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PRIMING IN CONCERT: ASSIMILATION AND CONTRAST WITH MULTIPLE AFFECTIVE AND GENDER PRIMES

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The present research investigated the influence of multiple sequential primes on social categorization processes. Study 1 examined an evaluative decision task in which targets were preceded and succeeded by two primes. As expected, the temporally closest forward primes had assimilative effects on target processing. Moreover, if the temporally closest forward prime and the target were congruent, backward affective primes had assimilative effects; if the temporally closest forward prime and the target were incongruent, the distal forward primes had contrastive effects. Study 2 found similar effects in a gender priming task. In a reanalysis of Gawronski, Deutsch, and Seidel (2005), Study 3 partly replicated Studies 1 and 2 with more complex and varied stimuli. The results indicate that people can flexibly extract and disentangle brief snapshots from a continuous stream of environmental stimulation.

Priming is a process by which environmental stimulation leads to the temporary activation of a mental representation or response tendency. Recent research indicates that virtually any psychological reaction can be primed. For instance, priming has been shown to influence people's feelings (Chartrand, van Baaren, & Bargh, 2006), goals (Förster, Liberman, & Friedman, 2007; Shah, 2005), social perception (Higgins, Rholes, & Jones, 1977), aggression (Bargh, Chen, & Burrows, 1996), intellectual performance (Dijksterhuis & van Knippenberg, 1998), and evaluation

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(Klauer & Musch, 2003). Consequently, priming appears to be a pervasive psychological phenomenon (Bargh, 1997; Bargh & Chartrand, 1999).

Recent research has moved from studying single priming events to the more complex interaction of multiple priming events (e.g., Ferguson & Bargh, 2003; Wittenbrink, Judd, & Park, 2001). This research takes an important step towards understanding how priming may operate under realistic conditions. One key question that arises in this context is how the influence of a series of priming events is combined in people's immediate responses towards environmental objects. Thus far, research has yielded mixed results: Some research has found that multiple priming events combine in an additive manner (Balota & Paul, 1996; Fockenberg, 2008). Such additive effects reflect an *assimilation* process, whereby primes blend together and direct processing in the direction of the prime. Other studies, however, have found evidence for a *contrast* process in multiple priming, such that a preceding prime increased the influence of a subsequent prime of opposite valence (Gawronski, Deutsch, & Seidel, 2005). To date, it has remained unresolved whether and when assimilation versus contrast of multiple primes are to be expected in multiple priming tasks.

In the present research, we propose a new conceptual model that integrates assimilative and contrastive effects of multiple primes. In particular, we suggest that people initially extract an assimilative, perceptual snapshot from the stream of multiple primes that is based on priming events within close temporal proximity of the target. If this initial perceptual snapshot yields clear-cut information, other priming stimuli are unlikely to have much influence on target processing. If the initial perceptual snapshot yields ambivalent information, however, people may engage in contrastive processing. In the following, we first provide a brief overview of assimilation and contrast effects in single stimulus contexts. Building on this research, we discuss a theoretical model that potentially integrates assimilation and contrast effects in multiple priming contexts. We then test this model in two experiments, and present a reanalysis of previous findings by Gawronksi and associates (2005).

ASSIMILATION AND CONTRAST IN SINGLE PRIMING TASKS

Over the last two decades, researchers in cognitive and social psychology have extensively studied the immediate influence of single priming events on human cognition. Most of this research makes use of a *sequential priming paradigm*, whereby prime and target are presented successively at short time intervals (i.e., stimulus onset asynchronies, SOA). In semantic priming, the semantic relationship between prime and target is varied, such that primes are either semantically related or unrelated to the target (McNamara, 2005). In affective priming, the affective relationship between prime and target is varied, such that primes are either affectively consistent or inconsistent with the target (Fazio, 2001; Klauer & Musch, 2003). Depending on the specific paradigm, participants are then to name or categorize the target stimulus as fast and accurate as possible, while ignoring the prime.

The most common finding across numerous semantic and affective priming studies is an assimilation effect, in particular at short SOAs. In semantic priming, primes appear to briefly activate semantically related information, as evidenced by faster response times and lower error rates for responding to semantically related rather than unrelated targets. In affective priming, primes appear to briefly activate affectively related information, as evidenced by faster response times and lower error rates for responding to affectively consistent rather than inconsistent targets. When the prime is irrelevant to the response towards the target (e.g., when participants simply have to pronounce the target), assimilation effects may be attributed to spreading activation (e.g., Fazio, 2001). When the prime is relevant to the response towards the target (e.g., when participants simply have to evaluate the target as good or bad after being primed with good or bad words), assimilation effects may attributed to response interference (e.g., De Houwer, 2003; Klauer & Musch, 2003).

Contrast effects have also been observed in sequential priming tasks. That is, primes sometimes promote responses to incongruent instead of congruent targets. Such contrast effects have been especially reported in affective priming (e.g., Fockenberg, Koole, & Semin, 2006; Glaser & Banaji, 1999; Hermans, 1996) and other bi-polar categorical priming tasks (e.g., gender priming, Versace & Allain, 2001). In particular, contrast effects occur with extreme primes (Banaji & Hardin, 1996) and/or when participants are high in accuracy motivation (Glaser, 2003; Wentura, 1999). Consequently, some authors have attributed contrast effects to correction processes (Glaser, 2003; Glaser & Banaji, 1999) whereby people overcorrect for primed information. Such correction processes are assumed to occur automatically and not require conscious deliberation. Alternatively, contrast effects have also been attributed to automatic inhibition processes, whereby information that is related to the targets gets automatically inhibited, when primes are sufficiently activated (Berner & Maier, 2004) or when targets are insufficiently activated (Dagenbach, Carr, & Barnhardt, 1990).

To our knowledge, no contrastive effects have been found in semantic priming research (McNamara, 2005). Presumably, this is because in semantic priming tasks, unrelated primes do not bear any relationship with the prime. Unrelated primes are unlikely to bias processing of the target in any specific direction. Accordingly, people may not see the need to engage in contrastive processing, or may even be unable to do so, given that the direction of a potential bias is unclear. By contrast, when a prime is the opposite of the target along some dimension, such as good versus bad or male versus female, it is obvious that the prime may bias target processing in a specific direction. For this reason, contrast effects are likely to be more prevalent in categorical priming tasks, such as the affective priming task, than in semantic priming tasks (e.g., Glaser, 2003; Wentura, 1999).

In sum, primes influence immediate target processing in assimilative and contrastive ways. Assimilation appears to be the more robust tendency, whereas contrast requires extreme primes, weak targets and/or accuracy motivation to occur. Notably, virtually all of the aforementioned research has used relatively fixed prime-target relationships with single primes or repeated prime sets. Most everyday environments are considerably more dynamic than this. Hence, the question arises how multiple, variable priming events are combined in people's immediate responses to target objects (Bargh, 2006; Ferguson & Bargh, 2003; Fockenberg, 2008).

THE INTERACTION OF MULTIPLE PRIMES

In recent years, researchers have begun to address more complex interactions between multiple, variable primes. For instance, two recent investigations presented participants with sequences of three stimuli: a positive or negative context picture, a black or white face and a target adjective, which had to be evaluated (Barden, Maddux, Petty, & Brewer, 2004; Wittenbrink et al., 2001). Across studies, black faces yielded more negative automatic evaluations than white faces, if they were preceded by a negative context. After a positive context prime, however, the reversed pattern or no differences between black and white face primes were found. This pattern could be seen as an assimilation effect between the context and face primes, whereby the context prime changed the evaluative meaning of the black faces (cf., Murphy & Zajonc, 1993). However, because both investigations used rather blatant context primes at relatively long presentation times (i.e., 1 second to several minutes), this may have allowed for more complex processing other than priming (see Barden et al., 2004).

Additional research has addressed the impact of more short-lived multiple primes on target processing (Balota & Paul, 1996; Fockenberg, 2008; Gawronski et al., 2005). These studies allow for the assessment of more immediate influences of sequential prime combinations on target processing, which most closely simulates the extraction of information of a dynamic stream of stimulation. Using semantic priming tasks, two sets of studies investigated the effects of sequential primes on subsequent target processing (Balota & Paul, 1996; Milberg, Sullivan, & Blumstein, 1998). In this research, participants were exposed to three letter strings in succession, which could be semantically related or unrelated. Between experiments, participants were either to pronounce the third letter string or decide whether it was a word or nonword. Across experiments, the two primes had additive effects on target processing, indexing an assimilation effect. However, in this research, the unrelated primes had no relationship with the targets. Consequently, participants may not have been motivated enough or unable to contrast the prime with the target (cf., Glaser, 2003; Stapel & Koomen, 2001, 2006).

A recent set of affective priming studies investigated the combined influence of multiple categorical primes (Fockenberg, 2008). In this research, participants had to respond to the valence of the target (i.e., evaluative decision task), and the targets appeared between the two primes (i.e., a forward and backward prime, Fockenberg et al., 2006). Across three experiments, an assimilation effect between both primes and the target emerged, whereby the forward prime became more dominant at somewhat higher prime-target intervals. More short-lived, but similar priming effects were found in two additional experiments, in which participants categorized the gender instead of the valence of the target stimuli (i.e., a gender decision task, Klauer & Musch, 2002). Consequently, assimilation of multiple primes has also been found in affective priming and priming of semantically bi-polar categories (i.e., gender).

Affective and other bi-polar, categorical primes allow people to contrast one category with the other (i.e., good vs. bad, male vs. female). Consequently, contrast effects may be possible for multiple categorical primes as well, in particular for distinct stimuli and at higher time intervals (cf., Stapel & Koomen, 2001, 2006). Consistent with this, recent affective priming research has obtained first evidence for a contrastive influence of two forward primes (Gawronski et al., 2005). In this research, participants performed an evaluative decision task. This time, the valenced target words were preceded by two sequentially presented valenced primes. Across experiments, a contrastive effect was found: The priming effect of the second forward prime was enhanced by an incongruent first prime. Accordingly, experiments using multiple categorical priming stimuli such as valence and gender have found evidence for both assimilation (Fockenberg, 2008) and contrast (Gawronski et al., 2005) effects. It remains unclear, however, when assimilation versus contrast are to be expected in multiple priming tasks.

OVERVIEW OF THE PRESENT RESEARCH

In the present research, we propose an integrative model that specifies how and when multiple primes have assimilation or contrast effects on target processing. Our theoretical model draws on compound cue theory (Ratcliff & McKoon, 1988), which proposes that during binary decision tasks, prime and target combine to form a compound cue to memory, whereby the familiarity of this compound then serves as basis for subsequent decisions. Within the scope of the present model, we hereby adopt a somewhat broader definition of "familiarity" as the general congruency of the stimuli in terms of the dimension, and assume that participants instigate contrastive processes, if the compound does not yield sufficiently congruent information.

Our model assumes that people continually and automatically activate prime information upon environmental stimulation (cf., Bargh & Chartrand, 1999; Stapel & Koomen, 2006). Once a target is detected, people extract an initial perceptual snapshot from the incoming stream of stimulus activation (i.e., a compound cue, Ratcliff & McKoon, 1988). If this perceptual snapshot yields a congruent pattern, target processing can be concluded and a given response initiated. However, if rapid changes occur during the extraction of the perceptual snapshot or extremely distinct primes are still active, the perceptual snapshot will be ambivalent, and require contrastive processes to disentangle the accumulated information. That is, people will have to break down the jointly activated information into distinct prime and target presentations and correct for irrelevant information via suppression to conclude target processing (cf., Glaser, 2003; Wentura & Rothermund, 2003).

As an initial test of our theoretical model, we conducted two experiments. In Study 1, participants performed an affective priming task, in which they were presented with five schematic affective stimuli. Participants were to evaluate the third stimulus on valence. In Study 2, participants performed a gender priming task which employed the same presentation parameters as Study 1. Using simple, schematic stimuli in Studies 1 and 2 allowed us to obtain a clear and noise-free estimation of the joint influence of multiple stimuli. However, it remains important to see if our model also applies to more complex and diverse pictorial and verbal stimuli. In Study 3, we therefore conducted a reanalysis of the data collected by Gawronski et al. (2005). The main goal of this study was to see whether our findings would translate to more diverse and complex stimulus environments, and across different task parameters and researchers.

Throughout the present studies, we expected that the primes in closest temporal proximity to the target would yield assimilation effects, as they would be absorbed into the initial perceptual compound. We further expected that the congruency of this prime-target compound would determine the influence of the temporally more distal primes. If the prime-target compound is congruent, no further contrastive processes are needed and responding will be quick and accurate. If the prime-target compound is incongruent, however, additional contrastive processes are needed to resolve the task. Consequently, processing time will increase, as well as the chance of error due to source confusion and for contrast effects due to automatic overcorrection. We predicted that contrast effects would be most apparent in temporally more distal forward primes. 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. By the same logic, an incongruent prime-target compound would instigate contrastive processing and thereby might suppress the activation of backward primes before they reach the necessary activation level to impact target processing. Accordingly, we predicted that backward primes would have no effects of target processing when the proximal prime-target compound was incongruent.

STUDY 1: AFFECTIVE PRIMING

Study 1 provided an initial investigation of the interaction between two forward primes and two backward primes in the evaluative decision task. The experimental stimuli consisted of schematic drawings of an angry and a happy human face (see Figure 1). These stimuli were developed by Öhman, Lundqvist, and Esteves (2001) and pre-tested in our participant sample (Jostmann, Koole, van der Wulp, & Fockenberg, 2005). We used these stimuli in the present research because faces are known to be particularly strong and significant affective primes (Zajonc, 1980). Furthermore, the use of schematic stimuli should limit the amount of irrelevant noise to provide clear and strong priming patterns, which is important given the complexity of possible stimulation patterns of sequences of five stimuli. The affective primes in Study 1 were presented sequentially on a within-trial basis at four different SOAs (i.e., 300 ms, 150 ms, -150 ms, and -300 ms). Based on previous research we expected to replicate cumulative priming effects at 300 ms, 150 ms, and -150 ms (Fockenberg, 2008; Gawronski et al., 2005). In particular, we expected to find an assimilation effects at an SOA of +150 ms and –150 ms, and contrast effects at an SOA of around 300 ms. The contrast effects should hereby be particularly pronounced, if the target and the adjacent forward prime are incongruent, as participants will have to contrast the target from its surrounding primes.

METHOD

Participants and Design

Sixty-four volunteers (46 women, 18 men, average age = 21 years) at the VU University Amsterdam participated in the experiment. Participants were exposed to sequences of five affectively polarized stimuli: two forward primes, a target, and two backward primes. In Studies 1 and 2, the valence of all primes was defined

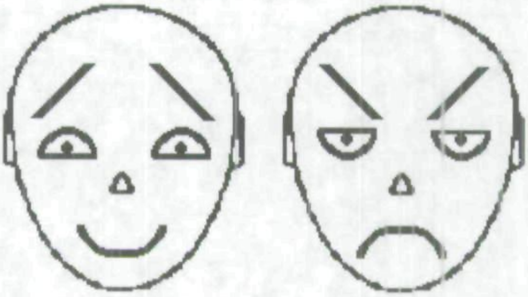

FIGURE 1. Stimuli of Study 1.

with regard to its congruency with the valence of the target. Consequently, the resulting design was a 2(forward prime 1: congruent/incongruent) x 2(forward prime 2: congruent/incongruent) x 2(backward prime 1: congruent/incongruent) x 2(backward prime 2: congruent/incongruent) within-subjects design. Response keys were counterbalanced between subjects.

Procedure and Materials

Upon arrival, participants were led to individual cubicles that contained a computer. The rest of the experiment was administered by a computer program. The program informed participants that they were to participate in a concentration task, which in reality consisted of the evaluative decision task. In particular they would be repeatedly exposed to five faces, whereby the third one would be presented in red, the others in black. Their task would be to indicate whether the third, red face was either positive or negative via two keys (i.e., "a" and "l", labeled as "+" and "-," respectively). Furthermore, participants were told neither to attend to nor to respond to the preceding and subsequent black faces. As can be seen in Figure 1, the experimental stimuli consisted of schematic drawings of an angry and happy human face. These stimuli were developed by Öhman, Lundqvist, and Esteves (2001) and pre-tested in our participant sample (Fockenberg et al., 2007; Jostmann et al., 2005). The stimuli were presented in black or red at 140 x 152 pixels.

Participants received 8 practice trials, which were drawn at random from of all possible combinations of the design, with the restriction that there were equal numbers of positive and negative targets. During practice trials, feedback was provided and participants were given the opportunity to repeat the trials, if they wished, before starting the actual task. The subsequent evaluative decision task consisted of 3 identical blocks, each of which had 64 trials. Within each block, each unique combination of stimuli was presented two times. Participants could take a short break between blocks. During experimental trials, no feedback was given and the computer recorded participants' response time and accuracy.

The sequence of events in the evaluative decision task was as follows: First, a fixation point (***) was presented for two seconds and replaced by the first black face (forward prime 1), which remained on screen for 100 ms. The forward prime was replaced by a blank screen for 50 ms, after which the second black face was

TABLE 1a. Mean RTs as a Function of Prime Congruency (Study 1)

Forward prime1	Forward prime2	Backward prime1	RTs
IC	C	C	551[a]
C	C	C	563[a]
IC	C	IC	586[b]
C	C	IC	598[b]
IC	IC	IC	632[c]
IC	IC	C	633[c]
C	IC	C	674[d]
C	IC	IC	703[d]

Note. The abbreviation "C" refers hereby to primes that are congruent with the target valence; "IC" refers to primes that are incongruent with the target valence. Different superscripts indicate significantly different RTs.

presented (forward prime 2). The second black face remained on screen for 100 ms, and was then replaced by a blank screen for 50 ms, before the red target face was shown. The red target face remained on screen for 100 ms, and was replaced by a blank screen for 50 ms, which was replaced by a third black face (backward prime 1) for 100 ms. Next, another blank screen was presented for 50 ms, which was followed by the fourth black face (backward prime 2). Finally, the fourth black face was replaced by a blank screen, which remained until participants responded. In short, the primes had within-trial SOAs of 300 ms (forward prime 1), 150 ms (forward prime 2), -150 ms (backward prime 1) and -300 ms (backward prime 2).

RESULTS

One participant (1.6% of the entire sample) was excluded from analyses, because she had made more errors than three standard deviations of the rest of the sample. Response times of incorrect responses, below 300 ms (2.7%) and above 1500 ms (1.9%) were excluded from analyses. Average response times (RTs) were 614 ms, average error rates (ERs) were 17.6%. Log-transformed RTs and ERs were subjected to a 2(forward prime 1: congruent/incongruent) x 2(forward prime 2: congruent/incongruent) x 2(backward prime 1: congruent/incongruent) x 2(backward prime 2: congruent/incongruent) repeated measures analysis of variance (ANOVA).

To facilitate interpretation, we report untransformed means throughout the article.

RESPONSE TIMES

The RTs revealed significant main effects for both forward primes and the first backward prime. In particular, participants were slower to evaluate the target stimulus when it was preceded by a congruent in contrast to incongruent first forward prime (i.e., SOA = 300 ms), $F(1,61) = 28.33$, $p < .001$, $\eta^2_p = .32$ ($M = 635$ vs. $M = 600$). Thus, the first forward prime elicited an overall *contrastive effect* on target processing (cf., Gawronski et al., 2005). Participants were faster to evaluate the

TABLE 1b. Mean ERs as a Function of Prime Congruency (Study 1)

Forward prime1	Forward prime2	Backward prime1	ERs
C	C	C	7.8[a]
IC	C	C	7.8[a]
C	C	IC	10.8[b]
IC	C	IC	11.0[b]
IC	IC	C	16.7[c]
IC	IC	IC	22.1[d]
C	IC	C	28.4[e]
C	IC	IC	36.0[f]

Note. The abbreviation 'C' refers hereby to primes that are congruent with the target valence; 'IC' refers to primes that are incongruent with the target valence. Different superscripts indicate significantly different ERs.

target stimulus when it was preceded by a congruent rather than an incongruent second forward prime (SOA = 150 ms), $F(1,61) = 166.97, p < .001, \eta^2_p = .73$ ($M = 575$ vs. $M = 660$). Likewise, participants were faster to evaluate the target stimulus if it was succeeded by a congruent in contrast to incongruent first backward prime (SOA = -150 ms), $F(1,61) = 5.15, p < .001, \eta^2_p = .29$ ($M = 605$ vs. $M = 630$). Thus, the forward and backward primes that were in nearest temporal proximity to the target yielded an *assimilation effect* with regard to the target. Finally, the second backward prime (SOA = -300) had no influence on target processing, $F(1,61) < 1$(cf., Fockenberg, 2008).

The main effects of the primes were qualified by a significant forward 1 x forward 2 interaction, $F(1,61) = 21.18, p < .001, \eta^2_p = .26$, a marginally significant forward 1 x backward 1 interaction, $F(1,61) = 2.75, p < .10, \eta^2_p = .04$ and a significant forward 2 x backward 1 interaction, $F(1,61) = 5.01, p < .05, \eta^2_p = .08$. Most importantly, these interactions were qualified by a marginally significant forward 1 x forward 2 x backward 1 interaction, $F(1,61) = 3.41, p = .07, \eta^2_p = .05$.[1]

As can be seen in Table 1a, the following pattern can be derived from the observed interaction effects: First, the second forward prime elicited the strongest influence on target processing. If the second forward prime was congruent with the target, processing was always faster than if it was incongruent, irrespective of the valence of the other primes, $Fs(1,61) \geq 23.88, p < .0001$.

Second, the second forward prime qualified the influence of both the first forward and first backward prime. In particular, if the second forward prime was congruent, the first backward prime exerted a similar, but weaker assimilation effect, $F(1,61) \geq 6.35$, $ps \leq .01$. On the contrary, the contrast effect of the first forward prime did not reach significance, $Fs(1,61) \leq 2.17$, $ps \geq .15$. If the second forward prime was incongruent, the role between the first forward and first backward prime was reversed. In that case, there was a clear (contrast) effect of the first for-

1. There were also a marginally significant forward 2 x backward 1 x backward 2 interaction, $F(1,61) = 5.2.84, p = .10, \eta^2 = .04$, and a marginally significant four way interaction, $F(1,61) = 3.23$, $p = .08, \eta^2 = .05$. However, in contrast to the reported three way interaction neither reached any significance in the untransformed data, both $F(1,61) \leq 2.30, p \geq .14$. We therefore decided to focus on the three way interaction (i.e., forward 1 x forward 2 x backward 1).

ward prime, $Fs(1,61) \geq 16.03$, $ps < .005$, and a less pronounced priming effect of the first backward prime, i.e., $F(1,61) < 1$, $F(1,61) = 7.10$, $p = .01$.

ERROR RATES

The analysis of the ERs revealed a similar pattern as the RTs in the main effects (see Table 1b). Again, there were significant main effects for both forward primes and the first backward prime. In particular, participants also made more errors to evaluate the target, when it was preceded by a congruent rather than incongruent first forward prime (SOA = 300), indicating a *contrastive effect* for the first prime onto target processing, $F(1, 62) = 37.12$, $p < .001$, $\eta^2_p = .38$ (M = 20.8% vs. M = 14.4%). In contrast, participants made fewer errors to evaluate the target, when it was preceded by a congruent rather than incongruent second forward prime (SOA = 150), $F(1,62) = 112.19$, $p < .001$, (SOA = 150), $\eta^2_p = .64$ (M = 9.4% vs. M = 25.8%). Likewise, participants made fewer errors, if the target was succeeded by a congruent in contrast to incongruent first backward prime (SOA = -150 ms), $F(1,62) = 47.44$, $p < .001$, $\eta^2_p = .43$. That is, both the second forward and first backward prime had *assimilation effects* on target processing (Fockenberg, 2008).

Importantly, the influence of both primes was qualified by a significant forward 1 x forward 2 interaction, $F(1,61) = 52.75$, $p < .001$, $\eta^2_p = .46$, and a significant forward 2 x backward 1 interaction, $F(1,61) = 5.59$, $p < .05$, $\eta^2_p = .08$. No other interactions reached statistical significance, $F(1,61) \leq 2.28$, $p \geq .14$.

The interaction between both forward primes was due to a strong assimilation effect of the second forward prime onto target processing, which qualified the somewhat weaker contrast effect of the first forward prime. In particular, the second forward prime revealed clear assimilation effects, irrespective of whether the first forward prime was congruent, $F(1,62) = 127.55$, $p < .0001$ (M = 9.3% vs. M = 32.2%), or incongruent, $F(1,62) = 43.73$, $p < .0001$ (M = 9.4% vs. M = 19.4%). If the second forward prime was congruent, the congruency of the first forward prime did not yield any significant effect, $F(2,62) < 1$ (M = 9.3% vs. M = 9.4%). When the second prime was incongruent, however, the first prime elicited a significant *contrast effect*, $F(1,62) = 50.90$, $p < .0001$ (M = 19.4% vs. M = 32.2%).

The interaction between the second forward prime and the first backward prime revealed an additive priming effect of both primes. In line with previous research (Fockenberg, 2008), forward priming was stronger than backward priming. In particular, participants made the least errors, if both primes where congruent with the target (M = 7.8%). They made more errors, if either the forward (M = 22.6%) or backward prime (M = 10.9%) where incongruent, both $Fs(1,62) \geq 16.33$, $p < .0001$. Participants made most errors, if both forward and backward prime were incongruent, $F(1,62) \geq 30.68$, $p < .0001$. Although both forward and backward priming were significant, the dominance of forward over backward priming can be seen (a) in the difference of effect size between pairs with either incongruent forward or backward prime with regard to all congruent pairs (i.e., $\eta^2_p = .21$ vs. $\eta^2_p = .57$) and (b) the fact that participants made more mistakes if the forward prime rather than the backward prime was incongruent, M = 10.9% vs. M = 22.6%, $F(1,62) = 43.25$, $p < .0001$).

DISCUSSION

Study 1 investigated the influence of multiple affective primes on evaluative processing. In line with the notion that people initially extracted a perceptual compound from the sequence of stimuli, participants displayed assimilative priming effects for the temporally proximal forward primes. The proximal forward prime also had overall the strongest influence on target processing. The proximal forward prime and the target may thus form the locus of the priming effect--and thus can be seen as the core of the perceptual snapshot. As expected, the congruency of this snapshot determined the influence of the other primes. If the proximal forward prime was congruent with the target's valence, the distal forward prime did not yield any clear contrastive influence on target processing, although the proximal backward prime showed clear assimilation effects. In contrast, if the proximal forward prime was incongruent with the target's valence, the distal forward prime yielded a contrastive influence on target processing, whereas backward primes had no influence on target processing.

In terms of our theoretical model, a congruent proximal prime and target may form a clear perceptual core. This core may allow for a quick classification of the target and render lingering activation of the distal forward prime ineffective. Proximal backward primes may then serve as either additional affirmation or a "bump on the road." If the proximal forward prime is incongruent with the target, however, the ambivalence of the perceptual snapshot (i.e., proximal forward prime and target) may be resolved by contrasting the target against its surroundings. The contrast effects might occur due to the initiation of automatic correction processes, which break the compound into distinct units and suppress irrelevant information. Due to the initiation of these automatic correction processes the lingering activation of the distal forward prime gets overcorrected, and thus yields contrast effects. The absence of any backward priming effects under these circumstances probably indicates that the backward primes are suppressed before they reach the necessary activation level to meddle with target processing.

STUDY 2: GENDER PRIMING

We designed Study 2 to see if we could replicate our observed pattern of assimilation and contrast effects for nonaffective stimuli. As can be seen in Figure 2, we modified the schematic faces of Study 1 by adding gender information in the form of male or female hair styles and removing affective information from the schematic face. Recent research indicates that hair is a powerful cue to gender information (Macrae & Martin, 2007; Martin & Macrae, 2007). Accordingly, we reasoned that hair cues would form a suitable basis for a categorization and priming processes in Study 2.

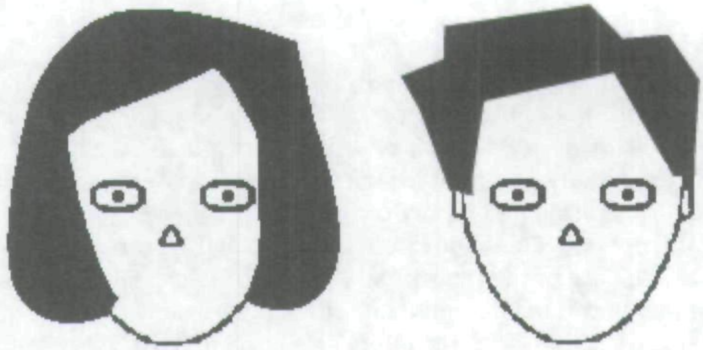

FIGURE 2. Stimuli of Study 2.

METHOD

Participants and Design. Sixty-four volunteers (40 woman, 24 men, average age = 21 years) at the VU University Amsterdam participated in the experiment.

In this experiment, participants were exposed to a series of five gendered stimuli: two forward primes, a target, and two backward primes. Because our present interest was in the influence of the gender congruency of all primes with regard to the target, the gender congruency of all primes was defined with regard to the target gender. Consequently, the resulting design was a 2(forward prime 1: congruent/incongruent) x 2(forward prime 2: congruent/incongruent) x 2(backward prime 1: congruent/incongruent) x 2(backward prime 2: congruent/incongruent) within-subjects design. Response keys were counterbalanced between subjects.

Procedure and Materials. The procedure and materials were identical to Study 1. The main difference was that (a) a modified version of the schematic faces of Study 1 was used that included gender, but no valence cues (see Figure 2 for the experimental stimuli), and (b) participants were asked to indicate whether the third, red-colored face was male or female.

RESULTS

Two participants (3.1% of entire sample) were excluded from analyses, because they made more errors than three standard deviations of the rest of the sample. Response times of incorrect responses, below 300 ms (3.6%) and above 1500 ms (0.9%) were excluded from analyses. Average response times (RTs) were 522 ms, average error rates (ERs) were 9.5%. Log-transformed RTs and ERs were subjected to a 2(forward prime 1: congruency) x 2(forward prime 2: congruency) x 2(backward prime 1: congruency) x 2(backward prime 2: congruency) repeated measures analyses of variance (ANOVA).

TABLE 2a. Mean RTs as a Function of Prime Congruency (Study 2)

Forward prime1	Forward prime2	Backward prime1	RTs
IC	C	C	485[a]
IC	C	IC	488[a]
C	C	C	491[a]
C	C	IC	501[a]
IC	IC	C	524[b]
IC	IC	IC	530[a]
C	IC	C	572[c]
C	IC	IC	585[d]

Note. The abbreviation "C" refers hereby to primes that are congruent with the target gender; "IC" refers to primes that are incongruent with the target gender. Different superscripts indicate significantly different RTs.

RESPONSE TIMES

The analysis of the RTs revealed a significant main effect for the congruency of both forward primes, and the first backward prime. That is, participants were slower to categorize the target stimulus, when it was preceded by a congruent rather than incongruent first forward prime (SOA = 300), $F(1,60) = 132.42$, $p < .001$, $\eta^2_p = .69$ ($M = 537$ vs. $M = 507$). That is, a *contrast* effect of the first forward prime on target processing emerged. Participants were faster to categorize the target stimulus when it was preceded by a congruent rather than incongruent second prime (SOA = 150), $F(1,60) = 164.49$, $p < .001$, $\eta^2_p = .73$ ($M = 491$ vs. $M = 553$). Likewise, participants were faster to evaluate the target stimulus if it was succeeded by a congruent in contrast to incongruent prime at an SOA of -150 ms, $F(1,60) = 7.95$, $p < .01$, $\eta^2_p = .12$ ($M = 518$ vs. $M = 526$). That is, both the second forward and first backward prime yielded *assimilation effects*. Finally, the second backward prime (SOA = -300) had no influence on target processing, $F(1,61) < 1$ (Fockenberg, 2008).

The influence of both forward primes was qualified by a significant forward 1 x forward 2 interaction, $F(1, 61) = 85.88$, $p = .001$, $\eta^2_p = .59$. No other interaction emerged, $F(1,60) \leq 1.34$, $ps \geq .25$. As can be seen in Table 2a, the gender priming task yielded similar effects as the evaluative decision task, in particular for primes before onset of target processing. In particular, the second forward prime yielded strong gender priming, irrespective of whether the first forward prime was congruent, $F(1,60) = 173.50$, $p < .0001$ ($M = 496$ vs. $M = 579$), or incongruent, $F(1,62) = 100.13$, $p < .0001$ ($M = 486$ vs. $M = 527$).

Again, the second forward prime qualified the influence of the first forward prime, whereby contrast effects of the first forward prime was increased, if the second prime was incongruent with the target. That is, the first forward prime had a marginally significant contrast effect, if the second prime was congruent, $F(2,60) = 3.79$, $p =. 06$ ($M = 496$ vs. $M = 486$), but a much stronger, significant contrast effect, if the forward prime was incongruent, $F(1,60) = 221.23$, $p < .0001$ ($M = 579$ vs. $M = 527$).

TABLE 2b. Mean ERs as a Function of Prime Congruency (Study 2)

Forward prime1	Forward prime2	Backward prime1	ERs
IC	C	C	4.4[a]
IC	C	IC	5.2[a]
C	C	C	6.3[a]
C	C	IC	6.5[a]
IC	IC	IC	11.4[b]
IC	IC	C	11.5[b]
C	IC	C	15.4[c]
C	IC	IC	15.5[c]

Note. The abbreviation "C" refers hereby to primes that are congruent with the target gender; "IC" refers to primes that are incongruent with the target gender. Different superscripts indicate significantly different ERs.

ERROR RATES

The analysis of the ERs revealed a similar, yet more short-lived priming pattern than the RTs (see Table 2b). Again, significant main effects for both forward primes were found, but no backward priming. Participants made more errors to evaluate the target, when it was preceded by a gender-congruent in contrast to a gender-incongruent first prime (SOA = 300), indicating again a *contrast* effect of the first prime on the target processing, $F(1, 61) = 11.76$, $p = .001$, $\eta^2_p = .16$ ($M = 10.9\%$ vs. $M = 8.1\%$), (cf., Gawronski et al., 2005). Participants made fewer errors to evaluate the target, when it was preceded by a congruent in contrast to incongruent second prime (SOA = 150), $F(1,61) = 34.62$, $p < .001$, (SOA = 150), $\eta^2_p = .36$ ($M = 5.6\%$ vs. $M = 13.4\%$). Finally, neither backward prime (SOA = -150 or -300) had a significant influence on target processing, both $Fs(1,61) < 1$.

Importantly, the effects of the primes where qualified by a marginally significant forward prime 1 x forward prime 2 interaction, $F(1, 61) = 3.29$, $p = .07$, $\eta^2_p = .05$. No other interaction effects reached statistical significance, $F(1,61) \leq 2.17$, $p \geq .15$. In particular, the interaction between the two forward primes revealed a contrastive effect of the first and an assimilation effect of the second prime. Again, the second forward prime yielded the strongest influence on target processing: it revealed strong gender priming irrespective of whether the first forward prime was congruent, $F(1,61) = 31.70$, $p < .0001$ ($M = 6.4\%$ vs. $M = 15.4\%$), or incongruent, $F(1,61) = 24.02$, $p < .0001$ ($M = 4.8\%$ vs. $M = 11.4\%$).

The first forward prime also revealed a significant contrast effect, when the second forward prime was congruent, $F(1,61) = 5.77$, $p < .05$ ($M = 6.4\%$ vs. $M = 4.8\%$), and even more reliably so pronounced when the second forward prime was incongruent, $F(1,61) = 9.13$, $p < .005$ ($M = 15.4\%$ vs. $M = 11.4\%$).

DISCUSSION

Study 2 investigated the influence of multiple, schematic gender primes on gender decisions. Overall, the gender priming task appeared to be easier than the previous affective priming task, as indicated by lower response times and error rates. This could be explained by a potentially weaker influence of gender primes on target processing (cf., Fockenberg, 2008) or the fact that the gender primes had fewer distinctive features (i.e., hair) compared to the affective primes (i.e., brows, eyes, mouth). The gender classification task may therefore have been easier to perform than the evaluative decision task. Priming effects can be regarded as "intrusions" or "meddling" influences (Wentura & Rothermund, 2003), an easier focal task may leave more cognitive resources for participants to push aside the meddling influence of priming events.

Though the priming effects in Study 2 were more short-lived, the basic pattern was strikingly similar to the observed pattern in Study 1. Again, the temporally proximal forward prime yielded the strongest priming influence on the target, and thus can be seen as the core of the perceptual snapshot. Similar to Study 1, the distal forward prime yielded a contrastive influence on target processing, which was particularly pronounced if the proximal forward prime was incongruent with target processing. If the proximal forward prime was congruent with the target processing, a (marginally) significant contrast effect still occurred, but the effect was much weaker. These weaker unconditional contrast effects are likely due to the distinctiveness of the primes (see Figure 2). Past research indicates that distinctive primes are more likely to infiltrate the perceptual compound to some degree and trigger some basic contrast processes (Glaser & Banaji, 1999; Stapel & Koomen, 2001, 2006).

In sum, the findings of Study 1 and 2 are in line with the compound cue model. In both studies, the contrast effects of the distal prime were moderated by the congruency between the proximal forward prime and the target: if the latter were incongruent, strong contrast effects were found; if they were congruent no or weaker (marginal) contrast effects occurred. The degree to which contrastive processes emerged depended on the clarity of the core of the perceptual snapshot, which in both studies was formed by the proximal forward prime and the target.

STUDY 3

Because Studies 1 and 2 included a limited number of schematic faces as stimuli, it remains an open question whether our findings were due to changes between the stimuli's identity rather than their broader category. Although such within-stimulus changes are of interest in their own right (Hugenberg & Bodenhausen, 2003, 2004; Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001), it remains important to determine whether our findings also generalize to priming of more complex objects. As it turns out, Gawronski et al. (2005) collected relevant data to this issue. We therefore conducted a reanalysis of the Gawronski et al.'s data in Study 3. This reanalysis sought to establish whether our findings generalized to more complex stimuli. Moreover, the reanalysis allowed us to see whether the rather complex pattern observed in our experiments was replicated by a different group of researchers in a different country.

TABLE 3a. Mean RTs as a Function of Prime Congruency (Study 3a)

Forward prime1	Forward prime2	RTs
IC	C	600
C	C	610
IC	IC	624
C	IC	627

Note. The abbreviation "C" refers hereby to primes that are congruent with the target valence; "IC" refers to primes that are incongruent with the target valence. The effects of both primes were not qualified by a significant interaction.

Study 3a - Reanalysis of Gawronski et al.'s (2005) Experiment 1: Affective Priming with Multiple, Variable Complex Pictures

In their first experiment, Gawronski et al. (2005) presented participants with two sequential forward primes in an evaluative decision task, using complex positive and negative pictures as primes (i.e., IAPS, Lang, Bradley, & Cuthbert, 2001) and positive and negative words as targets. The specific sequence of events in Gawronski et al.'s first experiment was somewhat different from ours, yet comparable: The first prime was presented for 133 ms, followed by the second prime for 133, a blank screen for 34 ms and the target, which remained visible until response.

Gawronski et al.'s (2005) analysis concentrated on the influence of the first prime as a moderator of the second primes influence on target processes. Accordingly, they coded and analyzed their data with a focus on the relationship between the second prime and the target for different values of the first prime. Their analyses did not consider the joined influence of both forward primes on congruent/incongruent target processing, which is central to the present investigation. We therefore reanalyzed Gawronski et al.'s data, using the same analytic strategies as in our Studies 1 and 2. In this manner, we sought to shed more light on the combined influence of more diverse, complex and abstract primes as well.

RESULTS

Our reanalyses were conducted on the original data set that was provided by Gawronski et al. (2005). Prior to analysis, all incorrect responses and RTs above 1,000 ms had been removed from the data set. In the remaining data set, the average RT was 615 ms, and the average ER was 5.0%. Due to the small ERs, we restricted the analyses to the RTs, as did Gawronski et al. These were subjected to a 2(forward prime 1: congruency) x 2(forward prime 2: congruency) repeated measures analyses of variance (ANOVA).

The analyses of the RTs revealed a significant main effect for the congruency of both primes. This effect indicated that participants were slower to evaluate the target stimulus, when it was preceded by a congruent rather then incongruent first prime (SOA = 300 ms), $F(1,32) = 4.26$, $p < .05$, $\eta^2_p = .12$ ($M = 619$ vs. $M = 612$). Thus, in line with our Studies 1-2, a *contrast* effect of the first prime on target processing emerged. Participants were faster to evaluate the target stimulus, when it was preceded by a congruent rather than incongruent second prime (SOA = 167 ms),

TABLE 3b. Mean RTs as a Function of Prime Congruency (Study 3b)

Forward prime1	Forward prime2	RTs
IC	C	588[a]
C	C	592[a]
IC	IC	595[a]
C	IC	608[b]

Note. The abbreviation "C" refers hereby to primes that are congruent with the target valence; "IC" refers to primes that are incongruent with the target valence. Different superscripts indicate significantly different RTs.

$F(1,32) = 22.10$, $p < .001$; $\eta^2_p = .41$ ($M = 606$ vs. $M = 625$). That is, the second prime yielded a strong *assimilation effect*.

The effects of both primes were not qualified by a significant interaction, $F(1,32) = 1.30$, $p = .26$. The first prime thus elicited contrast effects, irrespective of the congruency between the second prime and the target. Relevant means are displayed in Table 3a.

Study 3b - Reanalysis of Gawronski et al.'s (2005) Experiment 2: Affective Priming with Multiple, Variable Words

In their second experiment, Gawronski et al.'s (2005) again presented participants with two sequential forward primes in an evaluative decision task at the same presentation times. This time, however, they used positive, negative, and neutral nouns as primes for positive and negative adjectives.

RESULTS

In the second experiment by Gawronski et al. (2005), the average RT was 597 ms, the average ER was 4.1%. Due to the small ERs, the analyses was again restricted to the RTs as did Gawronski et al. The RTs were subjected to a 2(forward prime 1: congruency) x 2(forward prime 2: congruency) repeated measures analyses of variance (ANOVA).

The analyses of the RTs revealed a significant main effect for the congruency of both primes. Participants were slower to evaluate the target stimulus, when it was preceded by a congruent rather then incongruent first prime (SOA = 300 ms), $F(1,39) = 9.36$, $p =.004$, $\eta^2_p = .19$ ($M = 600$ vs. $M = 591$). Thus, as in our Studies 1 and 2, a *contrast* effect of the first prime on target processing emerged. In contrast, participants were faster to evaluate the target stimulus, when it was preceded by a congruent rather than incongruent second prime (SOA = 167 ms), $F(1,39) = 15.29$, $p < .001$; $\eta^2_p = .28$ ($M = 590$ vs. $M = 601$). Thus, similar to our results in Studies 1-2, the second prime yielded a somewhat stronger *assimilation effect*.

As expected, the effect of both primes was qualified by a prime 1 x prime 2 interaction, $F(1,39) = 5.13$, $p < .05$, $\eta^2_p = .12$. As can be seen in Table 3b, the RTs displayed a similar pattern with that in Study 1 and 2. The second forward prime again elicited the strongest influence on target processing, and qualified the effects of the first prime: If the second prime was congruent with the target, the first prime did exhibit no significant contrast effect, $F(1,39) = 1.63$, $p = .21$. If the second prime was incongruent with the target, the first prime showed clear *contrast effects*, $F(1,39) = 14.20, p = .0005$.

DISCUSSION

In Study 3 we reanalyzed data of two experiments reported in Gawronski et al. (2005). These reanalyses allowed us to investigate the influence of diverse and complex multiple primes on evaluative decisions. Overall, both experiments yielded somewhat weaker priming effects, which can be attributed to the use of more variable, complex and abstract primes. Nevertheless, similar priming effects to those found our experiments emerged. As in Studies 1 and 2, the temporally proximal forward prime yielded strong assimilative priming effects on the adjacent target. Furthermore, the distal forward prime again had a contrastive influence on target processing.

Notably, Study 3a yielded unconditional contrast effects, which might be attributed to the use of complex IAPS pictures. That is, similar to Study 2, these unconditional contrast processes are likely due to the extremity and thus distinctiveness of the primes (cf., Glaser, 2003; Stapel & Koomen, 2001, 2006). In general, IAPS pictures tend to be vivid and evaluatively extreme, depicting, among others, close-ups of babies and baby seals as positive stimuli and mutilated body parts as negative stimuli. Conceivably, these primes were therefore stronger, and remained activated for a longer time. This could have led to a stronger impact of those primes thereby rendering the perceptual snapshot more ambivalent and initiating contrastive correction and comparison processes.

The effects of Gawronski et al.'s (2005) second experiment, which used words as primes, were more similar to ours, because words are generally known to be less strong and obtrusive affective primes (e.g., De Houwer & Hermans, 1994). Consequently, it makes sense that the effects of the verbal primes was again moderated by the congruency of the second prime and the target (i.e., the perceptual snapshot). These findings fit with the idea that people extract an assimilative snapshot from dynamic priming events and flexibly initiate contrastive processes, when the snapshot yields ambivalent information.

GENERAL DISCUSSION

In the present research, we investigated how a dynamically changing sequence of primes jointly influences target processing. Based on compound cue theory (Ratcliff & McKoon, 1988), we proposed that people initially extract an assimilative perceptual snapshot from such dynamic environments. Contrastive processing should occur mainly to the extent that this initial perceptual snapshot yields ambivalent information. To test this prediction, we conducted an affective and gender decision task, in which participants were presented with five schematic affective or gender stimuli. Subsequently, we conducted a reanalysis of Gawronski et al. (2005), to see whether our findings would translate to more diverse and complex stimulus environments, and across different task parameters and researchers.

In line with the notion of an assimilative snapshot, we found strong assimilative priming effects between the target and the temporally adjacent forward prime.

The proximal forward prime and the target could be seen as the core of the perceptual snapshot. In addition, this assimilative snapshot may also include prime information that occurs after onset of target processing. This was suggested by the finding that backward priming had an assimilative effect in Study 1, provided that the proximal forward prime and the target were congruent.

In line with the proposed, flexible contrastive processes, the influence of the temporally more distal primes was moderated by the congruency of this perceptual snapshot. When the compound consisted of incongruent prime-target pairs (Studies 1 and 2, Study 3b) or when temporally distal forward primes were very distinctive (Study 2, Study 3a) the more distal forward prime had a contrastive influence on target processing. This pattern of findings indicates that temporally more distal primes may only affect target processes when the core perceptual compound (consisting of the proximal forward prime and the target) is ambivalent or when temporally more distal primes are very vivid and distinctive and hence difficult to ignore. Overall, the present studies draw a coherent picture across diverse priming stimuli (schematic faces, complex pictures, words) and processing (evaluative or gender categorization), that suggests that people navigate through dynamic environments via fast assimilative and flexible contrastive processes.

On a broader theoretical level, the finding of flexible contrast effects hereby poses both support and challenge to existing models of sequential priming. Classic spreading activation accounts do not include any inhibitory mechanisms (e.g., Klauer & Musch, 2003). Accordingly, the contrast effects that were observed in the present research once more suggest that affective and otherwise bi-polar categorical priming is not solely due to spreading activation within neural networks. Especially as the time between prime and target increases, more conditional mechanisms may influence how primed information gets processed.

Some recent spreading activation models do allow for inhibitory processes. For instance, the activation dependent inhibition model (ATI, Maier, Berner, & Pekrun, 2003) proposes that if super-ordinate representation is sufficiently strengthened, automatic spreading activation turns into inhibition of related information. Consequently, it can explain the occurrence or contrast effects due to prime extremity, as found in the present and recent research (i.e., Studies 2 and 3; Glaser & Banaji, 1999). However, it fares less well with the flexible nature of contrastive processing due to incongruence of prime-target compounds (i.e., Studies 1, 2, 3b). If contrast effects are solely due to activation dependent inhibition, one would expect that two congruent forward primes should lead to slower target processing than two incongruent forward primes. This, as both primes together should strengthen the super-ordinate representation (e.g., positive) which should foster inhibition of a congruent target. As clear from the data pattern, this is not the case.

The flexible contrast effects that were observed in the present research are highly compatible with automatic correction processes, which have been proposed to explain contrastive affective priming effects (Glaser, 2003). As suggested by Glaser and Banaji (1999, p. 682), such a fast and automatic "correction processes is instigated by the perceived potential of the peripheral prime to bias the response to the intended target." Whereas this previously has primarily been used to explain effects of prime extremity (cf., Studies 2 and 3a), the present research suggests that, in addition, temporally close, incongruent primes may similarly be perceived as a potential source of bias that needs compensation. As suggested by the lack of backward priming after incongruent prime-target compounds, primes that occur after target onset may be more easily ignored.

The present findings extend prominent interference models of (affective) priming (Klauer & Musch, 2003; Wentura & Rothermund, 2003). In these models, the categorization process is described as a decision process that accumulates evidence for the potential responses over time. Once the threshold for one of the responses is passed, a response can be elicited. The present assimilation effect of temporally close primes can be explained by the need to resolve conflicting response tendencies supported by incongruent prime and target pairs. The explanation for the flexible contrastive processes at higher SOA depend on the specific model applied.

For instance, Klauer and Musch's (2003) model explains the reversal of priming effects at higher SOAs by assuming that primes are strategically allocated large negative attentional weights at higher SOAs (e.g., Klauer, Rossnagel, & Musch, 1997). The present findings, however, suggest that the allocation of negative weights does not only depend on SOA between a prime and a target, but can also be influenced by the congruency of later primes with the target. A possible explanation may be that incongruent prime-target combinations require overall longer processing time, thereby allowing for an extended decrease of positive and increase of negative attentional weight to already activated prime information.

The Center-Surround-Inhibition Theory (CSI, Dagenbach, Carr, & Barnhardt, 1990) proposes that if a memory code of a target concept is weakly activated, the activation that stems from related items will additionally interfere with the processing of the target. Consequently, a CSI mechanism counteracts the interference of related items by maintaining the activation of the target presentation, while simultaneously inhibiting the activation of all related concepts. Notably, this could explain the snapshot dependent contrast effects, in particular for Studies 1 and 2, whereby congruent prime and target information could be seen as prolonged target presentation that does not activate the CSI mechanism. However, Study 3 reported similar effects for diverse stimuli. Consequently, one would have to assume that a congruent prime-target pair is processed as one memory code (cf., compound cue), and thus does not elicit the CSI mechanism, even though the specific target is weakly activated for congruent and incongruent prime-target compounds. Moreover, the CSI theory does not explain the general contrast effects due to extreme primes, as found in our own and previous research (i.e., Studies 2 and 3; Glaser & Banaji, 1999), unless one defines the weakness of the memory code of the target in relation to the prime activation.

LIMITATIONS AND AVENUES FOR FUTURE RESEARCH

Although the present research provides an informative glimpse at the flexible nature of assimilation and contrast in dynamic stimulus environments, it leaves many important questions to be addressed in future research. First, although the reanalysis of Gawronski et al. (2005) allowed us to generalize the effects of affective primes to more complex and variable primes, we still only applied one face per gender category. As a consequence of the recurrent use of identical faces, we cannot infer whether the obtained gender effects are really due to higher order categorization processes (e.g., male vs. female). Instead the present contrastive gender priming effects could be grounded in lower perceptual processes (i.e., identity of the face; same vs. different). Notably, previous research already found contrastive gender priming (Versace & Allain, 2001) in single priming research, and overall similar gender and affective priming effects in multiple priming research (Fockenberg, 2008). Together, this may add some credence to the existence of contrastive gender priming effects in multiple priming. Nevertheless, future research still needs to empirically confirm the existence of such effects for more complex stimuli.

Second, the present research exclusively studied the evaluative decision and gender decision task. Although these are the most commonly applied and reliable paradigms in affective and gender priming research (Klauer & Musch, 2003; Lemm, Dabady, & Banaji, 2005), they share one drawback: they require explicit categorization of the target stimuli. As a consequence, these tasks may heighten the salience of the category of attention, and thereby foster response interference effects (De Houwer, 2003) and stronger priming effects (cf., Fockenberg et al., 2006). It will be important to establish in future research whether similar contrast effects in multiple priming can be found in tasks that do not require explicit categorization.

Third, similar to other well-established priming paradigms (i.e., naming tasks, lexical decision task) the present categorical decision tasks required relatively simple, analytic processing of a single target. Everyday information processing often involves more complex processing of environmental stimulation. Consequently, future research may look into the role of ongoing environmental stimulation on more complex focal stimulus processing. For instance, it would be informative to address how integrative target processing, whereby multiple targets are integrated into overall responses over time, are influenced by multiple priming.

CONCLUDING REMARKS

In their daily lives, people are exposed to a never-ending stream of dynamically changing information. The present research suggests that, in this continuous concert of primes, the human mind may flexibly extract and disentangle brief snapshots from the continuous flow of environmental stimulation. In this way, automatic priming and flexible correction processes allow people to make sense of a dynamic world.

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