of words in quick succession. Words other than the target were shown for 100 ms, followed by a blank screen for 100 ms. The target was the last item in the stream, and it was taken off the screen either upon the participant's response or 1,200 ms after target onset, whichever occurred first. Intertrial interval was 800 ms. Participants were

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[9] Wentura and Rothermund (2003, p. 79) cited the studies by Glaser and Banaji (1999) as instances for balanced activations of prime and target; in these studies, strong primes and short SOAs of 150 ms and 300 ms were used. SOAs in Wentura (1999b) were below 100 ms.

Note that the temporal-discrimination account requires strong accuracy motivation to predict contrast, and our induction of accuracy motivation may not have been strong enough. In that case, however, the temporal-discrimination account predicts only assimilative priming effects that gradually decrease to 0 as SOA increases but never reverse into contrast effects, contrary to what was observed.

asked to respond correctly as fast as possible while the target was on screen.

Along with the targets, a plus and a minus sign were shown left and right of the target at a distance of about 5 cm from the center of the screen. The left/right position of the plus and minus signs was randomly determined for each trial, and participants' task was to respond with the key of the mouse on the side of the plus sign for positive targets and on the side of the minus sign for negative targets. The purpose of this random response assignment was to control for a response-related route to evaluative priming in which response tendencies elicited by the prime directly interact with target-derived response tendencies at a late response-selection stage of processing (Klauer et al., 2005), an assimilative component of priming effects that is additional to and independent of the component described by the psychophysical account (see Footnote 1). Switching the response mapping leaves priming effects intact (Abrams, Klinger, & Greenwald, 2002; Klauer et al., 2003, Experiment 3a; see also the present Study 5), while controlling for response conflict and synergy between response tendencies elicited by prime and target at the level of the specific motor responses. This issue is further discussed in the General Discussion.

In practice-block trials, the word *Fehler!* [Error!] appeared printed in red for 200 ms upon a wrong response. Trial-wise error feedback was discontinued for the experimental blocks. Participants' payment was contingent on performance: In the experimental blocks, they earned 2 euro cents for each correct response made during the 1,200 ms target presentation. End-of-block feedback reported percent correct responses and median response latency in the last block.

Results

Correct response latencies were preprocessed as in Study 1, leaving out 3.5% of the trials. Mean response latency was somewhat elevated relative to the previous studies ($M = 750$ ms), perhaps reflecting the added difficulty of the varied response mapping. Mean error rate was likewise somewhat higher than in Studies 1 and 2 ($M = 5.7\%$).

To obtain stable estimates of priming effects, we coded stream length in four steps, aggregating the data from streams of lengths two to three, four to five, six to seven, and eight to nine words, respectively; each priming effect was thereby based on the data from 48 trials. In Figure 3, priming effects are shown as a function of stream length. In Table 2, mean latencies and percent correct scores are shown as a function of prime–target consistency (see Footnote 8) and stream length, along with the priming effects.

As can be seen in Figure 3, all priming effects were negative. Our prediction was that the priming effect would be significantly smaller than 0 for the shortest streams (lengths two to three), and it was ($M = -8.01$ ms, $SD = 41.11$), $t(119) = -2.14$, $p = .03$.

The error rate again seemed sufficiently high for a meaningful analysis, and we submitted response latencies and the accuracy data to analyses of variance with the factors stream length and consistency. The analyses revealed main effects of stream length both in the latency data and in the accuracy data, $F(3, 357) = 31.28$, $p < .01$, $\eta_p^2 = .21$, and $F(3, 357) = 9.21$, $p < .01$, $\eta_p^2 = .07$, respectively. As can be seen in Table 2, latencies decreased and accuracy increased as stream length increased, indicating that participants were indeed less well prepared for target onset in short streams than they were in long streams. None of the other effects or interactions reached significance (all other Fs ≤ 2.42, ps $\geq .11$).

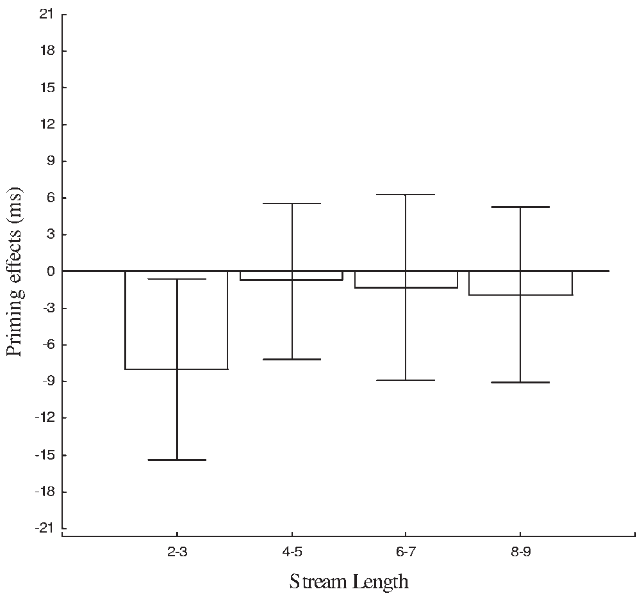

Figure 3. Priming effects in Study 4 as a function of stream length (number of words). Error bars show the 95% confidence intervals.

Discussion

Despite the short SOA of 200 ms, a reversed evaluative priming effect emerged for the shortest streams, as predicted. According to the psychophysical account, the unpredictability of target onset renders the prime useless as a go signal for setting up the evaluation window, leading to some variability in the temporal positioning of the evaluation window relative to target onset. We argued that most participants would be caught by surprise by short streams and would not have opened an evaluation window prior to target onset for such streams. The exclusive evaluation windows set up for such streams cause reversed priming effects.

It is difficult for the perceptual-snapshot account to explain contrast effects at short SOAs for two reasons: (a) The temporally closest prime and target are assumed to be absorbed in the assimilative perceptual snapshot, causing normal priming effects, and (b) reversed priming effects require prime activation to have decayed to low levels, allowing for overcorrection, that is, they require sufficiently long SOAs (Fockenberg et al., in press).

The present paradigm bears resemblance to the method of so-called rapid visual serial presentation, in which words are shown in quick succession and in which inhibitory effects are observed, such as the attentional blink (e.g., Chun & Potter, 1995) and repetition blindness (e.g., Kanwisher & Potter, 1990). Although related, the present contrast effects are distinct from these effects in several aspects, making it unlikely that they represent special cases of one of these. The attentional blink occurs in paradigms in which two targets in a stream have to be processed and refers to impaired processing of a second target shown in quick succession to a first target. In contrast, in the present paradigm only one target, the last word in the stream, had to be

Table 2
Mean Correct Response Latencies (ms) and Accuracy (%) in Study 4

Stream length (number of words)	Inc.		Con.		
	M	*SD*	*M*	*SD*	PE
Latency					
2–3	763	89	771	85	−8.01
4–5	748	85	749	86	−0.68
6–7	743	89	744	80	−1.29
8–9	742	85	744	81	−1.86
Accuracy					
2–3	93	6.9	93	6.5	−0.23
4–5	95	5.4	93	6.4	−1.45
6–7	95	6.0	94	6.2	−0.21
8–9	95	5.1	96	4.8	0.36

Note. Inc. = inconsistent prime–target pairs; Con. = consistent pairs; PE = priming effect (negative values indicate contrast).

processed. Repetition blindness refers to the fact that participants are less likely to detect the repetition of a target word in a rapid visual stream than they are to detect a second different target. The effect thus relies on stimulus identity. It also occurs with perceptually similar targets but not with semantically related words (Kanwisher & Potter, 1990), suggesting that the present contrast effect cannot be framed as a repetition blindness effect.

Study 5: A Test of Assumption 4

The previous studies were focused on testing predictions based primarily on Assumption 3 and on discriminating between the psychophysical account on the one hand and an attentional account, perceptual-snapshot account, or temporal-discrimination account on the other hand. Study 5 is a test of Assumption 4. With Assumption 4, we entertain the idea that participants have some control over the temporal positioning of evaluation windows so that exclusive evaluation windows can also be adopted via a top-down route when primes are perceived as misleading or extreme.

Recent work has focused on response conflicts and their effects on subsequent trials as a prime example of cognitive control. As reviewed by Goschke and Dreisbach (2008), conflicts are assumed to trigger enhanced mobilization of cognitive control to prevent interference on subsequent trials in a task. In particular, interference from distractors in speeded choice reaction tasks is reduced on trials following response-incompatible (high conflict) trials relative to trials following response-compatible (low conflict) trials (e.g., Gratton, Coles, & Donchin, 1992). Although the mechanism or, more likely, the different mechanisms that contribute to these effects are under debate, sequential effects of these kinds are seen as signifying the exertion of cognitive control (e.g., Botvinick, Braver, Barch, Carter, & Cohen, 2001).

In evaluative priming, a sequential effect of this kind was reported by Greenwald, Draine, and Abrams (1996) and replicated by Musch (2000; but see Klauer et al., 1997). Priming effects in Trial *n* were smaller when prime and target in Trial $n - 1$ were inconsistent rather than consistent, an effect that occurred when primes were visible but not when they were masked. According to the above, this demonstrates the mobilization of cognitive control triggered by misleading prime information in Trial $n - 1$. In terms of the psychophysical account and Assumption 4, perceiving the prime in Trial $n - 1$ as misleading prompts the adoption of a somewhat more exclusive evaluation window in the subsequent Trial *n*, causing smaller priming effects in that trial. The effect is consistent with the control mechanism postulated by the psychophysical account (i.e., the adoption of more exclusive evaluation windows) but does not rule out other mechanisms by which cognitive control might be exerted (see General Discussion). Nevertheless, it supports the prediction derived from Assumption 4 that misleading primes elicit the mobilization of cognitive control, leading to reduced priming effects in a subsequent trial.

Assumption 4 also maintains that extreme primes should elicit the mobilization of cognitive control, and the purpose of Study 5 was to test this prediction. If this mobilization does occur, by the same logic as for misleading primes, a sequential effect should be seen as a function of prime extremity according to Assumption 4. That is, priming effects in Trial *n* should be smaller after a Trial $n - 1$ with an extremely valenced rather than moderately valenced prime. In Study 5, we tested this new prediction by manipulating prime extremity. Thus, primes were either extremely positive or negative or only moderately positive or negative.

Apart from this primary hypothesis, two exploratory analyses investigated (a) the impact of prime extremity on priming effects in the same trial and (b) whether prime extremity in Trial $n - 1$ modulates the effect of target valence in Trial $n - 1$ on the response to the target in Trial *n*.

a. It is difficult to make a firm prediction for the effect of prime extremity on priming effects in the same trial. Given short SOAs, participants will usually not exclude all of the prime-derived activation from the evaluation window (Assumption 1). Nevertheless, if extreme primes already trigger more exclusive evaluation windows in the trial in which they occur (see Goschke & Dreisbach, 2008), priming effects should be decreased in that trial, ceteris paribus. On the other hand, extreme primes produce stronger and faster increases of the valence counters in the evaluation window than moderate primes do, leading to larger priming effects, ceteris paribus. These two effects counteract each other: Whether priming effects for extreme primes will in fact be smaller than, equal to, or larger than priming effects for moderate primes depends upon the relative sizes of the two effects.

b. Similarly, if extreme primes in Trial $n - 1$ trigger shorter evaluation windows in Trial *n*, activation stemming from the target in Trial $n - 1$ should be excluded to a larger extent or even completely from the evaluation window for target evaluation in Trial *n*, suggesting smaller repetition benefits for target valence and eventually alternation benefits as the evaluation window decreases. The prediction is, however, potentially compromised by expectancy-based repetition/alternation biases that are frequently seen in speeded decision tasks (e.g., Pashler & Baylis, 1991). That is, depending on a number of temporal and stimulus factors, participants sometimes expect responses and/or target categories to repeat or to alternate from trial to trial. Like in Study 4, response mapping of positive and negative stimuli to left versus right key was therefore switched randomly from trial to trial. This should leave priming effects intact (Abrams et al., 2002; Klauer et al., 2003, Experiment 3a) while controlling, in this case, for repetition/alternation biases at the level of the specific motor responses. But repetition and alternation expectancies operating at the level of more abstract response codes, such as positive versus negative instead of left key versus right key are thereby not controlled for. At the same time, such expectancies might be differentially affected by extreme versus moderate primes. For these reasons, we refrain from formulating a firm hypothesis for the effects of target-valence repetition.

Method

Participants. Participants were 70 University of Freiburg students with different majors; mean age was 24 years, ranging from 18 to 44 years. Two participants were extreme outliers according to Tukey, one with an error rate of 45%, the other one with an error rate of 46% in the total sample's distribution of error rates ($M = 13.40\%$, $SD = 7.75\%$). These participants were excluded from the analyses.

Materials. Targets and primes were pictures from the International Affective Picture System (Center for the Study of Emotions and Attention, 1995). Pictures were used because it is easier to manipulate prime extremity with pictures than it is with words. The International Affective Picture System evaluation norms range from 1 (*extremely negative*) to 9 (*extremely positive*). Eight extremely positive (negative) primes were chosen from the set of pictures with norm values between 8 and 9 (between 1 and 2). Eight moderately positive (negative) primes were chosen with norm values between 6 and 6.5 (between 3.5 and 4). Target pictures were 24 additional positive and 24 additional negative pictures sampled from the same intervals of evaluation norms as the moderate primes. Extreme primes were more extremely valenced than moderate primes were for positive primes, $t(14) = 38.54$, $p < .01$, and for negative primes, $t(14) = 33.66$, $p < .01$.

Procedure. There were four experimental blocks and three practice blocks. Each block comprised 48 trials plus 4 warm-up trials. Prime extremity, prime valence, target valence in Trial n, and target valence in Trial $n - 1$ were crossed orthogonally. Primes and targets were sampled randomly from the above-described picture sets.

All pictures had a size of 380 × 285 pixels and were presented on a screen measuring 43 cm diagonally (17 inch) that had a resolution of 1,280 × 1,024 pixels. Participants were seated at a distance of approximately 55 cm from the computer screen.

A priming trial began with a pause of 230 ms followed by the presentation of the prime picture for a duration of 200 ms. After a blank screen of 20 ms, the target picture was shown for 330 ms. In the practice blocks, the word *Fehler!* [Error!] appeared for 200 ms upon a wrong response. Trial-wise error feedback was discontinued for the experimental blocks. The second practice block and the experimental blocks comprised a response window signaled by an exclamation mark replacing the target picture 330 ms after target onset. The exclamation mark was taken off the screen either upon the participant's response or 1,000 ms after target onset, whichever occurred first. Participants were asked to respond correctly as fast as possible while the exclamation mark was on the screen. Participants' payment was contingent on performance: In the experimental blocks, they earned 2 euro cents for each correct response made during the response window.

A plus and a minus sign were also shown for the duration of the trial at a distance of 1 cm left and right of the picture boundary, respectively. The left/right position of plus and minus signs was randomly determined for each trial, and participants' task was to respond with the key of the mouse on the side of the plus sign for positive targets and on the side of the minus sign for negative targets. As elaborated earlier, the purpose of this random response assignment was to control for repetition/alternation biases at the level of the actual motor response. End-of-block feedback reported percent correct responses, proportion of correct responses in the response window (for all blocks other than the first practice block), mean response latency, and amount of money earned in the last block (for the experimental blocks).

Results

Correct response latencies were preprocessed as in Study 1, resulting in leaving out 5.0% of the trials. For the analyses of sequential effects, responses in Trial $n - 1$ also had to be correct for Trial n to be included in the analyses because latencies tend to be increased in the trial that follows a wrong response. Response latencies ($M = 820$ ms, $SD = 126$ ms) and error rates ($M = 12.46\%$, $SD = 5.47\%$) were somewhat elevated relative to the previous study, probably reflecting the use of pictures as targets.

Consider first the primary hypothesis that priming effects in Trial n are decreased when the prime in Trial $n - 1$ is extreme. Response latencies were submitted to a 2 (prime extremity in Trial $n - 1$: extreme vs. moderate) × 2 (prime–target consistency in Trial n: consistent vs. inconsistent; see Footnote 8) analysis of variance with repeated measures. The analysis revealed a main effect of prime–target consistency, $F(1, 67) = 29.20$, $p < .01$, $\eta_p^2 = .30$, indicating a significant positive priming effect, moderated by a significant interaction of consistency and prime extremity, $F(1, 67) = 6.89$, $p = .01$, $\eta_p^2 = .09$: Priming effects were larger when the previous trial contained a moderate prime ($M = 24.99$ ms, $SD = 36.73$ ms) than when it contained an extreme prime ($M = 11.35$ ms, $SD = 33.24$ ms), as predicted. The main effect of prime extremity was not significant ($F < 1$).

Because error rates seemed sufficiently high for a meaningful analysis of the accuracy data, the same analysis was run on error rates. There was a significant main effect of prime–target consistency, $F(1, 67) = 4.31$, $p = .04$, $\eta_p^2 = .06$, indicating a small positive priming effect of 1.95% ($SD = 7.74\%$). The interaction of consistency and prime extremity pointed in the same direction as the interaction obtained for latencies did but did not reach significance, $F(1, 67) = 1.65$, $p = .20$, $\eta_p^2 = .02$, nor was the main effect of prime extremity significant ($F < 1$).

For the exploratory analysis of the effects of prime extremity on priming effects in the same trial, response latencies and error rates were submitted to separate 2 (prime extremity in Trial n) × 2 (prime–target consistency) analyses of variance with repeated measures. These analyses confirmed the overall priming effects already reported earlier, that is, significant main effects of prime–target consistency in the latency domain as well as in the accuracy domain. But none of the effects involving prime extremity reached significance, largest $F(1, 67) = 1.25$, smallest $p = .27$.

For the exploratory analysis of whether prime extremity in Trial $n - 1$ modulates the effect of target valence in Trial $n - 1$ on the response to the target in Trial n, response latencies and error rates were submitted to separate 2 (prime extremity in Trial $n - 1$) × 2 (valence repetition: target valence repeats vs. alternates from Trial $n - 1$ to Trial n) analyses of variance with repeated measures. The analyses revealed a benefit of valence repetition that was significant for the error rates ($M = 2.32\%$, $SD = 5.80\%$), $F(1, 67) = 10.92$, $p = .01$, $\eta_p^2 = .14$, but did not reach significance in the latency domain, $F(1, 67) = 2.22$, $p = .14$, $\eta_p^2 = .03$ (all other Fs < 1, ps $> .55$).

Discussion

Study 5 tested another new prediction of the psychophysical account, this one based on Assumption 4. According to Assumption 4, primes perceived as extreme or misleading should lead to the mobilization of cognitive control, reducing priming effects in a subsequent trial. This accounts well for the sequential effect observed in previous studies in which prime–target inconsistency in Trial $n - 1$ led to smaller priming effects in Trial n. In Study 5, an analogous sequential effect was predicted and observed for the effect of prime extremity in Trial $n - 1$ on priming effects in Trial n. Results confirmed that priming effects in trials preceded by a trial with an extreme prime are reduced relative to trials preceded by a trial with a moderate prime.

It is interesting and perhaps surprising that prime extremity did not affect priming effects in the same trial. That is, priming effects were not substantially affected by whether the current prime was extreme or moderate. This finding, however, replicates an analogous finding by Simmons and Prentice (2006), who argued that the measurement validity of traditional priming measures of attitudes is diminished by the absence of an effect of prime extremity. In terms of the psychophysical account, the faster increases in valence counters caused by extreme primes may be counteracted by the adoption of a more exclusive response window, with the net result of little or no effect of prime extremity on priming effects within a trial.

There was a small benefit of target-valence repetition in the accuracy data but not in the latency data. The benefit was not moderated by prime extremity in Trial $n - 1$. Given the interpretational difficulties considered in the introduction to Study 5, it is probably prudent not to put too much theoretical weight on the effect.

Although consistent with the particular control process postulated by the psychophysical account (i.e., the adoption of more exclusive evaluation windows), the sequential effects themselves are relatively silent about the nature of the processes that cause or contribute to them as further discussed in the General Discussion. Whereas the previous studies in this series were designed to probe more deeply into the process of spontaneous evaluation as conceptualized in the psychophysical account, the purpose of Study 5 was to gather support for the heretofore untested hypothesis that extreme primes lead to enhanced cognitive control, as per Assumption 4. As discussed later, this has important implications for priming measures of attitudes and stereotypes.

General Discussion

The purpose of the present article is to propose a model of spontaneous evaluation accounting for both normal and reversed priming effects, that is, for assimilation as well as contrast, from the same underlying process. In what follows, we first review the empirical tests of the psychophysical account and its relationships to other accounts of contrast effects. Then we consider how the psychophysical account explains many of the contrast phenomena reviewed at the beginning of this article and explore the implications of our theory and findings for priming measures of evaluative associations, attitudes, and prejudice. Finally, we discuss possible extensions, open questions, and additional mechanisms that are likely to operate in evaluative priming.

Tests of the Psychophysical Account and Its Competitors

In Studies 1 and 2, we aimed to discriminate between the psychophysical account and an attentional account. Unlike the psychophysical account, the attentional account does not explain normal, assimilative priming effects; it is an add-on to account for contrast if and when it occurs. Both accounts make opposing predictions for trials with neutral Prime 2 in Gawronski et al.'s (2005) paradigm with two primes. According to the attentional account, Prime 1 should not engender a contrast effect in such trials. In contrast, according to the psychophysical account, Prime 1 should cause a reversed priming effect even in trials with neutral Prime 2.

Studies 1 and 2 reported significant reversed Prime 1 priming effects in trials with neutral Prime 2. These findings are difficult to reconcile with the attentional account, whereas they agree well with the psychophysical account.

Studies 3, 4, and 5 tested crucial implications of Assumptions 3 and 4. In Study 3, immediate temporal implications of Assumption 3 were tested through a manipulation of SOA: Priming effects shifted from normal, assimilative effects to reversed effects as SOA was increased from short to intermediate durations. In Study 4, we tested another central aspect of Assumption 3, namely that assimilative priming effects depend on being able to prepare for target evaluation prior to target onset. Hence, in a situation in which the target onset takes participants by surprise, contrast prevailed even when SOA was short. Finally, Study 5 tested Assumption 4, which states that extreme primes trigger corrective efforts.

The psychophysical account is compatible with some of the other theoretical mechanisms that have been proposed to account for different subsets of the contrast phenomena listed at the beginning of this article. For example, the psychophysical account specifies a natural corrective strategy that can lead to overcompensation (e.g., Fockenberg et al., in press; Glaser, 2003). Mechanisms proposed for correction and overcompensation in social judgments (e.g., Lombardi, Higgins, & Bargh, 1987; Newman & Uleman, 1990; Strack, Schwarz, Bless, Kübler, & Wänke, 1993) cannot be applied to explain correction in a reaction time paradigm. The corrective mechanism suggested by the psychophysical account is to adopt evaluation windows with smaller slack that exclude more of the activation contributed to by the prime.

In addition, there is overlap with ideas by Wentura and Rothermund (2003) based on temporal discrimination of prime and target. Like in Wentura and Rothermund's model, factors that promote efforts to discriminate between prime and target information are likely to reduce priming effects and to even cause contrast effects under certain circumstances. Nevertheless, for Study 3, the temporal-discrimination account as currently stated leads one to expect reversed priming effects, if any, at short SOAs where the activations of prime and target are initially balanced (Wentura & Rothermund, 2003, pp. 78–79). However, normal priming was observed at short SOAs, and reversed priming occurred at only the longest SOA used in Study 3. But it must be acknowledged, as Wentura and Rothermund did, that the temporal-discrimination account is part of a complex theoretical framework from which it is difficult to derive specific predictions.

Finally, there is also overlap with the perceptual-snapshot account (Fockenberg et al., in press). Like in the psychophysical account, a temporal window is postulated that includes target and temporally proximal primes. For stimuli outside the window, contrastive processing is assumed to prevail. Nevertheless, the nature of this contrastive processing differs between the two accounts: Suppression and overcorrection are postulated by the perceptual-snapshot account, whereas contrast is a passive outcome of a psychophysical principle in the present account. Empirically, the perceptual-snapshot account did not receive support on two counts: (a) For Studies 1 and 2, the account predicts that the Prime 1 priming effect is moderated by Prime 2–target consistency, but neither study revealed evidence for moderation; (b) it is difficult for the perceptual-snapshot account to explain reversed priming effects with short SOAs, but in Study 4, just such effects were demonstrated. Taken together, the perceptual-snapshot account needs to be modified to be able to account for the present pattern of findings.

Contrast Phenomena and the Psychophysical Account

Can the psychophysical account explain the other contrast phenomena listed at the beginning of this article? Let us briefly review the different phenomena.

Long SOA. Primes presented well before the target (by 1,000 ms or more) are unlikely to drive counter states within the evaluation window. Because counter states are assumed to drift back to the neutral zero state only slowly, primes may, however, still contribute to some extent to the initial counter states of the evaluation window of the target, causing small contrast effects. The conclusiveness of such findings is, however, reduced by the fact that the potential for contamination by participants' strategies increases as prime–target SOA increases.

Action valence blindness. In Eder's (2006; Eder & Klauer, 2007) paradigm, participants plan the execution of an action with an evaluative connotation (e.g., approach or avoidance movements) and then signal their readiness to execute the action by a key press. A valenced target word is then briefly flashed. The identification of target valence is impaired if an evaluatively consistent action was planned relative to the case that an inconsistent action was planned. The clear separation between action planning and target evaluation that is provided by participants' self-generated readiness signal should support the adoption of a strict temporal window via Assumption 3. Such a window excludes valence information activated during action planning, causing contrast by Assumption 2. Following Eder, we assume that the planning, but not as much the motor execution, of an action with evaluative connotations activates the associated valence information.

Contrast effects of success and failure feedback. Contrast effects reported by Rothermund (2003) can be explained similarly. Success or failure feedback from the previous trial exerts a contrast effect on target evaluation in the current trial. Here, the distribution of the two sources of valence activation over two distinct trials again provides a clear segmentation of events supporting evaluation windows that exclude evaluative connotations of feedback presented at the end of the previous trial (Assumption 3).[10]

Negative priming. A similar explanation can be given of the negative-priming effect reported by Wentura (1999a). The prime in Trial $n - 1$ is very likely excluded from the evaluation window in Trial n according to Assumption 3. Wentura also offered an explanation of the fact that the effect is restricted to trial pairs with differently valenced targets based on the additional assumption that exposure to a conflict pair in Trial $n - 1$ leads to a general slowdown in Trial n. Like in the case of long SOA, the conclusiveness of these findings is somewhat limited by the long intertrial interval of 1 s, which increases the potential for contamination by participants' strategies (Frings & Wentura, 2006).

Positivity proportion effect. Klauer et al. (2003) manipulated the proportion of positive to negative targets in masked evaluative priming and found that primes of the infrequent valence engendered larger priming effects than primes of the frequent valence did. This finding flows naturally from the psychophysical account because the frequent activation of one valence sustains increased levels for the associated valence counter throughout the experiment, making it more difficult to detect increases in that counter relative to the other counter. In other words, stimuli of the infrequent valence more easily cause detectable increases in their valence counter, explaining their greater impact as primes.

Emphasis on accuracy. To the extent that decision makers have strategic control over onset and width of the evaluation window, accuracy instructions that stress the importance of responding on the basis of the target rather than the prime encourage exclusive evaluation windows (Assumption 4). It seems unlikely that the window could be so precisely synchronized with the target onset that all, or even most, of the activation that is driven by the prime can be effectively excluded when SOA is small (Assumption 1). Nevertheless, the less overlap there is between evaluation window and prime-generated counter increases, the smaller priming effects are expected to become, turning into reversed priming effects eventually as overlap decreases (see Study 3).

Consistency proportion effect. Similarly, learning that prime valence most of the time conflicts with target valence in lists with high proportions of evaluatively inconsistent prime–target pairs may trigger efforts at adopting evaluation windows that exclude more of the misleading prime-derived valence activation (Assumption 4), efforts that are likely to be further enhanced when participants are alerted to the fact that inconsistent pairings prevail, as in the study by Klauer and Teige-Mocigemba (2007, Experiment 1; see also Teige-Mocigemba & Klauer, in press). This entails reduced, or even reversed, priming effects as consistency proportion decreases and corrective efforts increase.

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[10] In particular, after the screen with trial-wise feedback was cleared, the number of points reached in the current block was shown before the next target appeared, giving participants an opportunity to set up an evaluation window locked to that stimulus.

Note that the psychophysical account does not in itself provide an explanation of the fact that contrast effects were found primarily in trials in which target valence shifted from the previous trial to the current trial. Nor can it readily explain an evaluative contrast effect observed in this paradigm when targets were to be classified according to grammatical category rather than valence (Rothermund, 2003, Experiment 4). But the attentional account proposed by Rothermund (2003) also needs to be modified to account for these effect patterns.

Extreme primes, anxiety, and the pronunciation task. Although we focused on the evaluative decision task in the present article, the psychophysical account is more general and can be extended to account for contrast in the pronunciation task, as elaborated later in a separate section.

Masked priming. The conditions that give rise to rare reports of reversed priming effects in masked priming are currently unclear. But the psychophysical account predicts that reversed priming effects hinge on parameters of stimulus presentation that support a clear perceptual segmentation of the presented stimulus streams into three distinct stimuli: prime, mask, and target. This then leads to evaluation windows that are locked to the mask (as per Assumption 3) and that exclude the prime. In most masked priming studies, presentation parameters make it difficult to discriminate between prime and mask perceptually, explaining why normal priming effects prevail in masked evaluative priming (Klauer & Musch, 2003).

High frequency targets. The psychophysical account cannot explain the reversed priming effect for high frequency targets that emerged in an experiment by Chan et al. (2006). As pointed out by Chan et al., at least one other study used high frequency targets and found normal priming effects (Musch, Elze, & Klauer, 1998).

Summary. The psychophysical account is relatively broad in empirical scope. It provides natural explanations for many but not all of the above contrast phenomena in spontaneous evaluations. Given the diversity of contrast phenomena, it is, however, likely that more than one mechanism contributes to their making, as elaborated next.

Implications for Priming Measures of Evaluative Associations

The present Studies 3, 4, and 5 bear importantly on the interpretation of priming measures of attitudes and prejudice. One implication of the present account is that priming effects in evaluative priming are created rather than revealed by the repetitive and predictable nature of stimulus presentation in priming studies (Assumption 3). In Study 4, we removed the predictability, and a reliable contrast effect emerged even though prime–target SOA was 200 ms, an SOA that is overwhelmingly associated with assimilative evaluative priming in the evaluative priming literature (Klauer & Musch, 2003).

More generally, any factor that is likely to affect the positioning of the evaluation window has a direct influence on the size and potentially the sign of evaluative priming effects. In Study 3, this was illustrated for one such factor: SOA. As SOA was increased from short levels to intermediate levels, evaluative priming effects decreased from normal, positive effects over null effects to contrast effects. This is problematic for the use of priming measures of attitudes and stereotypes inasmuch as some of the factors affecting the evaluation window are difficult to control or are themselves functions of the respondents' attitudes.

For example, participants' degree of accuracy motivation, the use of misleading primes, the use of extreme primes (Assumption 4), even such seemingly innocuous factors as the proportion of positive relative to negative primes and targets (see the paragraph headed *Positivity Proportion Effect* in the previous section), affect the size and, in the limit, even the sign of priming effects according to the psychophysical account.

In Study 5, this was empirically illustrated for the use of extreme primes. A subtle sequential effect of prime extremity demonstrated that corrective efforts, the adoption of a more exclusive evaluation window, can be mobilized in a trial-by-trial fashion upon exposure to an extreme prime. A trial-by-trial adaptation of the evaluation window as a function of prime extremity compromises, however, the relationship between prime strength and size of the priming effects as shown in Study 5 (see also Simmons & Prentice, 2006); that is, it led to priming effects of equal size for moderate and extreme primes. This questions the validity of priming effects as measures of prime strength. In the limit, as corrective efforts are further increased, priming effects can be eliminated (Klauer & Teige-Mocigemba, 2007; Teige-Mocigemba & Klauer, in press) and eventually reversed, even when primes are strong (e.g., Glaser & Banaji, 1999; Maier et al., 2003). This renders comparisons between priming effects induced by different primes within one and the same person difficult. The issue is further complicated by the fact that individual differences in accuracy motivation and in the respondents' attitudes and prejudices also determine the extent to which given primes are seen as misleading or extreme, rendering comparisons between priming effects obtained from different respondents difficult.

Assuming that the present account is correct, does it suggest simple procedural changes to remove these difficulties? For example, masking primes should remove biases caused by perceptions of primes, such as perceiving primes as misleading or extreme. Note however that inserting a mask between prime and target introduces a new stimulus to which the onset of the evaluation window may become locked, as per Assumption 3, provided that the resulting stimulus stream is clearly segmented perceptually into three distinct stimuli: prime, mask, and target. This may explain occasional reports of reversed priming effects in masked evaluative priming and has the potential to compromise the interpretation of masked priming effects as measures of evaluative associations. Similarly, the use of no SOA, that is, the simultaneous presentation of prime and target, has the advantage that both prime and target are reliably included in the evaluation window, removing many of the above difficulties. But it comes at the disadvantage that simultaneous presentation of primes and targets renders the paradigm more obtrusive and invites explicit evaluations of primes alongside targets.

Nevertheless, conditions leading to assimilative priming are the norm and contrast effects the exception, suggesting that priming measures of evaluative associations will in most circumstances validly reflect at least the sign (positive vs. negative) of the attitudes to be measured. Furthermore, when onset and width of the evaluation window are constant (relative to target onset) across trials, priming measures will also validly reflect the strength of the underlying attitudes (but see Footnote 1). Indeed, priming measures of attitudes and prejudice have frequently been shown to correlate in a meaningful manner with external indicators of participants' evaluative associations (e.g., Wittenbrink, 2007).

Extensions, Open Questions, and Additional Mechanisms

One extension already addressed earlier (see subsection Scope of the Psychophysical Account) is that we believe that the principles discussed here in the context of the evaluative decision task apply to any categorization task in which objects have to be classified according to a pair of categories. Support for this possibility was produced in Study 2, in which the contrast phenomena observed with the evaluative decision task in Study 1 were replicated with a nonevaluative categorization task (see also Fockenberg et al., in press; Gawronski & Deutsch, 2006). Moreover, there are results from nonevaluative categorization tasks in which contrast depended upon the use of an intermediate SOA, analogous to what was found in Study 3 (see Footnote 6). Finally, analogous to Study 4 but based on a nonevaluative categorization, (masked) priming of numerical decisions (i.e., is a shown digit larger or smaller than 5?) is decreased if target onset is temporally unpredictable relative to when it is predictable (Naccache, Blandin, & Dehaene, 2002).

As already mentioned, many lines of research in social psychology rely on the use of categorization tasks and the category priming effects observed in them, for example, research on automatic gender stereotypes (e.g., Blair & Banaji, 1996), research on shooter bias (e.g., Payne, 2001), and research on automatic evaluation (e.g., Bargh & Chartrand, 2000). Considering nonevaluative categories also opens the door to accounting for a wide variety of assimilative and contrastive context effects in cognitive psychology. But it is beyond the scope of the present article to review this vast literature.

Another extension is suggested by the way in which Hochhaus and Johnston (1996) proposed to account for repetition blindness. Like the psychophysical account considered here, their account is based on detecting increases in counters of activation, but they postulated a separate counter for each individual word that can appear as a target. This accounts for assimilation and contrast in categorization tasks if it is assumed that the perception of stimuli that overlap with the target in category-relevant features adds to the target's counter. What is more, it could also explain contrast in evaluative priming studies employing the pronunciation task and related naming tasks in which target identity has to be determined. For example, in a recent study, we used the paradigm with two primes (see Studies 1 and 2) with a naming task and found that Prime 1 engendered a reversed priming effect on target naming.

Although this extension accommodates contrast in the pronunciation task, there remain a few of the above contrast phenomena that, if replicable, cannot be accounted for by the psychophysical account as far as we can see. In other cases, the account does not explain the entire pattern of findings satisfactorily and can only be argued to contribute to the pattern of findings rather than to account for it completely (see, for example, Footnote 10).

For these and other reasons, we believe that the present proposal describes only one mechanism out of an array of mechanisms that shape assimilation and contrast in spontaneous evaluations. For example, the psychophysical account describes an influence of the prime on central processes of semantic categorization of targets as good or bad that precede response selection. We believe that there is an additional and partly independent response-related route to evaluative priming in which response tendencies elicited by the prime directly interact with target-derived response tendencies at a late response-selection stage of processing (Klauer et al., 2005). This typically leads to assimilation, that is, response facilitation when prime and target agree in their response implications and impairment when both disagree. As a consequence, processes leading to contrast have to be strong enough to override this assimilative component before contrast effects are seen, an observation that may go some way toward explaining why contrast effects tend to be small.

Similarly, the psychophysical account integrates a mechanism for exerting cognitive control by making an effort to adopt more exclusive evaluation windows that exclude more of the prime information (Assumption 4). This temporal focusing on the target may contribute to the consistency proportion effect as explained previously and to the sequential effects considered in Study 5.

However, consistency proportion effects and the related sequential effects are also found in other interference paradigms, such as the Simon task in which SOA between prime (i.e., the distracting stimulus feature) and target (i.e., the task-relevant stimulus feature) is 0 ms (e.g., Hommel, Proctor, & Vu, 2004). With a 0 SOA, temporal focusing cannot be effective, suggesting that there are additional mechanisms by which cognitive control can be exerted. We think it likely that spatial attentional focusing (Musch & Klauer, 2001; Simmons & Prentice, 2006) and response suppression at a late response-selection stage are alternatives that participants have at their disposal for exerting cognitive control.

Evaluative Decisions Based on Late Counter States?

When evaluating objects under time pressure, it is a reasonable strategy to base one's evaluation on increases in valence counters monitored over a short evaluation window as explained at the beginning of this article. When fine-grained evaluations are required, when there are no correct or wrong responses, and/or time pressure is less severe, on the other hand, it is more reasonable to focus on the target for longer periods, to monitor how the valence counters develop, and to read off strength and direction of the target evaluation from the counter states that emerge after some target processing.[11]

Interestingly, evaluative judgments based on this latter strategy should be subject only to assimilative effects of recent valenced stimuli. Counter states comprise small contributions of recent expositions to valenced context stimuli. Thus, in the paradigms that lead to contrast effects in speeded evaluative decisions, contrast effects should disappear and perhaps even give rise to assimilation when more fine-grained and less strictly speeded evaluative judgments are required.

A case in point may be Payne, Cheng, Govorun, and Stewart's (2005) affect misattribution procedure (AMP). In the AMP, the target is a Chinese character, and participants' task is to decide whether the character is more pleasant or less pleasant than the average Chinese character. Results indicate that characters preceded by positive primes are more often classified as more pleasant than average, and characters preceded by negative primes are more often classified as less pleasant (Payne et al., 2005).

The AMP task requires a more fine-grained evaluative analysis of the target than a simple good versus bad decision does; there is no correct or wrong response, and time pressure is less severe than in the typical evaluative priming paradigm. Perhaps most importantly, the Chinese characters themselves are more or less neutral and do not evoke pronounced and rapid changes in the valence counters on which the decision strategy in the psychophysical mechanism capitalizes. For these reasons, participants might instead base their evaluations on the counter states that eventually

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[11] From a broader perspective, as time pressure diminishes, judgment processes are more likely to be affected by active inferences, intrusions of different kinds of knowledge, and second-order priming effects, and similarly by output norms, self-presentation concerns, and other kinds of controlled voluntary elaborations (Fiedler, 2003), all of which may cause contrast effects. Thus, this argument requires a ceteris paribus assumption.

emerge after some target processing. Interestingly, when Gawronski and Deutsch (2006) combined the paradigm with two primes and the AMP task, assimilative priming effects were found for Prime 1 (Gawronski & Deutsch, 2006), in contrast to the reversed Prime 1 priming effects consistently observed in the paradigm with speeded evaluative decisions, but in line with the possibility that the AMP task prompts decisions based on counter states rather than counter changes.[12]

The dissociation between the effects of two primes in the AMP and in spontaneous evaluative decisions also touches the wider issue of the relationship of implicit and explicit attitudes. Implicit attitudes are typically operationalized by measures of spontaneous evaluations, whereas explicit attitudes are typically assessed by more fine-grained rating measures administered without time pressure. Dissociations between the two kinds of measures (e.g., contrast in spontaneous evaluation, assimilation in ratings) therefore do not necessarily imply that different representations (such as, e.g., associations vs. propositional representations or dual representations) are being tapped. Instead, as just illustrated, dissociations might reflect differences in process. Clearly, we need to know more about the processes underlying spontaneous evaluations as tapped in the evaluative priming paradigm and in related implicit measures to resolve this thorny issue.

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[12] Besides target neutrality and decreased speed pressure, another procedural difference was that the target in the AMP was shown only very briefly, for a duration of 100 ms, and then masked by a pattern mask, whereas the target in the speeded evaluative decision task remained clearly visible and on screen until the participant responded. Another possibility is therefore that the brief and masked target presentation in the AMP promoted the adoption of more inclusive evaluation windows.

References

Abrams, R. L., Klinger, M. R., & Greenwald, A. G. (2002). Subliminal words activate semantic categories (not automated motor responses). *Psychonomic Bulletin and Review, 9,* 100–106.

Arnold, M. B. (1960). *Emotion and personality: Vol. 1. Psychological aspects*. New York: University Press.

Banaji, M., & Hardin, C. (1996). Automatic stereotyping. *Psychological Science, 7,* 136–141.

Banse, R. (2001). Affective priming with liked and disliked persons: Prime visibility determines congruency and incongruency effects. *Cognition and Emotion, 15,* 501–520.

Bargh, J. A. (1997). The automaticity of everyday life. In R. S. Wyer (Ed.), *Advances in social cognition* (Vol. 10, pp. 1–49). Mahwah, NJ: Erlbaum.

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

Blair, I. V., & Banaji, M. R. (1996). Automatic and controlled processes in stereotype priming. *Journal of Personality and Social Psychology, 70,* 1142–1163.

Botvinick, M., Braver, T., Barch, D., Carter, C., & Cohen, J. (2001). Conflict monitoring and cognitive control. *Psychological Review, 108,* 624–652.

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

Celex. (1995). *The Celex lexical database: Release 2.* Nijmegen, the Netherlands: Center for Lexical Information.

Center for the Study of Emotions and Attention (CSEA-NIMH). (1995). *The international affective picture system: Digitized photographs.* Gainesville, FL: University of Florida, The Center for Research in Psychophysiology.

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.

Chen, M., & Bargh, J. A. (1999). Consequences of automatic evaluation: Immediate behavioral predispositions to approach or avoid the stimulus. *Personality and Social Psychology Bulletin, 25,* 215–224.

Chun, M. M., & Potter, M. C. (1995). A two-stage model for multiple target detection in rapid serial visual presentation. *Journal of Experimental Psychology: Human Perception and Performance, 21,* 109–127.

Clark-Carter, D. (2004). *Quantitative psychological research: A student's handbook.* New York: Psychology Press.

Cooper, W. H. (1981). Ubiquitous halo. *Psychological Bulletin, 90,* 218–244.

Correll, J., Park, B., Judd, C. M., & Wittenbrink, B. (2002). The police officer's dilemma: Using ethnicity to disambiguate potentially threatening individuals. *Journal of Personality and Social Psychology, 83,* 1314–1329.

Curtis, R. C., & Miller, K. (1986). Believing another likes or dislikes you: Behaviors making the beliefs come true. *Journal of Personality and Social Psychology, 51,* 284–290.

Dagenbach, D., & Carr, T. H. (1994). Inhibitory processes in perceptual recognition. Evidence for a center-surround attentional mechanism. In D. Dagenbach & T. H. Carr (Eds.), *Inhibitory processes in attention, memory, and language* (pp. 327–357). San Diego, CA: Academic Press.

De Houwer, J., Baeyens, F., & Field, A. P. (2005). Associative learning of likes and dislikes: Some current controversies and possible ways forward. *Cognition & Emotion, 19,* 175–196.

Derryberry, D. (1993). Attentional consequences of outcome-related motivational states: Congruent, incongruent, and focusing effects. *Motivation & Emotion, 17,* 65–89.

Duckworth, K. L., Bargh, J. A., Garcia, M., & Chaiken, S. (2002). The automatic evaluation of novel stimuli. *Psychological Science, 13,* 513–519.

Eder, A. (2006). *"Common Coding" von Handlung und Bewertung* [Common coding of action and valence]. Berlin, Germany: Logos.

Eder, A., & Klauer, K. C. (2007). Common valence coding in action and evaluation: Affective blindness towards response-compatible stimuli. *Cognition & Emotion, 21,* 1297–1322.

Eimer, M., & Schlaghecken, F. (1998). Effects of masked stimuli on motor activation: Behavioral and electrophysiological evidence. *Journal of Experimental Psychology: Human Perception and Performance, 24,* 1737–1747.

Fazio, R. H., & Olson, M. A. (2003). Implicit measures in social cognition research: Their meaning and use. *Annual Review of Psychology, 54,* 297–327.

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.

Fazio, R. H., & Towles-Schwen, T. (1999). The MODE model of attitude-behavior processes. In S. Chaiken & Y. Trope (Eds.), *Dual process theories in social psychology* (pp. 97–116). New York: Guilford.

Fechner, G. T. (1860). *Elemente der Psychophysik* [Elements of psychophysics]. Leipzig, Germany: Breitkopf und Härtel.

Fiedler, K. (2003). The hidden vicissitudes of the priming paradigm in evaluative judgment research. In J. Musch & K. C. Klauer (Eds.), *The* *psychology of evaluation: Affective processes in cognition and emotion* (pp. 109–137). Mahwah, NJ: Erlbaum.

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.

Fockenberg, D. A., Koole, S. L., & Semin, G. (in press). Priming in concert: Assimilation and contrast with multiple affective and gender primes. *Social Cognition.*

Frings, C., & Wentura, D. (2006). Strategy effects counter distractor inhibition: Negative priming with constantly absent probe distractors. *Journal of Experimental Psychology: Human Perception and Performance, 32,* 854–864.

Gawronski, B., & Deutsch, R. (2006). *Contextual contrast effects on measures of "implicit" evaluation: Hedonic contrast or stimulus-response compatibility?* Manuscript submitted for publication.

Gawronski, B., Deutsch, R., & Seidel, O. (2005). Contextual influences on implicit evaluation: A test of additive versus contrastive effects of evaluative context stimuli in affective priming. *Personality and Social Psychology Bulletin, 31,* 1226–1236.

Glaser, J. (2003). Reverse priming: Implications for the (un)conditionality of automatic evaluation. In J. Musch & K. C. Klauer (Eds.), *The psychology of evaluation* (pp. 87–108). London: Erlbaum.

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.

Goschke, T., & Dreisbach, G. (2008). Conflict-triggered goal-shielding attenuates background-monitoring for prospective memory cues. *Psychological Science, 19,* 25–32.

Gratton, G., Coles, M. G. H., & Donchin, E. (1992). Optimizing the use of information: Strategic control of activation and responses. *Journal of Experimental Psychology: General, 4,* 480–506.

Greenwald, A. G., Draine, S. C., & Abrams, R. L. (1996, September 20). Three cognitive markers of unconscious semantic activation. *Science, 273,* 1699–1702.

Greenwald, A. G., Klinger, M. R., & Liu, T. J. (1989). Unconscious processing of dichoptically masked words. *Memory & Cognition, 17,* 35–47.

Hager, W., & Hasselhorn, M. (1994). *Handbuch deutschsprachiger Wortnormen* [Handbook of German word norms]. Göttingen, Germany: Hogrefe.

Hermans, D., De Houwer, J., & Eelen, P. (2001). A time course analysis of the affective priming effect. *Cognition & Emotion, 15,* 143–165.

Hermans, D., Spruyt, A., De Houwer, J., & Eelen, P. (2003). Affective priming with subliminally presented pictures. *Canadian Journal of Experimental Psychology, 57,* 97–114.

Hochhaus, L., & Johnston, J. C. (1996). Perceptual repetition blindness effects. *Journal of Experimental Psychology: Human Perception and Performance, 22,* 355–366.

Hommel, B., Proctor, R. W., & Vu, K. L. (2004). A feature-integration account of sequential effects in the Simon task. *Psychological Research, 68,* 1–17.

Houghton, G., & Tipper, S. P. (1999). A model of selective attention as a mechanism of cognitive control. In J. Grainger & M. Jacobs (Eds.), *Localist connectionist approaches to human cognition (pp. 39–74).* Mahwah, NJ: Erlbaum.

Hutchison, K. A. (2007). Attentional control and the relatedness proportion effect in semantic priming. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33,* 645–662.

Jaśkowski, P., & Verleger, R. (2007). What determines the direction of subliminal priming. *Advances in Cognitive Psychology, 3,* 181–192.

Kanwisher, N. G., & Potter, M. C. (1990). Repetition blindness: Levels of processing. *Journal of Experimental Psychology: Human Perception and Performance, 16,* 30–47.

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

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 and emotion* (pp. 7–50). Mahwah, NJ: Erlbaum.

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

Klauer, K. C., Roβnagel, C., & Musch, J. (1997). List-context effects in evaluative priming. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23,* 246–255.

Klauer, K. C., & Teige-Mocigemba, S. (2007). Controllability and resource dependence in automatic evaluation. *Journal of Experimental Social Psychology, 43,* 648–655.

Lazarus, R. S. (1966). *Psychological stress and the coping process.* New York: McGraw-Hill.

Lombardi, W. J., Higgins, E. T., & Bargh, J. A. (1987). The role of consciousness in priming effects on categorization: Assimilation versus contrasts as a function of awareness of the priming task. *Personality and Social Psychology Bulletin, 13,* 411–429.

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.

Martin, I., & Levey, A. B. (1978). Evaluative conditioning. *Advances in Behaviour Research and Therapy, 1,* 57–102.

Milliken, B., Joordens, S., Merikle, P. M., & Seiffert, A. E. (1998). Selective attention: A re-evaluation of the implications of negative priming. *Psychological Review, 105,* 203–229.

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.

Musch, J. (2000). *Affektives Priming: Kongruenzeffekte bei der evaluativen Bewertung* [Affective priming: Congruency effects in evaluation]. Unpublished doctoral dissertation, University of Bonn, Germany.

Musch, J., Elze, A., & Klauer, K. C. (1998). Gibt es Wortlängeneffekte in der evaluativen Entscheidungsaufgabe? [Are there word length effects in evaluative decisions?]. *Zeitschrift für Experimentelle Psychologie, 45,* 109–119.

Musch, J., & Klauer, K. C. (2001). Locational uncertainty moderates affective priming effects in the evaluative decision task. *Cognition and Emotion, 15,* 167–188.

Naccache, L., Blandin, E., & Dehaene, S. (2002). Unconscious masked priming depends on temporal attention. *Psychological Science, 13,* 416–424.

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

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

Newman, L. S., & Uleman, J. S. (1990). Assimilation and contrast effects in spontaneous trait inference. *Personality and Social Psychology Bulletin, 16,* 224–240.

Ortony, A., Clore, G., & Collins, A. (1988). *The cognitive structures of emotions.* Cambridge, MA: Cambridge University Press.

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1957). *The measurement of meaning.* Urbana, IL: University of Illinois Press.

Pashler, H., & Baylis, G. (1991). Procedural learning: 2. Intertrial repetition effects in speeded-choice tasks. *Journal of Experimental Psychology, 17,* 33–48.

Payne, B. K. (2001). Prejudice and perception: The role of automatic and controlled processes in misperceiving a weapon. *Journal of Personality and Social Psychology, 81,* 181–192.

Payne, B. K., Cheng, C. M., Govorun, O., & Stewart, B. D. (2005). An inkblot for attitudes: Affect misattribution as implicit measurement. *Journal of Personality and Social Psychology, 89,* 277–293.

Ratcliff, R. (1978). A theory of memory retrieval. *Psychological Review, 85,* 59–108.

Rothermund, K. (2003). Motivation and attention: Incongruent effects of feedback on the processing of valence. *Emotion, 3,* 223–238.

Scherer, K. R. (1988). Criteria for emotion-antecedent appraisal: A review. In V. Hamilton, G. H. Bower, & H. Frijda (Eds.), *Cognitive perspectives on emotion and motivation* (pp. 89–126). Dordrecht, Netherlands: Kluwer.

Schwarz, N., & Bless, H. (2007). Mental construal processes: The inclusion/exclusion model. In D. A. Stapel & J. Suls (Eds.), *Assimilation and contrast in social psychology* (pp. 119–141). Philadelphia: Psychology Press.

Simmons, J. P., & Prentice, D. A. (2006). Pay attention! Attention to the prime increases attitude assessment accuracy. *Journal of Experimental Social Psychology, 42,* 784–791.

Spruyt, A., Hermans, D., De Houwer, J., Vanderkerckhove, J., & Eelen, P. (2007). On the predictive validity of indirect attitude measures: Prediction of consumer choice behavior on the basis of affective priming in the picture–picture naming task. *Journal of Experimental Social Psychology, 43,* 599–610.

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.

Strack, F., Schwarz, N., Bless, H., Kübler, A., & Wänke, M. (1993). Awareness of the influence as a determinant of assimilation versus contrast. *European Journal of Social Psychology, 23,* 53–62.

Teige-Mocigemba, S., & Klauer, K. C. (in press). “Automatic” evaluation? Strategic effects on affective priming. *Journal of Experimental Social Psychology.*

Treisman, A. (1996). The binding problem. *Current Opinion in Neurobiology, 6,* 171–178.

Versace, R., & Allain, G. (2001). Negative priming in a gender decision task and in a semantic categorization task. *Acta Psychologica, 108,* 73–90.

Voss, A., Leonhart, R., & Stahl, C. (2007). How to make your own response boxes: A step-by-step guide for the construction of reliable and inexpensive parallel-port response pads from computer mice. *Behaviour Research Methods, 39,* 797–801.

Wentura, D. (1999a). Activation and inhibition of affective information: Evidence for negative priming in the evaluation task. *Cognition and Emotion, 13,* 65–91.

Wentura, D. (1999b). *Masked priming in the evaluation task: A switch from positive to negative priming due to speed-accuracy instructions.* Unpublished manuscript, University Münster, Germany.

Wentura, D., & Rothermund, K. (2003). The “meddling-in” of affective information: A general model of automatic evaluation. In J. Musch & K. C. Klauer (Eds.), *The psychology of evaluation: Affective processes in cognition and emotion* (pp. 51–86). Mahwah, NJ: Erlbaum.

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

Appendix

Materials

Study 1

Prime Set 1: Negative Words

Hölle [hell], Krieg [war], Angst [fear], Armut [poverty], Panik [panic], Bomben [bombs], Ratten [rats], Kummer [worry], Verrat [betrayal].

Prime Set 1: Positive Words

Blüte [blossom], Glück [happiness], Liebe [love], Chance [opportunity], Garten [garden], Geduld [patience], Hawai [Hawaii], Sommer [summer], Schnee [snow], Geschenk [present], Feier [celebration], Party [party].

Prime Set 2: Negative Words

Krebs [cancer], Virus [virus], Ärger [annoyance], Elend [misery], Abfall [waste], Räuber [robber], Geisel [hostage], Leiche [corpse], Sklave [slave], Teufel [devil], Moskito [mosquito], Verlust [loss].

Prime Set 2: Positive Words

Genuss [enjoyment], Humor [humor], Wiese [lawn], Freund [friend], Strand [beach], Blumen [flowers], Urlaub [vacation], Kuchen [cake], Freitag [Friday], Kätzchen [kitten], Musik [music], Pizza [pizza].

Neutral Primes

Gelenk [joint], Gabel [fork], Quadrat [square], Brett [plank], Format [format], Winkel [angle], Epoche [epoque], Hektar [hectare], Betrag [amount], Metall [metal], Anlass [occasion], Thema [topic].

Negative Targets

Brutal [brutal], einsam [lonely], falsch [wrong], geizig [stingy], gierig [avaricious], kaputt [bust], lästig [bothersome], morsch [rotten], streng [stern], teuer [costly], krank [ill], feige [cowardly].

Positive Targets

Gesund [healthy], heiter [happy], lustig [funny], munter [alert], sonnig [sunny], sozial [prosocial], witzig [humorous], ehrlich [honest], gerecht [just], human [humane], sanft [tender], schön [beautiful].

Study 2

Prime Set 1: Animals

Eule [owl], Affe [monkey], Esel [ass], Dachs [badger], Lachs [salmon], Luchs [lynx], Kamel [camel], Gepard [cheetah], Storch [stork], Forelle [trout], Maulwurf [mole], Schimpanse [chimpanzee].

Prime Set 1: Plants

Farn [fern], Iris [iris], Rose [rose], Aster [aster], Minze [mint], Tanne [fir], Palme [palm], Dahlie [dahlia], Kiefer [pine], Flieder [lilac], Edelweiß [edelweiss], Feigenbaum [fig tree].

Prime Set 2: Animals

Elch [moose], Rabe [raven], Hase [rabbit], Otter [otter], Robbe [seal], Pudel [poodle], Spatz [sparrow], Seekuh [manatee], Ameise [ant], Giraffe [giraffe], Nilpferd [hippopotamus], Fledermaus [bat].

Prime Set 2: Plants

Erle [alder], Ulme [elm tree], Moos [moss], Esche [ash tree], Tulpe [tulip], Buche [beech], Linde [lime], Bambus [bamboo], Kaktus [cactus], Kirsche [cherry], Holunder [elder], Pusteblume [dandelion].

Neutral Primes

Gips [plaster], Seil [rope], Ecke [corner], Ampel [traffic lights], Liege [couch], Tasse [cup], Taste [key], Gelenk [joint], Würfel [dice], Graphik [graph], Schraube [screw], Verpackung [package].

Target Animals

Lama [llama], Igel [hedgehog], Maus [mouse], Amsel [blackbird], Panda [panda], Biber [beaver], Tiger [tiger], Dackel [dachshund], Frosch [frog], Hamster [hamster], Eidechse [lizard], Murmeltier [marmot].

Target Plants

Dill [dill], Efeu [ivy], Grass [grass], Ahorn [maple], Lilie [lily], Eiche [oak tree], Nelke [carnation], Fichte [fir], Krokus [crocus], Lorbeer [laurel], Lavendel [lavender], Petersilie [parsley].

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Call for Nominations: *Psychology of Violence*

The Publications and Communications (P&C) Board of the American Psychological Association has opened nominations for the editorship of ***Psychology of Violence*,** for the years 2011–2016. The editor search committee is chaired by William Howell, PhD.

> ***Psychology of Violence***, to begin publishing in 2011, is a multidisciplinary research journal devoted to violence and extreme aggression, including identifying the causes and consequences of violence from a psychological framework, finding ways to prevent or reduce violence, and developing practical interventions and treatments.
>
> As a multidisciplinary forum, ***Psychology of Violence*** recognizes that all forms of violence and aggression are interconnected and require cross-cutting work that incorporates research from psychology, public health, neuroscience, sociology, medicine, and other related behavioral and social sciences. Research areas of interest include murder, sexual violence, youth violence, inpatient aggression against staff, suicide, child maltreatment, bullying, intimate partner violence, international violence, and prevention efforts.

Editorial candidates should be members of APA and should be available to start receiving manuscripts in early 2010 to prepare for issues published in 2011. Please note that the P&C Board encourages participation by members of underrepresented groups in the publication process and would particularly welcome such nominees. Self-nominations are also encouraged.

Candidates should be nominated by accessing APA's EditorQuest site on the Web. Using your Web browser, go to http://editorquest.apa.org. On the Home menu on the left, find "Guests." Next, click on the link "Submit a Nomination," enter your nominee's information, and click "Submit."

Prepared statements of one page or less in support of a nominee can also be submitted by e-mail to Emnet Tesfaye, P&C Board Search Liaison, at Emnet@apa.org.

Deadline for accepting nominations is January 31, 2009, when reviews will begin.