Affect and action : contrasting conscious and nonconscious processes

Rotteveel, M.

Publication date
2003

CHAPTER 3

LOADING WORKING MEMORY ENHANCES AFFECTIVE PRIMING*

Stronger affective priming (Murphy & Zajonc, 1993) with suboptimal (i.e., reduced consciousness) than with optimal prime presentation (i.e., full consciousness) suggests that nonconscious processes form an important part of emotions. Merikle and Joordens (1997) argued that both impoverished presentation and divided attention can produce suboptimal conditions and result in parallel effects. We manipulated attention by means of a concurrent working memory load while keeping presentation duration constant, when participants evaluated Japanese ideographs that were preceded by happy, neutral, or angry (affective priming), and male or female (non-affective priming) faces. In contrast to non-affective priming, affective priming was larger with divided attention than with focused attention. It is concluded that manipulations of stimulus quality and of attention can both be used to probe the distinction between conscious and nonconscious processes and that the highest chances of obtaining the stronger-suboptimal-than-optimal pattern are in the affective domain.

To investigate what it means whether or not a stimulus is processed consciously, Baars and McGovern (1992; see also Merikle, 1992) proposed the general method of experimentally manipulating level of consciousness and contrasting the effects of conscious (optimal) and less conscious (suboptimal) conditions (i.e., a contrastive analysis). It can be applied to many independent variables and has provided a number of qualitative differences (e.g., Cheesman & Merikle, 1984; Groeger, 1984, 1988; Jacoby & Whitehouse, 1989), suggesting that conscious and nonconscious processes do not always have the same form. In addition, the finding of stronger effects in less conscious than in fully conscious conditions, contradicts the view that suboptimal processing constitutes only diluted conscious processing (i.e., some trials were inadvertently processed consciously). This type of result has primarily been found in the affective domain (Bornstein, 1989; Fulcher & Hammerl, 2001; Janssen, Everaerd, Spiering & Janssen, 2000; Murphy & Zajonc, 1993; Stapel, Koomen, & Ruys, 2002; Chapter 2), whereas weaker-suboptimal-than-optimal effects are usually obtained in other, more non-affective,

*This Chapter is a slightly adapted version of Rotteveel, M., & Phaf, R.H. (In press). Loading working memory enhances affective priming. *Psychonomic Bulletin and Review.*

domains (e.g., Lubke, Kerssens, Phaf, & Sebel, 1999; Maxfield, 1997; Murphy & Zajonc, Experiments 3-6; but see De Fockert, Rees, Frith, & Lavie, 2001). Merikle and Joordens (1997) argued that dividing attention and impoverished (i.e., short, masked) presentation can both be used to produce suboptimal conditions, so that both should have corresponding effects. To our knowledge, however, this correspondence has not been explicitly studied in the affective domain. We investigated whether stronger-suboptimal-than-optimal affective priming (Murphy & Zajonc, 1993) also occurs when suboptimal conditions are achieved by dividing attention instead of by impoverished presentation and whether this contrasted to non-affective priming.

Murphy and Zajonc (1993) investigated priming on affective and non-affective evaluation of unfamiliar Chinese ideographs. Affectively valenced (i.e., happy or angry faces) and control (polygons, faces with neutral expressions) stimuli were presented either in a suboptimal (4 ms, about 10 ms effectively, see Winkielman, Zajonc & Schwarz, 1997), or optimal fashion (1000 ms) by means of a projection tachistoscope. Because the absence of an effect in a (direct) task measuring conscious effects cannot guarantee that all conscious processing was exhaustively excluded (Cheesman & Merikle, 1984), the cautious terminology of suboptimal and optimal, instead of subliminal and supraliminal, presentation was adopted by Murphy and Zajonc. In the first two experiments, happy and angry faces led to reliable, valence-congruent, shifts in ideograph evaluation only with suboptimal prime presentation. The stronger suboptimal than optimal results preclude the possibility that suboptimal effects are only caused by conscious processing 'leaking through'. Non-affective priming of size (Experiment 3), symmetry (Experiment 4), and gender (Experiment 5), however, only revealed congruent shifts in optimal conditions.

In Chapter 2 it is argued that the finding of stronger-suboptimal-than-optimal affective priming may be rather brittle and sensitive to problems associated with impoverished prime presentation. Eye-blinks or saccades may, for instance, cause participants to miss suboptimal primes. Because one is effectively blind during a saccade (Morgan, 1994; Tovée, 1996), a brief stimulus presented during the saccade cannot exert a priming effect. The stronger-suboptimal-than-optimal affective priming pattern may, thus, be weakened only with short presentation due to the influence of saccades. Single frame presentation on a computer screen may also dilute suboptimal effects. The picture is built up pixel by pixel and line by line. The visibility of a single pixel corresponds to the effective persistence of the specific phosphor used in the screen (about 4 ms, Bridgeman, 1998). This time is generally shorter than a single screen frame and prime presentation may sometimes be too short to allow for any processing at all. Impoverished presentation may, furthermore, allow for a confounding of presentation condition and instruction. Murphy and Zajonc (1993) only instructed participants to ignore the faces in optimal conditions, but did not tell them about the suboptimal primes. The participants may have applied the controlled strategy of counteracting the prime influences only in optimal conditions, whereas in suboptimal conditions no effort was spent to discard possible effects of the faces. Although in Chapter 2 stronger-suboptimal-than-optimal priming with impoverished presentation was obtained when instructions were equated, it seems better to have some form of suboptimal presentation which allows more fully for the application of the same instruction.

Merikle and Joordens (1997) proposed that manipulations of attention and of stimulus quality (i.e., in terms of presentation duration and masking) have parallel effects. They obtained equivalent effects of both manipulations with false recognition, exclusion failure and a variant of the Stroop-task. To achieve suboptimal processing, attention was diverted away from a stimulus that was presented as long as in the optimal conditions. Monitoring a sequence of auditory digits for three consecutive odd digits served to divide attention. Merikle and Joordens argued that finding similar qualitative differences supports the view that both manipulations address the same underlying process distinction (i.e., of conscious and nonconscious processing). In terms of a contrastive analysis, both manipulations may thus serve to reduce level of consciousness.

Merikle and Joordens' (1997) position is strengthened further if the stronger-suboptimal-than-optimal pattern is also reproduced with attentional manipulations. Affective priming seems to be most suited, because the pattern appears to be predominant in the affective domain (but see Clore & Ortony, 2000). A non-affective priming task was, however, also included to further investigate whether affective value was indeed the critical factor in the priming pattern. We manipulated attention in both an affective priming (i.e., with emotional faces as primes) and non-affective priming (i.e., male and female faces serving as primes) task. Attention was varied by concurrently loading working memory (see Mulligan and Stone, 1999). Participants were instructed to maintain, and reproduce at the end of the trial a digit-letter string of 7 elements with divided attention, or an empty string (i.e., a "-") with focused attention. Participants were instructed emphatically to perform the concurrent working-memory task as accurately as possible. They also had to judge intuitively whether Japanese ideographs (see also Chapter 2) preceded by the faces either represented something positive or negative (i.e., affective task), or something masculine or feminine (i.e., non-affective task). We expected stronger affective priming and weaker non-affective priming under conditions of divided than of focused attention.

Method

Participants

In total ninety-six (65 female) first-year psychology students (M=21.96 year, SD=2.69) from the University of Amsterdam participated in the two tasks for course credit. All were right-handed and had normal or corrected-to-normal vision. The experiment was announced as a test of "Intuitive knowledge of the Japanese language". Only naive participants with regard to eastern languages were enrolled. The participants were divided in two groups of 48 for the affective and non-affective priming tasks, respectively.

Design

The affective task had a 2 (focused vs. divided attention) x 3 (happy, neutral, vs. angry face) mixed-factorial design, and the non-affective task a 2 (focused vs. divided attention) x 2 (male vs. female face) mixed-factorial design. Attention was manipulated between participants. The coupling of prime to target was counterbalanced over participants. Order of presentation was randomized by the computer for each participant, individually. Affective and gender ratings of the ideographs served as dependent variables. As an exploratory dependent variable, the proportion of correct reproductions of individual string elements was calculated per condition for each participant.

Material and apparatus

Forty-eight pictures (measuring 12.5 cm x 15.8 cm on the screen in gray scales) of Caucasian models (24 female) with happy, neutral, and angry facial expressions were selected from the Ekman and Friesen (1976) and Matsumoto and Ekman (1988) picture sets. Also 24 male and 24 female faces with a neutral expression (transformed to the same format as the affective pictures) served as primes (Lundqvist, Flykt, & Öhman, 1998). In pilot experiments, the selected faces received the most consistent ratings on their respective attributes. The 48 prime faces for the non-affective task were, moreover, judged affectively neutral in these experiments. Forty-eight different Japanese ideographs of equal complexity (i.e., consisting of 10-12 black strokes on a light background) served as targets. Forty-eight different digit-letter strings consisting of seven elements (e.g., 3D6F8G2) were prepared for the divided attention conditions. The strings consisted of digits (1-9) and letters (B, C, D, F, G, H, J, K, L) that were combined in a string according to three rules: every string started with a digit, digits and letters were alternated, and digits and letters were not repeated within a string.

Participants made two-alternative-forced-choice ratings with their index finger on marked keys from the keyboard. The labels (the ideograph either represented something 'negative' or 'positive' or something 'masculine' or 'feminine') were balanced over both keys across participants. The experiment was controlled by a Power Macintosh 4400/200 computer equipped with a 15 inch screen. Viewing distance was approximately 60 cm, resulting in an 11.8° horizontal and 14.8° vertical visual angle. The fixation-point was presented for 500 ms and was followed by a blank field for 500 ms. The digit-letter-string (or "-", with zero load) appeared for 3.5 s, and was followed by a blank field for 1 s. The second fixation-point was presented for 0.5 s, immediately followed by the face for 1 s, after which the target was presented for 1 s. If a string was presented before the trial, participants typed on the keyboard what they remembered of the string after rating the ideograph.

Procedure.

To determine individual working-memory capacity, a modified Dutch version of the 15-words test (Deelman, 1990) was first administered. Participants were instructed to reproduce lists of Dutch words spoken by the experimenter. List length started with two and after two lists each time increased with one additional word until a length of seven words was reached. Whenever participants make a mistake in one of the two lists with the same number of words, the preceding number of words was taken as the verbal working memory span.

Participants were instructed that the experiment was about intuitive knowledge of the meaning of signs from an unfamiliar language. They were informed that this knowledge presumably surfaces best when they are actively engaged in another task. The importance of the concurrent working-memory task was stressed and participants were encouraged to keep trying although they would probably not succeed in reproducing all strings correctly. They were also told to ignore the faces appearing before the ideographs which served to increase the concurrent load in other experimental conditions. Participants first practiced on the rating task for 10 trials. After 24 experimental trials, a two-minute break was given. The experiment was concluded by an exit interview.

Results

Participants, generally, reported to have been well aware of the faces before the ideographs, even with divided attention. Working-memory load was relatively homogeneous with divided attention throughout the two tasks. The average scores on the 15-words test (see Table 1) did not differ significantly between the four groups. In the divided attention conditions the affective primes did not clearly influence string reproduction (positive 0.52, SD=0.16, neutral 0.53, SD=0.12, negative 0.55, SD=0.13,), nor did the gender primes in the non-affective task (male 0.61, SD=0.16; female 0.63, SD=0.17).

The affective and non-affective ratings (see Table 2) were first subjected to a combined analysis. To have the same number of levels of the factor 'Prime' in the affective and the non-affective tasks, the neutral condition in the former task was omitted. Because we are primarily interested in differential priming patterns between divided and focused attention conditions, the actual coding of the judgments does not matter. We choose to code both negative and masculine ratings by a '1', and positive and feminine ratings by a '2'. In the 2 (affective vs. non-affective task) x 2 (divided vs. focused attention) x (prime '1' vs. prime '2') ANOVA only the type of prime constituted a within-participants factor. If the stronger-suboptimal-than-optimal priming pattern only occurred in affective conditions, a three-way interaction between task, attention, and prime would be expected. This interaction was indeed found to be significant ($F(1,92)=7.03$, $p<0.01$). In addition, an overall priming effect ($F(1,92)=27.0$, $p<0.01$) and a Task x Prime interaction ($F(1,92)=7.25$, $p<0.01$) were obtained. Prime '1' (1.45, SD=0.16) and Prime '2' (1.57, SD=0.16) resulted overall in congruent ideograph ratings. The priming effect was, moreover, somewhat larger in the affective (negative 1.43, SD=0.18; positive 1.62, SD=0.15) than in the non-affective task (male 1.46, SD=0.14; female 1.52, SD=0.14). No further main or interaction effects were significant. To see whether the effect of dividing attention indeed diverged in the affective and non-affective tasks, the two tasks were analyzed separately.

Table 1. *Average verbal working-memory span (SD) in the 15-words test for the participant groups in the focused and divided attention conditions of the affective and non-affective priming conditions.*

	focused attention	divided attention
affective	4.96 (0.86)	4.96 (0.55)
non-affective	5.20 (0.72)	4.88 (0.68)

Affective priming

Ideographs were overall evaluated congruently with the affective primes (positive 1.62, *SD*=0.15; neutral 1.52, *SD*=0.14; negative 1.43, *SD*=0.18). Because the affective ratings of the happy, neutral, and angry faces in the pilot experiment obeyed a linear relationship, a linear trend could also be expected in the priming effects. The overall linear trend of affective valence ($F(1, 92)=24.2$, $p<0.01$) was indeed significant and was qualified by an interaction with attention condition ($F(1, 92)=5.47$, $p<0.05$), indicating that the priming effect was stronger with divided than with focused attention (see Table 2). No significant quadratic trends were observed (*F*s<1). Planned comparisons revealed that with divided attention priming by positive faces differed reliably from priming by negative faces (paired, one-tailed $t(23)=5.79$, $p<0.01$), whereas this difference did not reach the level of significance with focused attention ($t(23)=1.66$, $p=0.0553$). Affective priming was not qualified by participant gender in any respect. In the divided attention condition, moreover, there was no significant relation (r=0.27, n.s.) between string performance and affective priming (i.e., the ideograph rating difference with positive and negative primes).

Table 2a. *Means (SD) of the affective ratings (1=negative, 2=positive) as a function of attention and of facial expression.*

	focused attention	divided attention
positive	1.56 (0.17)	1.69 (0.11)
neutral	1.52 (0.16)	1.54 (0.11)
negative	1.46 (0.18)	1.39 (0.18)

Table 2b. *Means (SD) of the non-affective ratings (1=masculine, 2=feminine) as a function of attention and of model gender.*

	focused attention	divided attention
male	1.42 (0.12)	1.50 (0.17)
female	1.52 (0.12)	1.52 (0.17)

Non-affective priming

In view of the expectations, a-priori tests were performed. With focused attention the priming effect (see Table 2) was significant (paired, one-tailed $t(23)=3.19$, $p<0.01$), but it disappeared with divided attention ($t(23)=0.467$, n.s.). Participant gender again did not influence the priming effects. With divided attention, moreover, the strength of priming again did not depend on string performance (r=0.19, n.s.).

Discussion

Stronger affective priming occurred with divided than with focused attention, but non-affective conditions showed the more classical pattern of weaker priming with divided attention. The notion that dividing attention and impoverished presentation have parallel effects (Merikle & Joordens, 1997) is, therefore, supported by the finding of stronger-suboptimal-than-optimal affective priming and of weaker-suboptimal-than-optimal non-affective priming with both types of manipulations. The finding of parallel effects by Merikle and Joordens and by us clearly suggests that the same type of conscious processing is affected by impoverished presentation and by dividing attention. These results, moreover, imply that predominantly nonconscious processes can be studied even under conditions in which participants subjectively report to be aware of the primes. They, therefore, support the notion than no direct measure can be used to exhaustively exclude all conscious processing (Cheesman & Merikle, 1984; Merikle, 1992) and that a contrastive analysis is the better research strategy for characterizing conscious and nonconscious processes.

Dividing attention for obtaining suboptimal presentation not only has practical advantages, but also has theoretical implications. Alternative interpretations in terms of timing of stimuli (e.g., habituation processes) can be excluded due to the matching of presentation durations. With divided attention, moreover, less conscious perception may be excluded than with impoverished presentation. Participants, generally, reported to have seen the face preceding the ideograph even when working memory was loaded. This remaining consciousness with divided attention only presents a problem, when one wants to exhaustively exclude all consciousness and wants to show that all remaining processing must be nonconscious (an indirect-without-direct effect; Merikle, 1992). Creating suboptimal conditions by dividing attention, thus, only makes sense in a contrastive analysis and not if one wants to obtain an indirect-without-direct effect. The generalization of these effects to other consciousness manipulations further strengthens the idea that a fundamental contrast is involved and that the distinction between conscious and nonconscious processes is meaningful.

Clore and Ortony (2000) have attacked the notion that stronger-suboptimal-than-optimal priming is specific for emotion. They argued that it should be explained in the same way as other types of priming, and claimed that "The only difference is that the visual mask, which ensures that the image is available for only a few milliseconds, interferes with the episodic knowledge of having seen the stimulus. But it does not interfere with the semantic knowledge of what was seen." (p.43) This fails to explain, however, why in similar conditions the opposite pattern (i.e., weaker-suboptimal-than-optimal priming; Murphy & Zajonc, 1993, Experiments 3-6) should occur with non-affective priming. The participants in our experiment, moreover, appeared well able to report the presence of faces despite the working memory load. Episodic knowledge was, thus, not suppressed by dividing attention. If anything, moreover, dividing attention actually reduces semantic processing (e.g., Craik, Govoni, Naveh-Benjamin, Anderson, 1996; Mulligan & Stone, 1999). When participants, for instance, searched a prime word for a specific letter and attention was redirected to non-semantic stimulus attributes, semantic priming was reduced or even disappeared (Maxfield, 1997). If affective priming is equivalent to semantic priming, we should, therefore, have obtained less, instead of more, affective priming with divided attention.

The stronger-suboptimal-than-optimal pattern does not seem restricted only to the affective domain. De Fockert et al. (2001) recently reported stronger-suboptimal-than-optimal interference by (non-emotional) faces in a name classification task. A working-memory load resulted in increased face-related activity in the visual cortex due to the distracter faces and increased interference effects. Fockert et al. argued that working memory is a prerequisite for directing attention to relevant stimuli and ignoring irrelevant stimuli. To also explain our results, however, the idea that divided attention decreased conscious control (i.e., to ignore the faces), so that nonconscious response tendencies become more dominant, needs to be supplemented with the hypothesis that such response tendencies are generally stronger for affective than for non-affective stimuli. Because affective processes may be biologically (and genetically) prepared (Öhman, 1986; Öhman & Mineka, 2001), there is a higher chance of finding such nonconscious tendencies in the affective domain than in other domains. It does not preclude, however, the occurrence of the stronger-suboptimal-than-optimal pattern outside affective processing (e.g., due to the highly automatized tendency to recognize faces; De Fockert et al., 2001). Even with affective processing, moreover, the inhibition of nonconscious processing may result from learning and our extensive training to exclude emotions from conscious reasoning.

The present account of affective priming (for a more detailed connectionist model, see Den Dulk, Capalbo, & Phaf, 2003) still allows for some attentional modulation of emotional face processing, even at the lowest levels. Pessoa, McKenna, Gutierrez, and Ungerleider (2002) obtained evidence in a fMRI study for top-down influences of attention, even at the level of the amygdala. At first sight, this would seem at odds with our finding of increased affective priming with divided attention. The crucial question here is, however, in what respect affective and non-affective processing differ, so that dividing attention reduces non-affective priming, and can even increase affective priming. This question is answered in connectionist terms by assuming 'prewired' (i.e., biologically prepared, cf., Öhman & Mineka, 2001) connections that have a larger influence on the activations than top-down attentional modulation. For non-affective stimuli similarly strong connections may be formed after frequent stimulus encounters, so that processing of the stimuli is automatized and less affected by attentional modulation.

Particularly in the affective domain, attention and sufficient free working memory capacity are required to keep nonconscious response tendencies under control. Impoverished presentation may have similar effects to dividing attention because the stimulus is not sufficiently processed to allow for attentional control (see also Klinger, 2001). Whether the nonconscious processes have an evolutionary origin (cf., Den Dulk, Heerebout, &Phaf, 2003) or were automatized in the individual's lifetime, remains a question for further research. The more frequent occurrence of the-stronger-suboptimal-than-optimal pattern with affective than with non-affective processing, however, appears to favor a biological preparation.