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Please cite this article as:

Kemps, E.B.F., Erauw K., & Vandierendonck, A. (1996). The affective primacy hypothesis: Affective or cognitive processing of optimally and suboptimally presented primes? *Psychologica Belgica*, 36, 209-219.

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The affective primacy hypothesis: Affective or cognitive processing of
optimally and suboptimally presented primes?

Eva B.F. Kemps, Kris Erauw, and André Vandierendonck
Department of Experimental Psychology
University of Ghent

Running Head: Affective optimal and suboptimal priming

Mailing address: Eva Kemps
Department of Experimental Psychology
University of Ghent
Henri Dunantlaan 2, 9000 Gent
Belgium
Phone: +32-(0)9-264 64 06
Fax: +32-(0)9-264 64 96
E-mail: Eva.Kemps@rug.ac.be

ABSTRACT

The aim of the present study was to pursue the research on the affective primacy hypothesis, which claims that positive and negative affective reactions can be evoked with minimal stimulus input and virtually no cognitive processing (Zajonc, 1980). In line with Murphy and Zajonc (1993) a priming paradigm was used. The present work is basically a replication of their study in which the effects of affective priming under very brief (suboptimal - 4 ms) and longer (optimal - 1000 ms) exposure durations were compared, but using two additional exposure durations: 30 ms and 100 ms. Like Murphy and Zajonc, facial expressions were used as affective primes in addition to pictures which portrayed scenes and situations of everyday life. These were obtained in a preliminary study. Contrary to Murphy and Zajonc's results, the affective primes only produced significant shifts in subjects' preferential judgements of novel stimuli at longer exposure durations. At suboptimal exposures the novel stimuli were not judged differentially when primed with positive or negative affect. This was true for both facial expressions and pictures. Facial expressions influenced the liking ratings of the ideographs only at exposure durations of 30 ms and longer; pictures not until they were exposed for at least 100 ms. Thus, pictures depicting daily events require longer exposure durations than facial expressions in order to elicit an affective reaction. These results however do not provide any clear-cut evidence in support of the affective primacy hypothesis. Instead, they seem to suggest that affective stimuli do not evoke an affective reaction without additional cognitive processing, a conclusion that is supported by LeDoux's theory of affective-cognitive interaction in the brain.

INTRODUCTION

The affective primacy hypothesis asserts that affective reactions can be elicited with minimal stimulus input, and virtually no cognitive processing (Zajonc, 1980, 1984). Therefore, affective reactions can occur without the involvement of cognitive processes. A stimulus can be processed affectively after an exposure duration of merely 1 ms, while cognitive processing requires a stimulus presentation of at least 8 ms (Seamon, Marsh, & Brody, 1984). This means that affective processing precedes cognitive processing. In fact, the affective primacy hypothesis rests on the assumption that the affective qualities of stimuli, such as positive versus negative, can be processed more readily than their non-affective attributes. This contradicts the cognitive appraisal point of view, which claims that affect cannot emerge without prior cognitive mediation (Lazarus, 1982, 1984, 1991).

Kunst-Wilson and Zajonc (1980) first suggested the notion of affective primacy in a mere exposure experiment in which subjects developed affective preferences for previously novel Chinese ideographs, merely as a result of repeated exposures. In the experiment the ideographs were first presented suboptimally (1 ms). Subsequently the affective preference and the recognisability of these stimuli were measured. For this purpose the ideographs were presented again paired with new ones that had not been presented before. When asked which of two ideographs, old or new, they liked better, subjects consistently preferred the previously presented stimuli. However, on the recognition test subjects were unable to distinguish the old stimuli from the new ones. Furthermore, in a study by Seamon, Brody and Kauff (1983) it was found that the reaction time for the preference judgement was significantly shorter than that for the recognition judgement. These results seem to support the view that gross affective discriminations can be made virtually without awareness, whereas cognitive discriminations require longer access to stimulus information.

Murphy and Zajonc (1993) pursued the research on the affective primacy hypothesis, using a priming paradigm. In priming it is assumed that the presentation of one stimulus, or prime, alters the processing of a second target stimulus. Murphy and Zajonc set up 5 experiments to test their hypothesis. To this end they used two kinds of primes: affective primes (photos of male and female faces expressing happiness or anger) and affectively bland primes (random polygons, faces expressing no emotional reactions). Chinese ideographs, selected as being affectively neutral, served as target masks. The primes were presented suboptimally (4 ms) or optimally (1000 ms) prior to a 2000 ms exposure of one of the target

Chinese ideographs. The latter were to be rated on a 5-point scale for likability (experiments 1 & 2), size (exp. 3), symmetry (exp. 4), or masculinity or femininity (exp. 5). In these studies cognitive judgements, either categorical or psychophysical, were affected by primes only at the optimal level of awareness. Judgements of size, symmetry and gender were unaffected by their respective suboptimal primes, even when the priming stimulus was a neutral face. On the contrary, using facial expressions as suboptimal primes resulted in significant shifts of affective judgements. The average preferential scores of the Chinese ideographs preceded by a positive suboptimal prime (happy face) were significantly higher than when they were preceded by a negative suboptimal prime (angry face). Optimal stimulus exposure of the affective primes had no differential effect on the liking judgements. In a recent study Murphy, Monahan and Zajonc (1995) confirmed that novel stimuli are judged differentially only when the affective priming is suboptimal. Taken together, these findings support the affective primacy hypothesis, suggesting that emotional reactions can occur with minimal stimulation and can therefore precede and alter subsequent cognition.

In line with the study by Murphy and Zajonc (1993), the purpose of the present work was to pursue the research on the affective primacy hypothesis using a priming paradigm. In particular the following experiment sought to explore whether affective stimuli other than facial expressions would confirm the affective primacy hypothesis. In other words, would there be a difference between stimuli that elicit an innate affective reaction, such as facial expressions (e.g. Haviland & Lelwica, 1987; Izard, Huebner, Risser, McGinnes, & Dougherty, 1980), and stimuli which evoke an affective reaction acquired by learning? To this end a comparison was made between the optimal and suboptimal affective priming of facial expressions with that of pictures depicting scenes and situations of everyday life.

EXPERIMENT

To test the hypothesis that discriminations of positive and negative affect can also be made outside of conscious awareness with pictures other than facial expressions as affective primes, an experiment was set up in which subjects evaluated novel stimuli, Korean ideographs, that were preceded by suboptimally or optimally presented affective and neutral primes. More specifically, the present study compared the affect ratings of Korean ideographs that were preceded by happy and angry faces with the liking judgements of ideographs

preceded by pictures depicting pleasant and unpleasant scenes and situations of everyday life, and this under extremely brief and longer exposure durations. A condition in which the ideographs were preceded by non-affective primes (geometrical shapes) was also included.

Method

Subjects. Forty first year psychology students of the University of Ghent participated in partial fulfilment of a course requirement.

Stimuli. In accordance with the study of Murphy and Zajonc, male and female faces expressing happiness and anger were selected as affective primes. Photographs of 4 male and 6 female faces were taken. Each face was photographed against a light background, once smiling and once scowling. Thus 20 photos were obtained. An equal number of pictures and geometrical shapes were selected. To ensure that the pictures and the geometrical shapes could be classified unequivocally into one of three priming categories (positive, negative and neutral), a preliminary study was carried out in which fifty-six persons (27 males, 29 females) between the ages of 13 and 70 rated the likability of a large number of pictures. The stimulus-set consisted of a pool of 170 pictures from which the primes were to be chosen. The pictures which were presumed to elicit positive or negative affective reactions were chosen from magazines, books, brochures, ... Given that the primes were to be presented tachistoscopically in the experiment proper only pictures that could be photographed and printed on a 15 x 10 cm format were taken into account. The geometrical shapes which were expected to be found affectively neutral came from encyclopaedia and mathematics textbooks. Similarly to the selected facial expressions (happy and angry), the affective reactions to be induced by the pictures were limited to gross positive and negative influences. For more differentiated emotions, such as fear, disgust or sadness, to emerge, some sort of cognitive appraisal may in fact be necessary; thus these emotions cannot be distinguished at suboptimal presentation (Murphy, 1990). Subjects were asked to rate each of the 170 pictures in turn on a 9-point scale, where 1 indicated that they did not like the picture at all and 9 indicated that they liked the picture very much. The presentation-order of the pictures was randomised across subjects. On the basis of the results, 40 pictures were retained: the 10 pictures rated most favourable to elicit a positive affect, the 10 rated most favourable to evoke a negative affect, and the 20 geometrical shapes rated most closely to the midpoint of the 9-point scale, namely the ones nearest to 5. In the selection, the mean, the standard deviation and the interquartile range were taken into account. These statistical values of the selected primes are presented in Table 1.

The pictures portrayed a variety of themes. The target masks were 60 Korean ideographs, selected as being affectively bland and novel. The primes and the Korean ideographs were put onto 10 x 15 cm cards for tachistoscopic presentation.

Insert Table 1 about here

Design. Two variables were manipulated in this study: priming category and exposure duration of the primes. There were 5 priming categories: smiling faces, scowling faces, pleasant pictures, unpleasant pictures and neutral geometrical shapes. Four exposure durations were used. Next to the suboptimal (4 ms) and the optimal (1000 ms) exposure durations used by Murphy and Zajonc, two intermediate exposure duration conditions were added: 30 ms and 100 ms. These additional conditions were based on a study by Lavadas, Cimatti, Del Pesce and Tuoizzi (1993). Since a stimulus can be processed affectively after an exposure duration of merely 1 ms, while cognitive processing requires a stimulus presentation of at least 8 ms (Seamon et al., 1984), the suboptimally presented primes can only be processed affectively, whereas the primes in the other exposure duration conditions can be processed both affectively and cognitively. The subjects were divided equally among the four exposure duration conditions; thus there were 10 subjects per exposure duration condition. The presentation-order of the primes and the Korean ideographs was completely random.

Procedure. Subjects were told that they would be participating in a study on snap judgements of visual stimuli. Per trial they were presented a prime immediately prior to a 2000 ms exposure of a Korean ideograph. Subjects then rated the likability of the Korean ideograph on a 5-point scale, where 1 indicated that they did not like the ideograph at all and 5 indicated that they liked the ideograph very much. To ensure that subjects were attending to the prime during the exposure, a fixation point was presented for 1000 ms immediately prior to the prime, signalling the start of each trial. Because the subjects could clearly see the primes that were presented optimally, they were told that at times they might see other pictures among the Korean ideographs. It was stressed that subjects should only rate the second stimulus, the Korean ideograph. Stimulus presentation was controlled by a Gerbrands 3-field tachistoscope (Model T-3B-2).

Results

A multivariate analysis was performed with contrasts in the dependent variables, the average liking ratings obtained in the 5 priming categories: smiling face, scowling face, pleasant picture, unpleasant picture and neutral. The between-subjects effect of exposure duration (4 ms, 30 ms, 100 ms and 1000 ms) and the within-subjects effect of priming categories were analysed. This is conform with suggestions formulated by McCall & Appelbaum (1973) for the analysis of repeated measures designs. No global analysis was performed; data analyses were confined to testing the hypotheses.

The results revealed a significant prime x exposure interaction, both for facial expressions, $F(3, 36) = 3.39$, $p < 0.05$ and pictures, $F(3, 36) = 12.45$, $p < 0.001$. The exact nature of the relationship between priming and exposure level will be explained by the analyses to follow. The average liking judgements of the Korean ideographs in the various exposure and priming conditions are presented in Table 2.

 Insert Table 2 about here

Facial expressions

As is shown in Table 2, suboptimal priming (4 ms) failed to produce a significant shift in subjects' liking of the ideographs, $F < 1$. When the primes were exposed for at least 30 ms there was a significant influence on subjects' perception of the ideographs. The average liking ratings were significantly higher when the Korean ideographs were preceded by happy faces than when they were preceded by angry faces, $F(1, 9) = 5.51$, $p < 0.05$ (30 ms); $F(1, 9) = 9.81$, $p < 0.01$ (100 ms); $F(1, 9) = 10.55$, $p < 0.01$ (1000 ms). On the whole the preferential judgements of Korean ideographs preceded by happy faces were higher than those preceded by non-affective primes, which were in turn rated higher in likability than the Korean ideographs preceded by angry faces. However, in none of the four exposure duration conditions was the mean liking of target stimuli preceded by facial expressions significantly different from those preceded by geometrical shapes: happy versus neutral, $F < 1$ (4 ms, 30 ms), $F(1, 9) = 3.69$, $p < 0.10$ (100 ms), $F(1, 9) = 4.02$, $p < 0.10$ (1000 ms); angry versus neutral, $F < 1$ (4 ms, 100 ms), $F(1, 9) = 2.92$, $p < 0.25$ (30 ms), $F(1, 9) = 1.11$, $p > 0.25$ (1000 ms).

Pictures

The suboptimal priming of pictures (4 ms) did not generate significant shifts in subjects' preferences for the target ideographs, $F(1, 9) = 1.14, p > 0.25$. This was true for an exposure duration of 30 ms as well, $F < 1$. The Korean ideographs preceded by pleasant pictures were rated significantly higher than those preceded by unpleasant pictures only when the primes had been exposed for at least 100 ms, $F(1, 9) = 5.15, p < 0.05$ (100 ms); $F(1, 9) = 49.64, p < 0.001$ (1000 ms). Like the facial expressions, the preferential judgements of Korean ideographs preceded by pleasant pictures were also higher than those preceded by non-affective primes, which were in turn rated higher in likability than the Korean ideographs preceded by unpleasant pictures. Apart from the condition in which the primes were exposed for 1000 ms, there was no significant difference between the liking measures of target stimuli preceded by pleasant and unpleasant pictures and those preceded by geometrical shapes in the various exposure duration conditions: pleasant versus neutral, $F < 1$ (4 ms, 30 ms), $F(1, 9) = 4.50, p < 0.10$ (100 ms), $F(1, 9) = 13.93, p < 0.01$ (1000 ms); unpleasant versus neutral, $F(1, 9) = 1.31, p > 0.25$ (4 ms), $F < 1$ (30 ms), $F(1, 9) = 2.52, p < 0.25$ (100 ms), $F(1, 9) = 50.25, p < 0.001$ (1000 ms).

Geometrical shapes

The average liking judgements of ideographs preceded by non-affective primes did not significantly differ across exposure duration conditions, $F(3, 36) = 1.01, p > 0.25$, and did not depart significantly from the midpoint value.

Discussion

In summary, suboptimal priming of both facial expressions and pictures did not elicit an affective reaction. With additional cognitive processing an affective reaction did emerge. Although the present study failed to replicate the affective reaction obtained by Murphy and Zajonc at 4 ms, the results are not necessarily in contradiction with the affective primacy hypothesis. It would be premature to conclude that suboptimal priming had not evoked an initial gross affective reaction, just because none had been observed. It is possible that an early vague affective impression was evoked, but not strong enough to make positive or negative discriminations of the priming stimuli, and influence the subsequent ratings of the target

stimuli as such. Indeed, when the facial expressions and pictures were exposed for only 4 ms there was an effect, although not significant, in the expected direction. It could well be that, at least for the facial expressions, an exposure duration of 5, 6, or 7 ms might have elicited an affective reaction. Bearing in mind though that both Murphy and Zajonc (1993) and Murphy et al. (1995) found a highly significant affective priming effect at an exposure duration of merely 4 ms, the latter is rather unlikely. The present study lends support to the interpretation that subsequent cognitive processing will be required to make the initially evoked vague impression of the pictures clearer. This will result in an affective reaction, which in turn will have an influence on the rating of the ideographs. Accordingly, it would seem that both facial expressions and the scenes and situations portrayed on the pictures require supplementary cognitive processing in order to evoke an affective reaction.

Furthermore, facial expressions and pictures differed with respect to the minimal exposure duration at which an affective reaction was elicited. Facial expressions gave rise to significant shifts in subjects' evaluation of the Korean ideographs at an exposure duration of 30 ms. Pictures however needed to be exposed for 100 ms to influence subjects' perception of the target stimuli. This difference can either have a qualitative or a quantitative origin. On the one hand, it could be that facial expressions are in a class of their own. Facial expressions elicit an immediate unambiguous innate affective reaction (Haviland & Lelwica, 1987; Izard et al., 1980), whereas affective pictures evoke an affective reaction acquired by learning. Contrary to pleasant and unpleasant pictures, happy and angry faces can be classified into one of two universal categories straight away. All over the world a happy face will bring about a strong positive feeling, just as an angry face will evoke a strong negative feeling (e.g. Ekman & Friesen, 1986; Smith 1989). This requires little or no further processing of the face. On the other hand, pictures may require more processing than facial expressions in order to elicit an affective reaction due to their complexity.

LeDoux's theory of affective-cognitive interaction in the brain can accommodate the above lines of reasoning. According to LeDoux (1989) a stimulus is simultaneously processed by two independent information processing functions, as opposed to the serial processing proposed by the affective primacy hypothesis: an affective computational system and a cognitive computational system which are mediated by separate but interacting parts of the brain. LeDoux defines affective computations as those that yield information about how a stimulus relates to the well-being and goals of an organism. Cognitive computations yield information about a stimulus and the relations between that stimulus and other features of the

external world. Affective computations occur primarily in the amygdala, whereas cognitive computations occur primarily in the hippocampus and the neocortex. The amygdala receives sensory inputs from the thalamus both directly and by way of the cortex. As the projection to the amygdala from the thalamus is monosynaptic, and thus several synapses shorter than the projections to the amygdala through the cortex, the processing of a stimulus via the thalamo-amygdala route (the affective route) is faster though cruder than via the cortico-amygdala route (the cognitive route). The advantage of affective computations over cognitive computations in quickness of responding to stimuli is restricted to simple stimuli. The processing of complex stimuli requires additional cortico-amygdala projections. The rapid arrival of crude stimulus information from the thalamus prepares the amygdala to receive more complex stimulus information from the cortex. This facilitates subsequent affective processing based on a more complete perceptual analysis by way of cortical projections to the amygdala.

Due to its notion of affective and cognitive computation in parallel and its distinction between different processing routes to account for the difference in emotional reactions to simple and complex stimuli, LeDoux's theory of affective-cognitive interaction in the brain provides an adequate framework for interpreting the results of the present study. Given that the pictures in this experiment are complex, emotional responses cannot be rapidly initiated on the basis of crude stimulus properties alone. The pictures reach the amygdala directly via the thalamus as well as indirectly via the association areas of the cortex. As such, the affective processing of the pictures occurs faster and is independent of their cognitive processing. Moreover, this early affective computation is facilitated by subsequent cognitive computation. To a certain extent the same is also true for the facial expressions. As mentioned before, compared to the pictures facial expressions are presumably less complex. Therefore they would not require as much cognitive processing to facilitate their affective processing to elicit an affective reaction. Nonetheless, if the emotion system is to react appropriately to complex affective stimuli, whether they be pictures or facial expressions, it must be dependent on input from the cognitive system.

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AUTHOR'S NOTE

Requests for reprints should be addressed to: Eva Kemps, Department of Experimental Psychology, University of Ghent, Henri Dunantlaan 2, B-9000 Gent, Belgium. E-mail: Eva.Kemps@rug.ac.be

Table 1. Average, Standard Deviation, Interquartile Range and Theme of the Selected Primes in the Preliminary Study

	Average	Standard Deviation	Interquartile Range	Theme
Pleasant pictures				
1.	7.34	1.52	2	Baby's hand
2.	7.68	1.32	2	Dog in hammock
3.	7.34	1.58	2.5	Couple kissing
4.	7.75	1.18	2	Child and dog
5.	7.52	1.37	2	Sunset
6.	7.84	1.16	2	Scenery (sea)
7.	7.89	1.11	2	Caribbean
8.	7.96	1.45	2	Baby
9.	7.48	1.44	2	Girls on swing
10.	7.91	1.07	2	Waterfall
Unpleasant pictures				
1.	1.32	0.69	0	Human remains
2.	1.52	1.19	1	Cadaver
3.	1.54	1.26	1	Human skull
4.	1.59	0.93	1	Execution
5.	2.38	1.09	1	Child in hospital
6.	1.32	0.79	0	Child with bloody face
7.	1.77	0.95	1	Humans behind barbed wire
8.	2.09	1.08	2	Child crying
9.	1.79	0.97	1	Man in puddle of blood
10.	2.04	1.29	1	Decayed teeth

Table 2. Average Ratings of the Korean Ideographs in the Various Exposure Duration and Priming Conditions

Exposure Duration	Primes				
	Smiling Face	Scowling Face	Pleasant Picture	Unpleasant Picture	Neutral
4 ms	2.84	2.78	2.77	2.61	2.77
30 ms	3.11	2.80	3.04	2.98	3.04
100 ms	3.30	2.73	3.12	2.42	2.81
1000 ms	3.32	2.84	3.61	1.82	3.06