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Evaluative Conditioning and Affective Priming: Awareness,
Contingency, and Cue-Competition

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Abstract

Previous research suggests that evaluative conditioning (EC) is insensitive to contingency awareness, and insensitive to extinction and contingency manipulations. Recent studies have tested the generality of these EC results using physiological (startle reflex) and behavioural (affective priming) measures of affect rather than verbal ratings of liking. The current experiments used an affective priming measure to extend this program of work. Over four experiments we examined the role of awareness, the role of contingency, and the phenomena of cue-competition in evaluative conditioning. Each experiment involved subjects experiencing conditioned stimuli (CSs) paired with affectively valenced (positive and negative) visual images. Subjects then classified words as either positive or negative. Each word was preceded by presentation of a CS. It was found that subjects classified the words faster if the valence of the word was the same as that of the immediately preceding CS. However, this conditioning effect did not depend on contingency awareness, was not reduced by contingency degradation, and there was no evidence of cue-competition in a blocking procedure that used an overshadowing control.

Keywords: evaluative conditioning, affective priming, contingency, awareness, blocking

Introduction

Evaluative conditioning (EC) refers to a change in the affective valence of one stimulus that occurs as a result of pairing it with another, affectively valenced, stimulus. Even though many EC experiments do not use biologically significant stimulus events they are, in many respects similar to the procedures used in traditional classical or Pavlovian conditioning experiments. For example, pairing an affectively neutral picture with one that is disliked corresponds to pairing a neutral conditioned stimulus (CS) with an aversive unconditioned stimulus (US), such as an electric shock. Typically EC studies measure learning by asking subjects to rate the valence of CSs that have been paired with the affectively valenced USs and in many EC experiments it has been found that the valence of the CSs shifts in the direction of the US it was paired with. For example, a neutral visual image may be rated more positively after it has been paired with a liked image or more negatively after it has been paired with a disliked image (e.g. Martin & Levey, 1978; Baeyens, Eelen, & Van den Bergh, 1990).

Interest in EC experiments has grown recently because they have produced a number of results that appear to differ from those obtained in more traditional human conditioning preparations. First, in traditional experiments using skin conductance as a measure of

conditioning and an electric shock US it is usually found that contingency awareness is required before the CS can elicit responding (e.g. Dawson & Schell, 1985).

Contingency awareness refers to the extent to which a participant is able to identify which CS was paired with the US during conditioning. However, the magnitude of the EC effect does not appear to be related to whether participants can report which CSs were paired with which USs (Baeyens et al., 1990; Martin & Levey, 1994; Hammerl & Grabitz, 1996; De Houwer, Baeyens, & Hendrickx, 1997; but see Field, 2000). Second, in traditional conditioning studies an extinction procedure usually produces a rapid reduction in conditioned responding providing participants' US expectancy also declines and providing neutral (e.g. flower) rather than "prepared" (e.g. spider) CSs are used (Dawson & Schell, 1985). However, conditioned evaluative responses appear to be resistant to extinction. For example, Baeyens and colleagues have failed to obtain extinction effects following unreinforced CS presentations (Baeyens, Crombez, Van den Bergh, & Eelen, 1988; 1989; Vansteenwegen, Crombez, Baeyens, & Eelen, 1998; De Houwer, Baeyens, & Eelen, 2000). Finally, the degree of CS-US contingency (Rescorla, 1968) is an important determiner of conditioning in traditional conditioning studies (e.g. Furedy, 1971). However, Baeyens, Hermans, and Eelen (1993) found no significant reductions in conditioning

when CS alone and US alone trials were added to a standard acquisition phase consisting of CS-US pairings. Presentation of unreinforced CSs and unsignalled USs should both reduce learning. In contrast Hammerl, Bloch, and Silverthorne (1997) did find that US alone presentations reduced EC but this effect occurred whether or not the US alone trials were given before or after the conditioning procedure. Because widely accepted conditioning theories based upon Rescorla and Wagner (1972) would not predict an effect for US alone presentations after conditioning, Hammerl et al. considered that a non-associative process may have accounted for their results. They suggested that US alone presentations may have caused habituation to the US and, via a mechanism akin to post-conditioning revaluation of the US, undermined EC. Thus, in the absence of further experiments there is at least some evidence that reduction of contingency may not have a large impact on EC. On the basis of these findings it can also be predicted that EC will not exhibit cue-competition phenomena such as blocking (Kamin, 1969). The effect of US-alone presentations can be viewed as an instance of cue-competition in which conditioning of the background context on the US-alone trials allows the context to block learning about the discrete CS (Durlach, 1989). Thus, if US-alone presentations do not reduce learning in EC it may be that EC does not show other forms of cue-

competition effects. Baeyens, Eelen, and Crombez (1995) have also suggested that EC will not show cue-competition effects.

It has been proposed (e.g. Martin & Levey, 1978; 1994; Baeyens et al., 1995) that the differences between EC and traditional conditioning experiments exist because conditioning of evaluative responses relies upon different mechanisms than does conditioning of other kinds of responses. Whereas EC studies focus very directly on using measures of affect, traditional conditioning experiments have tended to rely on relatively non-specific measures (e.g. skin conductance may index arousal, expectation, and other processes as well as affective reactions). Martin and Levey have argued that conditioning of evaluative responses is based upon a primitive learning system that "fuses" CS-US representations whenever they are co-activated. This effectively means that the CS acquires US attributes so that when the CS is subsequently presented it is perceived as more similar to the US that it was paired with than it was on initial presentation. The principal function, according to Martin and Levey, of this process is to allow us to acquire likes and dislikes that can guide our behaviour. CSs that are paired with affectively positive USs are evaluated positively and can be safely approached whereas CSs that are paired with negative USs are evaluated negatively and should be avoided.

Martin and Levey distinguished the acquisition of evaluative responses from cognitively mediated signal-learning processes as did Baeyens et al. (1995). Baeyens et al. identified a system of referential learning in which CS-US pairings cause the CS to take on the valence of the US and an expectancy learning system. In expectancy learning CSs act to signal that the US is actually about to occur. Expectancy learning therefore can only be accomplished efficiently if it is based upon a mechanism capable of encoding the statistical relationships (contingencies) between CS and US events, as exemplified, for example, in the Rescorla-Wagner model of classical conditioning (Rescorla & Wagner, 1972). On the other hand, the referential system that governs acquisition of likes and dislikes does not require special sensitivity to statistical contingency, a simple contiguity based mechanism suffices. In the words of Baeyens et al. 1993 "an objective statistical correlation between two events seems no pre-requisite for one event (CS) acquiring the capacity to lead to the 'thought of' the other (US)." (p. 736).

Unfortunately, the majority of EC studies to date have used verbal measures of liking whereas traditional conditioning studies have tended to use behavioural and psychophysiological measures of conditioning. This places something of a limit upon the generality of the conclusions that can be drawn from EC experiments.

However, in principle, on the assumption that a distinct evaluative conditioning mechanism does exist, it should be possible to produce the characteristic EC results (relative lack of sensitivity to awareness, extinction, and contingency) using different dependent measures. In order to do this it would, of course, be necessary to use measures that were relatively specific indices of affect. In fact, some work has already been carried out to test the generality of the EC results using facial electromyographic (EMG) and affective priming measures of valence. Acoustic startle, as measured by eyeblink magnitude at the obicularis oculi, is regarded as a relatively specific physiological measure of affective valence (e.g. Vrana, Spence, & Lang, 1988; Lang, Bradley, & Cuthbert, 1990; Bradley, Cuthbert, & Lang, 1990) and startle measures have been found to be sensitive to conditioned valence when an electric shock was used as a US (Davis, 1986; Hamm, Greenwald, Bradley, & Lang, 1993; Lipp, Sheridan, & Siddle, 1994, Vansteenwegen et al., 1998, Hardwick & Lipp, 2000). Similarly, affective priming effects are now regarded as providing a specific measure of valence. In an affective priming task subjects are presented with an affectively valenced priming stimulus (e.g. a picture) and then have to determine the valence (positive or negative) of a second, target stimulus, as quickly as possible. It has been found that primes facilitate identification of targets that are

affectively congruent, i.e. positive primes facilitate identification of positive targets and vice-versa, (e.g. Fazio, Sanbonmatsu, Powell, & Kardes, 1986; Hermans, De Houwer, & Eelen, 1994). The affective priming measure has been found to be sensitive to conditioned, as well as to unconditioned, affective responses (De Houwer et al., 1998; Hermans, Vansteenwegen, Crombez, Baeyens, & Eelen, *in press*).

The EC experiments carried out using these measures are limited in number but some of the hallmarks of EC studies using verbal ratings have been reproduced. Experiments using startle response measures have produced a pattern of data that is partially consistent with the EC literature. Whereas some studies have found that conditioning of startle responses was not dependent upon contingency awareness (Hamm & Vaitl, 1996; Hardwick & Lipp, 2000 (Experiment 2)), others have (Purkis & Lipp, 2001). Startle responses have also been found to extinguish following unreinforced CS presentation but in the same study verbal ratings did not show an extinction effect (Vansteenwegen et al., 1998). However, the use of startle reflex to index EC effects may be problematic. Cuthbert, Bradley, and Lang (1996) found that affective modulation of the startle reflex only occurred under conditions of high arousal. Vansteenwegen et al., (1998) offered an explanation for their extinction results in terms of a reduction of arousal over the course of

extinction trials. Vansteenwegen et al. speculated that low arousal levels at the end of the extinction period rendered their startle probes insensitive.

The current experiments were intended as a further exploration of the extent to which the hallmark results of EC experiments could be replicated using an affective priming measure. If the results can be replicated then this would extend the generality of the EC results and give further support to the view that differences may exist between the learning processes that operate in traditional conditioning and EC procedures. In each of the experiments reported below we paired visual CSs with pleasant and unpleasant visual images drawn from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1997) database. Following this conditioning procedure subjects were then tested in an affective priming task wherein they had to classify words as "good" or "bad". The words were primed by CSs that had been paired with either negative or positive images. If conditioning of an evaluative response had taken place, we predicted that subjects would be faster at classifying words that were affectively congruent with the priming CS. For example, classification of a negative word should be faster when primed with a CS that had been paired with a negative image than when primed with a CS paired with a positive image. In Experiments 1 and 2 we assessed whether or not any conditioning effects were related to

contingency awareness and, in Experiment 2, we also examined whether or not degrading the CS-US contingency by US-alone presentations would affect conditioning. In Experiments 3 and 4 we examined the prediction that EC would not be subject to cue-competition effects.

Experiment 1

Method

Participants and setting.

Thirty-one subjects (including 12 males) took part in an experiment presented as a study of "human learning and emotion". They were recruited via posted advertisement and word of mouth from the campus of Southampton University and received a payment of £8 or subject pool credits for participating in a session lasting 60-70 mins. The average age of the subjects was 21.0 (range 18-27, standard deviation (SD) 2.9). The experiment took place in a psychophysiological laboratory.

Design and procedure.

On arrival subjects were shown the laboratory and the general procedure was explained to them. They were informed that they would view a series of images on a computer screen and that some of the images would be

unpleasant including, for example, pictures of mutilated bodies. Subjects were advised that if they thought they might be upset or offended by unpleasant images that they should not take part. Following this introduction the subjects signed a consent form, completed a personality questionnaire, and were connected to electrodes for electromyograph (EMG) recording. The data from the personality questionnaire and from the EMG recording were used in separate studies. Subjects were then seated in front of the computer screen used to present the experimental stimuli and instructed (as described below) to either (a) watch the computer screen or, (b) to watch the screen and try to learn when pleasant and unpleasant pictures would be shown. They were informed that after a viewing an initial series of trials that they would then have to categorise each of a series of words as "good" or "bad" using the keys on a response box. The use of the keys was explained and subjects were told that instructions on the computer screen would inform them when the word categorisation phase was about to begin. All subjects were told that afterwards they would be asked some questions about what they had seen.

The experimenter then left the room and a 5 min acclimation period began. Once this was over the experiment proper began; the general design of the experiment is shown in Table 1. Stage 1 was preceded by 5 CS alone "practise" trials using a black CS that was not

presented during the remaining 27 trials that formed the Stage 1 "learning trials". Each learning trial consisted of a 4 s CS followed immediately by either a 4 s US or by a blank screen. Trials were separated by an inter-trial-interval of between 15 and 45 s (mean 30 s). All subjects were trained with three CSs; CS- (negative) always signalled the occurrence of negative images, CS+ (positive) always signalled the occurrence of positive images, whereas CS0 (unpaired) was always presented alone. Subjects were randomly assigned to one of three CS colour/CS function combinations selected so that assignment of each colour was equally likely to be paired with each CS function (-, +, or 0). Following the first five CS alone trials, which used a black CS, the learning trials were arranged in three blocks of 9. Each block involved three CS-, three CS+, and three CS0 trials in a random order subject to the constraint that a maximum of two of each type could occur in a row. For each CS- and CS+ trial one image from the appropriate set (positive or negative valence) was selected at random to serve as US. At the start of the experiment the first 10 subjects were simply told to watch the screen during the first part of the experiment. However, only nine of these subjects could be classified as contingency aware so the remaining subjects were instructed to try and learn when pleasant and unpleasant pictures would appear.

Once Stage 1 was complete there was a 30 s pause before starting the 48 affective priming trials that made up the Test Stage. During this pause instructions appeared on the computer screen warning subjects that the word categorisation phase was about to begin. Each priming trial involved the presentation of a word on the computer screen in the centre of one of the CSs which had just been trained. Words were presented 100 ms after CS onset. Trials were terminated when the subject pressed one of two keys to indicate whether the word was emotionally positive or emotionally negative. Subjects were instructed to respond as quickly as possible consistent with accuracy and latency to classify each word was the dependent measure. If no response was given within 3 s the trial was terminated automatically. The inter-trial interval was between 2 and 4 s (mean 3 s). On each trial one word was selected at random from the appropriate set (positive or negative valence) and presented in combination with the CS- or CS+ colour that had been presented in Stage 1. Thus, there were four possible trial types; a positive word presented on a CS+ colour, a positive word presented on a CS- colour, a negative word presented on a CS+ colour, or a negative word presented on a CS- colour. The trials were arranged in four randomly ordered blocks of 12, each block consisting of three presentations of each trial type. On completion of the Test Stage subjects were disconnected

from the recording apparatus and completed their post-experimental questionnaire.

Materials, stimuli, and apparatus.

The post-experimental questionnaire elicited valence and arousal rating for the unpleasant and pleasant IAPS images and assessed contingency awareness. Ratings of arousal and valence were made on 5 point scales running from "dull" to "very arousing" and from "very unpleasant" to "very pleasant" respectively. Contingency awareness was assessed by asking subjects how often they felt they could predict each picture type and asking them how they were able to make their prediction.

An Opus Technology Pentium® based PC controlled stimulus presentation. Stimuli consisted of CSs, USs, and the word targets used in the priming phase. CSs were 4 s presentations of blue, green, or yellow coloured circles of approximately 8 cm diameter that were accompanied at onset by a 50 ms 60 decibel percussive orienting stimulus (five black CS alone trials were presented before the main part of the experiment began). Two sets of pictures were chosen from the IAPS picture set (Lang et al., 1997) to serve as USs. One set of positive images and one set of negative images were created. All IAPS images have valence ratings (minimum value 1, maximum 7), low values indicate a negative image while high values indicate a

positive image. Selection of the negative images was done by identifying pictures of mutilated bodies with the 10 lowest valence ratings for males and for females and taking the union of these two sets. A similar process was used to select the positive images. Positive images were those with the highest valence ratings excluding those with a sexual content. The identifying numbers and descriptions of the pictures used are presented in Appendix 1. In all there were (a) 12 negative images with a mean valence rating of 1.5 (SD = 0.3) and a mean arousal rating of 6.7 (SD = 0.9) and, (b) 14 positive images with a mean valence rating of 8.2 (SD = 0.4) and a mean arousal rating of 5.1 (SD = 0.8). The images were presented as 800 x 600 pixel images (full screen) on the 21" monitor for 4 s.

The words used in the affective priming trials were chosen on the basis of norms provided by Toggia and Battig (1978) and are listed in Appendix 2. The 15 positive words had a mean valence rating (minimum value 1, maximum 7) of 5.6 (SD 0.3), a mean familiarity rating of 6.3 (SD 0.2), and a mean length of 4.2 (SD 0.5). The 15 negative words had a mean valence rating of 2.4 (SD 0.3), a mean familiarity rating of 6.3 (SD 0.1), and a mean length of 4.1 (SD 0.8).

Data reduction and analysis.

As is customary in affective priming experiments the first 12 affective priming trials carried out at the start of the Test Stage were treated as practice trials and discarded (e.g. Hermans et al., 1994). The average latencies to classify the words on each of the four trial types over the remaining trials were obtained and, before averaging, extreme values (response times < 250 ms and > 2500 ms) were excluded (Hermans et al., 1994). An initial examination of the data was carried out by calculating mean response times for the classification of negative and positive words during the presence of CS+ and CS- and by calculating priming scores. Priming scores were calculated by averaging the difference between incongruent and congruent trials on positive and negative word trials (i.e. the average of CS+ minus CS- (on negative word trials) and CS- minus CS+ (on positive word trials)). The priming scores were used to assess effect sizes, d (Cohen, 1988), for the conditioning effect and to assess the difference in conditioning between the aware and unaware groups. Statistical analyses were then carried out on the log transformed response times (Winer, Brown, & Michels, 1991) using a univariate analysis of variance (ANOVA). There were two repeated measures factors, cue (two levels, CS- and CS+; A and B, respectively, in Table 1) and word (two levels - negative and positive) and a single between-subjects factor,

awareness (two levels - aware and unaware). Subjects were classified as aware if, on their post-experimental questionnaire, they correctly stated that they could predict the occurrence of pleasant and unpleasant images on the basis of the colour of the CS. Seventeen subjects were classified as aware on this basis. Significant effects, with an α level of 0.05, in the overall analyses were followed up using t-tests.

Results

The cue by word interaction suggested that conditioning had occurred and is illustrated in panel A) of Figure 1. The figure shows that negative words were identified more quickly during CS- than during CS+ and that positive words were identified more quickly during CS+ than during CS- colours. The average priming score was 25 ms, this was a moderately large effect ($d = 0.68$). Examination of the priming scores in the aware and unaware subjects suggested that conditioning was somewhat more effective in the aware subjects (priming scores of 29 and 21 ms for the aware and unaware subjects, respectively) but this difference was small ($d=0.22$).

Only one significant effect emerged from the ANOVA. This was a cue by word interaction ($F(1,29)=12.53$, $p<0.01$), none of the other effects approached significance ($F_s(1,29)<1.5$ in all cases). Thus, the conditioning effect illustrated in panel A) of Figure 1

was reliable but the observed difference between aware and unaware subjects was not. The conditioning effect was further explored by direct comparisons of responses to negative and positive words during CS+ and CS-. These showed that there was a significantly faster response to negative words when CS- was present than when CS+ was present ($t(30)=2.97$, $p<0.01$) but the facilitation of responding to positive words by CS+ did not reach significance.

Experiment 2

Experiment 1 was successful in establishing conditioned responding, as indexed by the affective priming measure, but this effect was largely independent of contingency awareness. Those subjects classified as contingency aware did not respond any more strongly to CS presentation than those classified as unaware. Thus, the result is in keeping with evaluative conditioning studies (e.g. Baeyens et al., 1990) that suggest contingency awareness is not important for conditioning and out of keeping with traditional classical conditioning studies that have tended to suggest awareness is necessary (e.g. Dawson & Schell, 1985; 1987).

Experiment 2 sought to replicate and extend these basic results. Studies described in the introduction suggested that evaluative conditioning can be resistant to extinction (Baeyens, Eelen, Van den Bergh, & Crombez,

1989) and not susceptible to degradation of the CS-US contingency (Baeyens et al., 1993). Baeyens et al. manipulated contingency by the introduction of unreinforced CSs and unsignalled USs. While there are several studies showing that CS alone trials have relatively little effect, the unique role of the additional unsignalled USs is not so clear. According to Hammerl et al., (1997) presentation of the US alone trials should have reduced the EC effect, perhaps by causing habituation to the USs. We therefore tested two groups of subjects, one group experienced a perfect CS-US contingency whereas the other group had additional unsignalled USs. The main purpose was to see whether our original results were replicable and to determine whether contingency degradation would affect conditioning.

Method

The experiment was carried out in the same way as Experiment 1 with the differences noted below.

Participants.

Forty subjects (including 18 males) took part, their average age was 20.6 (range 18-45, SD 4.4). Data was lost for two subjects leaving a sample of 38 who contributed data to the analyses presented below. Nineteen subjects were in the experimental group that received unsignalled US presentations, the other half of the subjects were

assigned to the control group that only received paired CS-US presentations.

Design and procedure.

The general design of the experiment is shown in Table 1. After subjects were introduced to the experiment they were all instructed to watch the computer screen and to try and learn when pleasant and unpleasant pictures would be presented. After five CS alone trials the Stage 1 trials began. Over the course of these trials each subject was trained with two CSs. Subjects were randomly assigned to receive a blue circle as CS- and a green circle as CS+ or vice-versa and randomly assigned to group paired or group unpaired. Group paired received two blocks of 12 trials. Each block contained six CS- and six CS+ presentations in a random sequence subject to the constraint that no more than four trials of the same type could occur in a row. Group unpaired received the same treatment with the exception that, within each block, an additional 12 trials occurred in which USs were presented alone; six trials were negative USs and six were positive USs. Throughout, the duration of the USs was 6 s. These arrangements meant that, for the group unpaired, the overall contingency was zero (calculated as $P(\text{US}|\text{CS}) - P(\text{US}|\sim\text{CS})$) whereas the overall contingency for the paired group was 1.

Data reduction and analysis.

After calculation of priming scores and initial examination of the data an ANOVA was carried out to formally determine whether or not conditioning had taken place, and to assess whether there were any differences between the awareness and contingency groups. Responses to the post-experimental questionnaire led to classification of 25 subjects as contingency aware. There were more subjects classified as aware in group paired (14 out of 19) than in the group unpaired (11 out of 19) but this difference was not statistically significant. The ANOVA had two repeated measures factors cue (two levels, CS- and CS+ (A and B, respectively, in Table 1) and word (two levels - negative and positive) and two between-subjects factors, awareness (two levels - aware and unaware) and group (two levels - paired and unpaired).

Results

The critical data indicating whether conditioning occurred are illustrated in panel B) of Figure 1. There it can be seen that subjects responded to the positive words more quickly during the presence of CS+, as compared to CS-, and they responded more quickly to negative words during CS- than during CS+. The average priming score was 19 ms and the value of d was 0.33

indicating that the conditioning effect was not as strong as in Experiment 1. Examination of the priming scores in the aware and unaware subjects again showed a small advantage for the aware subjects (priming scores of 20 and 17 ms for aware and unaware, respectively) but this difference was much smaller than in Experiment 1 ($d = 0.05$). The priming scores for subjects in the paired condition suggested they had conditioned better than the unpaired subjects (25 versus 13 ms, respectively) but, once again this was a small effect ($d=0.21$).

There were two significant effects to consider from the ANOVA carried out on the response times; an effect of cue type and an effect of word type ($F(1,34)=7.38$, $p<0.05$; $F(1,34)=4.60$, $p<0.05$). For the remaining effects only two approached significance, these were a word type by awareness by contingency interaction ($F(1,34)=3.43$, $p=0.07$) and the critical cue by word interaction ($F(1,34)=3.16$, $p=0.09$). The theoretical significance of the word by awareness by contingency interaction was not clear so no further analysis was undertaken. However, the cue by word interaction was of particular *a priori* interest and the means showed the predicted pattern of results. Responding to the positive words was faster in the presence of CS+ than in the presence of CS- and this was confirmed in a t-test ($t(37)=3.03$, $p<0.01$). However, responding to negative words was not significantly faster in the presence of CS- than in the presence of CS+

Experiment 3

Experiment 2 replicated the conditioning effects from Experiment 1 but the observed effects were not as strong as before. The failure to find a significant effect of awareness was replicated and, there was little evidence of an effect of contingency upon conditioning. This failure to find an effect of contingency suggests that the USs remained effective despite their additional presentations in the unpaired group. The result is interesting, however, since it suggests that degradation of contingency had little impact upon conditioning. Although there was no interaction of cue, word, and group it is possible that this interaction effect requires larger numbers to detect. However, the d value of 0.21 that we calculated for this effect indicates that approximately 300 subjects would be needed in each group to achieve power of more than 80% (Cohen, 1988). This is despite the fact that there was a large difference in the contingencies in the paired and unpaired groups (1 and 0 respectively) and despite the fact that adding USs might decrease conditioning as a result of habituation to the USs (Hammerl et al., 1997).

The fact that US-alone presentations had such a small effect supports the view that EC will not be subject to cue-competition effects such as blocking. This is because the effect of US alone presentations can be

interpreted as a cue-competition phenomena in which the experimental context acquires conditioned strength during the US-alone trials and competes with the nominal CSs. According to some authors (e.g. Baeyens et al. (1995); Martin & Levey, 1978) the characteristic pattern of EC results arises because conditioning of evaluative responses relies upon a simple stimulus contiguity based learning mechanism rather than the kind of competitive learning rule exemplified in, for example, the Rescorla-Wagner theory (Rescorla & Wagner, 1972). In the following two experiments we therefore set out to make a more explicit test of the hypothesis that EC would not be subject to cue-competition effects. The test used a conventional blocking group and an overshadowing control group rather than a "superconditioning" control that was reported in a recent study of EC using physiological measures as well as ratings of liking (Lipp, Neumann, & Mason, *in press*, see discussion).

Method

The experiment was carried out in the same way as Experiment 1 with the differences noted below.

Participants.

Forty-two subjects (including 10 males) took part and received course/subject pool credit for their participation. Their average age was 21.4 (range 18-43,

SD 3.5). Subjects were tested in individual experimental cubicles, the procedure lasted about 15 mins.

Design and procedure.

Personality questionnaire and EMG data were not collected in this experiment. Following a general introduction to the procedure subjects signed a consent form, were seated in front of the computer screen, and were asked to read the following on-screen instructions:

Instructions for the first part of the learning and emotion experiment:-

In this part of the experiment you will see various stimuli presented on the computer screen. Some of these will be simple coloured shapes, some will be more complex unpleasant images. The computer program works by first randomly selecting a simple coloured shape to display and then, on the basis of this choice, "decides" whether to show an unpleasant image. Your task is to learn which of the coloured shapes are most effective in causing the program to display unpleasant images. Click to continue...

These instructions were designed to encourage subjects to view the CS images as causes of the occurrence of the USs. Previous experiments have suggested that cue-competition effects are less likely in situations where

the causal links between CSs and USs are not clearly established (e.g. Waldmann, 2000; De Houwer, Beckers, & Glautier, *under review*). After Stages 1 and 2 had finished subjects were reminded of the requirements of the word categorisation phase by a message that appeared on the screen.

The general design of the experiment is shown in Table 1. During Stages 1 and 2 CSs and USs were presented for 2 s with US images presented immediately after CS offset. The duration of the CS in the Test Stage was 200 ms and the to be classified word was presented, in the same screen location as the CS, immediately after CS offset. The word remained on-screen until the subject made their classification. Throughout, the inter-trial-interval was varied around an average of 3.5 s (values of 2, 3, 4, or 5 s were chosen at random for each trial). During Stage 1 there were 16 trials of each type and in Stage 2 there were 12 trials of each type. The order of trials within Stages 1 and 2 was randomised but subject to the constraint that no more than three trials of the same type were allowed to occur successively. During Stage 2 trials, when there were two CSs, each CS occurred equally often on the left and right-hand sides of the screen. During the Test Stage, trials were divided into 4 blocks of 18. Each block consisted of six presentations of each CS; on half of the presentations the CS preceded a negative word and on the other half it preceded a positive word. The order

of the Test Stage trials was randomised within each of the four blocks. Subjects were randomly assigned to receive either the blocking or the overshadowing treatments and, within these groups, the cues serving the A, W, and X functions were fully counterbalanced.

Materials, stimuli, and apparatus.

CSs consisted of simple distinctive yellow symbols that were presented in 100 x 100 pixel 256 colour bitmaps against the black background of a 17" colour monitor. A 20 ms auditory alerting stimulus accompanied presentation of each CS.

Data reduction and analysis.

Two ANOVAs were carried out after an initial inspection of response times and priming scores. Priming scores to assess conditioning in this experiment were calculated as before but response times during CS0 (Y) were used instead of response times during CS- (W) (i.e. the average of response times in W minus Y on positive word trials and response times in Y minus W on negative word trials). The priming score to assess blocking, however, was calculated as the difference between the congruent and incongruent trials during X (i.e. positive word response during X minus negative word response during X). The first ANOVA was to determine whether or

not conditioning had taken place and the second was to determine whether or not blocking had occurred. The first ANOVA had two repeated measures factors, cue (two levels, CS0 and CS- (Y and W in Table 1, respectively)) and word (two levels - negative and positive). The second ANOVA examined responses made in the presence of X and had a single repeated measures factor, word (two levels - negative and positive) and a single between-subjects factor group (two levels - blocking and overshadowing).

Results

As shown in panel C) of Figure 1, a conditioning effect was apparent in the response times. Responses to the negative words were faster in the presence of CS- than in the presence of CS0 whereas responses to positive words were faster when CS0 was present. The overall priming score indexing this conditioning effect was 21 ms ($d=0.39$). The priming score to index learning about X was 9 ms ($d=0.1$) suggesting that relatively little was learned about X. The priming score for X in the overshadowing group was 2 ms, compared to 20 ms in the blocking group, with a d value of 0.21 for the blocking effect. Unfortunately this effect was in the wrong direction - the priming score for the overshadowing group should have been larger.

Turning to the first ANOVA, a test for conditioning, there was a significant cue by word interaction ($F(1,$

41)=7.03, $p < 0.05$), substantiating the impression that conditioning had occurred, but there was no effect of either cue or word ($F_s < 1$). A t-test showed that there were significantly faster responses to the negative words when they were presented in the context of a CS- than when they were presented in the context of a CS0 ($t(41)=2.31$, $p < 0.05$). However, positive words were not classified any faster in the presence of CS0 than in the presence of CS-. In the second analysis, a test for blocking, the responses to negative and positive words, in the presence of X, were compared in the blocking and overshadowing groups. Neither the word effect, the group effect, nor the word by group interaction approached significance ($F_s(1,40) < 1.6$). Thus, X did not facilitate responding to the negative words to a greater extent in the overshadowing as compared to the blocking group; there was no evidence of blocking.

Experiment 4

Experiment 3 once again showed a reliable conditioning effect but there was no evidence of blocking. The reason(s) for the failure of the blocking treatment *per se* failing to work remain unclear but one suggestion was followed up in Experiment 4. Inspection of panel C) of Figure 1 shows that the largest priming effect occurred in the facilitation of classification of positive words by CS0. This can be taken as an indication

that, in the context of CS- and CS0 trials, CS0 did not remain affectively neutral but that it took on positive affective qualities that were larger, in absolute terms, than the negative valence acquired by CS-. Of course, the stronger the Stage 1 conditioning the more likely it is that blocking will occur. It was decided, therefore, in the current experiment to see if blocking could be obtained based upon the acquisition of positive valence by CS0.

Method

The experiment was carried out in the same way as Experiment 3 with the differences noted below.

Participants.

Forty-two subjects (including 19 males) took part and received payment of £4 for their participation. Their average age was 21.9 years (range 18-34, SD 3.5).

Design and procedure.

The general design of the experiment is shown in Table 1. The main difference between this experiment and Experiment 3 was that, during Stage 2, X was presented in compound with CS0. For the blocking group X always occurred with a cue that was pre-trained as a CS0 whereas in the overshadowing group it was paired with a novel cue and trained as a CS0.

Data reduction and analysis.

The analysis of this experiment paralleled that carried out for Experiment 3. Priming scores calculated for the initial analysis used data from cues A and W (Table 1) to assess conditioning and data from cue X to assess blocking. The priming score to indicate conditioning was calculated as the average response time during cue A minus W for positive words and W minus A for negative words. Priming scores for X were calculated as the response time to classify negative words minus time to classify positive words. Following this an analysis of the response times was carried out. The first ANOVA had two repeated measures factors, cue (two levels, CS0 and CS- (W and A in Table 1, respectively) and word (two levels - negative and positive). The second ANOVA examined responses made in the presence of X and had a single repeated measures factor, word (two levels - negative and positive) and a single between-subjects factor group (two levels - blocking and overshadowing).

Results

The pattern of response times shown in Figure 1, panel D) again indicates a conditioning effect. Responses to negative words were faster when CS- was present than when CS0 was present and vice-versa for the positive words. The priming score indexing this effect was 29 ms

($d=0.30$) whereas the priming score for X again suggested that little was learnt about this cue (-3 ms, $d=0.04$). The priming scores for X in the overshadowing group and in the blocking group were -24 and 19 ms, respectively with a d value of 0.62 for the difference. However, again the priming score showed a direction of effect opposite to that predicted; a positive priming score would indicate conditioning and more conditioning was expected in the overshadowing group. Furthermore, the negative priming score in the overshadowing group indicates that X actually resulted in slower identification positive words, as compared to negative words.

The ANOVA to test for conditioning resulted in a significant cue by word interaction ($F(1,41)=7.58$, $p<0.01$) but there was no effect of either cue or word ($F(1,41)=3.01$, $p=0.09$ and $F<1$, respectively). Again the interaction indicates a reliable conditioning effect (see Figure 1, panel D). A t-test showed that there were significantly faster responses to the negative words when they were presented in the context of a CS- than when they were presented in the context of a CS0 ($t(41)=2.99$, $p<0.01$). However, positive words were not classified any faster in the presence of CS0 than in the presence of CS-. In the second analysis, a test for blocking, the responses to negative and positive words, in the presence of X, were compared in the blocking and overshadowing groups. Neither the word effect nor the group effect

approached significance ($F(1,40) < 1$), and although the word by group interaction approached significance ($F(1,40) = 3.88$, $p = 0.06$) the pattern of results did not indicate a blocking effect. As described above when X was present there was a tendency for faster classification of positive words in the blocking group but, rather than this effect being larger in the overshadowing group the direction of the effect was reversed.

General discussion

In summary, in four experiments, we found evidence of conditioning based upon visual US images using an affective priming measure replicating the work of Hermans et al. (*in press*). We also explored whether or not our procedure would produce similar results to those found in previous studies of EC. We found that awareness had little effect on conditioning (Experiments 1 & 2) and in Experiment 2 we also confirmed the prediction that degradation of the CS-US contingency would have little effect on EC. This result extends the findings of Baeyens et al. (1993) who found that EC based on verbal ratings was not sensitive to contingency degradation. The failure to find an effect of US-alone presentations suggested that conditioning in this procedure would not be subject to cue-competition and this was confirmed in comparisons of learning in the blocking and overshadowing treatments of Experiments 3 and 4.

However, a recent study (Lipp et al., *in press*) did find some evidence for cue-competition effects using a shock US and ratings of liking plus startle response as measures of EC. This study did not, however, use a standard overshadowing control group. Instead a "superconditioning" control was used. This control received A+ and B0 trials in Stage 1 followed by AC+ and BD+ trials in Stage 2. If B0 acquired inhibitory strength in Stage 1 then this might have led to superconditioning² of D in Stage 2. Thus, any difference between C and D might arise from two sources - a failure of learning about C (blocking) and enhanced learning about D (superconditioning). In any case though, both of these effects rely upon the operation of a competitive learning mechanism. Thus, our failure to find blocking effects and effects of US-alone presentations cannot be taken to rule out the operation of a competitive learning mechanism in EC. However, it may be the case that the superconditioning procedure is better suited to

² Strictly speaking the term superconditioning should be used when Stage 1 training results in a cue becoming inhibitory. Whether this was achieved in Lipp et al.'s experiment is unclear so the term "reduced overshadowing" might be preferred although we use the term superconditioning for the sake of consistency.

demonstrating cue-competition effects, especially as these effects have often been difficult to demonstrate.

The successes and failures reported in obtaining blocking effects in various learning paradigms (e.g. Martin & Levey, 1991; Williams, Sagness, & McPhee, 1994) have indicated that a number of more or less subtle variables may determine whether or not cue-competition effects can be seen. Although our instructions were designed to enhance the likelihood that subjects perceived a causal link between cues and outcomes it is possible that this instruction was not as effective as it might have been. Lipp et al. took considerable care to ensure their subjects viewed their cues as additive causal agents. Subjects were carefully instructed at the outset to regard the cues as additive, effectively signalling that if cue A led to the same outcome as the AC compound then C could not be contributing. Future experiments on cue-competition using affective priming (and other measures) would benefit from instructional manipulations to determine whether or not these are demonstrably important variables.

It is also possible that we found no effect of US-alone presentations because our procedure was simply not one that would produce cue-competition. As explained above, cue-competition effects depend upon subjects' processing cues as independent additive causal agents (Waldmann, 2000; De Houwer et al., *under review*) and the

effect of US-alone presentations is likely to be mediated by competition between CSs and context cues (Durlach, 1989). If the conditions for cue-competition were not fulfilled for the discrete, experimentally programmed cues, is there any more reason to suppose they would be fulfilled so that competition could take place between programmed cues and the cue formed by the experimental context? Although it is not clear why competition between CSs and context cues should be relatively easy to demonstrate it is true to say that contingency effects in traditional conditioning experiments have not suffered the same difficulties that have confronted attempts to demonstrate blocking. In the introduction we referred to studies showing contingency effects (e.g. Furedy, 1971) and noted that there had been some published failures to find blocking. While some traditional conditioning studies have demonstrated blocking effects (e.g. Martin & Levey, 1991; Hinchy, Lovibond, & Ter-Horst, 1995) they are matched by as many that have failed to show blocking (e.g. Davey & Singh, 1988; Lovibond, Siddle, & Bond, 1988). Thus, we suggest that the failure to show an effect of US-alone presentations in EC does not augur well for future attempts to show cue-competition effects in EC. Judging by the results of traditional conditioning studies showing an effect of US-alone presentations should not be difficult. On the other hand, if EC is

based upon different associative principles, all forms of cue-competition will be difficult to demonstrate.

Turning now the issue of contingency awareness, we do not wish to claim that we have shown that EC can proceed without awareness. It is notoriously difficult (c.f. Shanks & St. John, 1994, for a discussion) to establish unequivocally that unaware subjects did not have at least some degree of knowledge of the contingencies that a more sensitive test (e.g. a recognition rather than a recall test) would reveal. Equally it is difficult to show that aware subjects were aware at the time of learning by a test of awareness that takes place "after the event". It seems quite possible that the test itself might cause people to review their experience and reach a conclusion about event contingencies at that point. Because our procedure used a recall test (subjects had to state the relation between colour cues and outcomes) that was carried out at the end of the experiment it seems likely that some subjects were wrongly classified. However, it is also true to say that many other studies have shown awareness effects using relatively unsophisticated procedures in traditional conditioning experiments and that more sophisticated approaches have failed to find effects in EC. For example, Baeyens et al. (1990) used a combination of awareness assessment during learning and recognition measures and were still unable to find an effect of

awareness in EC. However, one recent study of EC did find an effect of awareness on verbal ratings and startle reflex responding and this finding might show that awareness can play a part in EC under certain conditions (Purkis & Lipp, 2001). The study of Purkis and Lipp does, however, need to be viewed in the context of many failures to find awareness effects in EC and the ready observation that awareness does matter in other conditioning paradigms.

In conclusion, we have found that an affective priming measure can be used to provide a reliable measure of EC, replicating the recent work of Hermans et al. (*in press*). In addition the current experiments showed that the priming measure behaved largely in the way that would be expected on the basis of previous EC work using verbal ratings of liking. Although conditioning proceeded readily there was no evidence for an effect of awareness, nor an effect of US-alone presentations, and no evidence for blocking. In the case of each of these "failures" to find an effect it is entirely possible that various parameters of the experiment could be manipulated to show that EC can behave as would be expected on the basis of the traditional conditioning literature. An alternative view is that EC is based upon different principles and that a distinction should be drawn, for example, between predictive and referential learning (e.g. Baeyens et al., 1995). With the current state of knowledge it is not

possible to make a definitive choice between these two positions and, it is not possible to select one over the other on the basis of parsimony. However, the use of the priming measure as a relatively specific measure of affect offers an opportunity to test the generality of the EC findings beyond the scope of verbal ratings and physiological measures of affect such as the modulation of startle reflex.

References

Baeyens, F., Crombez, G., Van den Bergh, O., & Eelen, P. (1988). Once in contact always in contact: evaluative conditioning is resistant to extinction. *Advances in Behavior Research and Therapy*, **10**, 179-199.

Baeyens, F., Eelen, P., & Crombez, G. (1995). Pavlovian associations are forever: on classical conditioning and extinction. *Journal of Psychophysiology*, **9**, 127-141.

Baeyens, F., Eelen, P., & Van den Bergh, O. (1990). Contingency awareness in evaluative conditioning: a case for unaware affective evaluative learning. *Cognition and Emotion*, **4**, 3-18.

Baeyens, F., Eelen, P., Van den Bergh, O., & Crombez, G. (1989). Acquired affective-evaluative value:

conservative but not unchangeable. *Behaviour Research and Therapy*, **27**, 279-287.

Baeyens, F., Hermans, D., & Eelen, P. (1993). The role of CS-US contingency in human evaluative conditioning. *Behaviour Research and Therapy*, **31**, 731-737.

Bradley, M.M., Cuthbert, B.N., & Lang, P.J. (1990). Startle reflex modification: emotion or attention, *Psychophysiology*, **27**, 513-522.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd Edition)*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Cuthbert, B.N., Bradley, M.M., & Lang, P.J. (1996). Probing picture perception: activation and emotion. *Psychophysiology*, **33**, 103-111.

Davis, M. (1986). Pharmacological and anatomical analysis of fear conditioning using the fear-potentiated startle paradigm. *Behavioural Neuroscience*, **100**, 814-824.

Davey, G.C.L., Singh, J. (1988). The Kamin 'blocking' effect and electrodermal conditioning in humans. *Journal of Psychophysiology*, **2**, 17-25.

Dawson, M.E., & Schell, A.M. (1985). Information processing and human autonomic classical conditioning. *Advances in Psychophysiology*, **1**, 89-165.

De Houwer, J., Beckers, T., & Glautier, S. (under review). Outcome and cue properties modulate blocking.

De Houwer, J., Baeyens, F., & Hendrickx, H. (1997).
Implicit learning of evaluative associations.
Psychologica Belgica, **37**, 115-130.

De Houwer, J., Baeyens, F., Vansteegwegen, D., &
Eelen, P. (2000). Evaluative conditioning in the picture-
picture paradigm with random assignment of CSs to USs.
*Journal of Experimental Psychology: Animal Behavior
Processes*, **26**, 237-242.

De Houwer, J., Hermans, D., & Eelen, P. (1998).
Affective and identity priming with episodically
associated stimuli. *Cognition and Emotion*, **12**, 145-169.

Durlach, P.J. (1989). Learning and performance in
Pavlovian conditioning: are failures of contiguity
failures of learning or performance? In S.B. Klein & R.R.
Mowrer (Eds.), *Contemporary learning theories: Pavlovian
conditioning and the status of traditional learning
theory* (pp. 19-60). Hillsdale, New Jersey: Lawrence
Erlbaum Associates

Fazio, R.H., Sanbonmatsu, D.M., Powell, M.C., &
Kardes, F.R. (1986). On the automatic activation of
attitudes. *Journal of Personality and Social Psychology*,
50, 229-238.

Field, A.P. (2000). I like it but I'm not sure why:
can evaluative conditioning occur without conscious
awareness? *Consciousness and Cognition*, **9**, 13-36.

Furedy, J.J. (1971). Explicitly-unpaired and truly-random CS controls in human classical differential autonomic conditioning. *Psychophysiology*, **8**, 497-503.

Hamm, A.O., Greenwald, M.K., Bradley, M.M., & Lang, P.J. (1993). Emotional learning, hedonic change, and the startle probe. *Journal of Abnormal Psychology*, **102**, 453-465.

Hamm, A.O., & Vaitl, D. (1996). Affective learning: awareness and aversion. *Psychophysiology*, **33**, 698-710.

Hammerl, M., Bloch, M., & Silverthorne, C.P. (1997). Effects of US-alone presentations on human evaluative conditioning. *Learning and Motivation*, **28**, 491-509.

Hardwick, S.A., & Lipp, O.V. (2000). Modulation of affective learning: an occasion for evaluative conditioning? *Learning and Motivation*, **31**, 251-271.

Hermans, D., Vansteenwegen, D., Crombez, G., Baeyens, F., & Eelen, P. (in press). Expectancy learning and evaluative learning in human classical conditioning: affective priming as an indirect and unobtrusive measure of conditioned stimulus valence, *Behaviour Research and Therapy*.

Hermans, D., De Houwer, J., & Eelen, P. (1994). The affective priming effect: automatic activation of evaluative information in memory. *Cognition and Emotion*, **6**, 515-533.

Hinchy, J., Lovibond, P.F., & Ter-Horst, K.M. (1995). Blocking in human electrodermal conditioning. *The*

Quarterly Journal of Experimental Psychology, **48**, 2-12.

Kamin, L.J. (1969). Predictability, surprise, attention and conditioning. In, B.A. Campbell & R.M. Church (Eds.), *Punishment and Aversive Behaviour* (pp. 279-296). New Jersey: Prentice Hall.

Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (1990). Emotion, attention, and the startle reflex. *Psychological Review*, **97**, 377-395.

Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (1997). International Affective Picture System (IAPS): Technical Manual and Affective Ratings. Gainesville, Florida: NIMH Center for the Study of Emotion and Attention.

Lipp, O.V., Neumann, D.L., & Mason, V. (in press). Stimulus competition in affective and relational learning. *Learning and Motivation*.

Lipp, O.V., Sheridan, J., & Siddle D.A.T. (1994). Human blink startle during aversive and non-aversive Pavlovian conditioning. *Journal of Experimental Psychology: Animal Behavior Processes*, **20**, 380-389.

Lovibond, P.F., Siddle, D.A.T., & Bond, N. (1988). Insensitivity to stimulus validity in human classical conditioning. *The Quarterly Journal of Experimental Psychology*, **40B**, 377-410.

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

Martin, I., & Levy, A.B. (1991). Blocking observed in human eyelid conditioning. *The Quarterly Journal of Experimental Psychology*, **43B**, 233-256.

Martin, I., & Levey, A.B. (1994). The evaluative response: primitive but necessary. *Behaviour Research and Therapy*, **32**, 301-305.

Purkis, H.M., & Lipp, O.V. (2001). Does affective learning exist in the absence of contingency awareness? *Learning and Motivation*, **32**, 84-99.

Rescorla, R.A. (1968). Probability of shock in the presence and absence of CS in fear conditioning. *Journal of Comparative and Physiological Psychology*, **66**, 1-5.

Rescorla, R.A., & Wagner, A.R. (1972). A theory of Pavlovian conditioning: variations in the effectiveness of reinforcement and non-reinforcement. In, A.H. Black & W.F. Prokasy (Eds.), *Classical Conditioning II: Current Research and Theory* (pp. 64-99). New York: Appleton Century Crofts.

Shanks, D.R., St. John, M.F. (1994). Characteristics of dissociable human learning systems. *Behavioral and Brain Sciences*, **17**, 367-447.

Toglia, M.P., & Battig, W.F. (1978). *Handbook of Semantic Word Norms*. Hillsdale, NJ: Erlbaum.

Vansteenwegen, D., Crombez, G., Baeyens, F., & Eelen, P. (1998). Extinction in fear conditioning: effects on startle modulation and evaluative self-reports. *Psychophysiology*, **35**, 729-736.

Vrana, S.R., Spence, E.L., & Lang, P.J. (1988). The startle probe: a new measure of emotion? *Journal of Abnormal Psychology*, **97**, 487-491.

Waldmann, M.R. (2000). Competition among causes but not effects in predictive and diagnostic learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **26**, 53-76.

Winer, B.J., Brown, D.R., & Michels, K.M. (1991). *Statistical principles in experimental design* (3rd ed.). New York: McGraw-Hill.

Williams, D.A., Sagness, K.E., & McPhee, J.E. (1994). Configural and elemental strategies in predictive learning. *Journal of Experimental Psychology: Learning, Memory and Cognition*, **20**, 694-709.

Author Note

We would like to thank Anton Humphries for recruiting and testing subjects for Experiment 3.

Appendix 1.

Identifying numbers and descriptions for the IAPS picture sets used in this experiment (Lang et al., 1997).

Negative USs	Positive USs
3000 - Mutilation	1440 - Seal
3010 - Mutilation	1460 - Kitten
3053 - Burn victim	1710 - Puppies
3063 - Mutilation	1750 - Bunnies
3064 - Mutilation	1920 - Porpoise
3080 - Mangled face	2040 - Baby
3100 - Burn victim	2070 - Baby
3102 - Burn victim	2080 - Babies
3120 - Body	2260 - NeutBaby
3130 - Body	4150 - Skater
3170 - Baby tumour	5830 - Sunset
9040 - Child	8080 - Sailing
	8190 - Skiers
	8501 - Cash

Appendix 2.

Words used in the affective priming trials selected from
Toglia and Battig (1978).

Ratings			Ratings		
Word	Valence	Familiarity	Word	Valence	Familiarity
brave	5.27	6.53	anger	2.45	6.19
glad	5.65	6.34	bad	2.19	6.32
heal	5.28	6.10	danger	2.94	6.32
hope	5.46	6.34	dead	2.22	6.27
joy	6.00	6.27	die	2.20	6.43
kind	5.37	6.26	steal	2.50	6.23
merry	5.75	6.00	fear	2.84	6.43
nice	5.50	6.31	hate	2.06	6.29
peace	6.00	6.45	hell	2.40	6.38
safe	5.21	6.05	kill	1.95	6.23
true	5.45	6.51	liar	2.30	6.19
wise	5.58	5.98	pain	2.46	6.43
film	5.41	6.52	sad	2.55	6.44
gold	5.27	6.03	sick	2.08	6.45
smile	6.23	6.41	ugly	2.27	6.16

Figure caption

Results of affective priming tests in Experiments 1-4 (panels A-D, respectively).

Table 1

The designs used in Experiments 1-4. The + and - signs indicate whether a cue was followed by a positively or negatively valenced picture (respectively) whereas a "0" indicates that a cue was presented alone, not followed by a picture. The symbol "Φ" indicates an unsignalled picture.

	Stage 1	Stage 2	Test
Experiment 1	A-/B+/C0	-	A/B
Experiment 2			
Paired group	A-/B+	-	A/B
Unpaired group	A-/B+/Φ-/Φ+		- "-
Experiment 3			
Blocking group	A-/Y0	AX-/W-/Y0	W/X/Y
Overshadowing group	B-/Y0	- "-	- "-
Experiment 4			
Blocking group	A-/Y0	A-/W0/XY0	A/W/X
Overshadowing group	A-/Z0	- "-	- "-