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DISSOCIATING THE EFFECTS OF ATTENTION AND CONTINGENCY AWARENESS ON EVALUATIVE CONDITIONING EFFECTS IN THE VISUAL PARADIGM

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ABSTRACT

Two experiments are described that investigate the effects of attention in moderating evaluative conditioning (EC) effects in a picture-picture paradigm in which previously discovered experimental artifacts (e.g. Field & Davey, 1999) were overcome by counterbalancing conditioned stimuli (CSs) and unconditioned stimuli (USs) across participants. Conditioned responses for individuals who had attention enhanced were compared against a control group and groups for whom attention was impeded using a distracter task. In a second Experiment the effects of attention were dissociated from those of contingency awareness by using backward masked US presentations. The results of these experiments indicate that although associative EC effects may not be disrupted by a lack of contingency awareness, attention is an important factor in establishing conditioning. These results shed some light onto the possible boundary conditions that could explain past inconsistencies in obtaining EC effects in the visual paradigm.

DISSOCIATING THE EFFECTS OF ATTENTION AND CONTINGENCY AWARENESS ON EVALUATIVE CONDITIONING EFFECTS IN THE VISUAL PARADIGM

Evaluative conditioning (EC) is a process by which neutral stimuli acquire affect through contiguous pairing with a stimulus that already evokes an emotional response. In conditioning terms, the affectively neutral stimulus is the conditioned stimulus (CS) and is paired with either a liked or disliked unconditioned stimulus (US), resulting in the CS evoking a response congruent with the US with which it was paired (see De Houwer, Thomas & Baeyens, 2001, for a review). EC has been an elusive and controversial phenomenon with Stevenson, Boakes and Wilson (2000), and Lovibond and Shanks (2002) recently noting that EC experiments using visual stimuli had come under considerable criticism. The controversy surrounding EC stems from failures to obtain the basic effect (e.g. Field, Lascelles & Davey, 2003; Rozin, Wrzesniewski & Byrnes, 1998; Field and Davey, 1999; Field, 1997); demonstrations that EC effects can be elicited when participants have never been exposed to CS-US presentations, which have illustrated that EC effects can emerge from non-associative processes (Field & Davey, 1997, 1999); and criticisms that some early research could not rule out such non-associative processes because of a failure to counterbalance CSs and USs (Shanks & Dickinson, 1990) or to use between-group controls in which participants are exposed to CSs and USs, but not in contingent pairings (Davey, 1994; Field & Davey, 1998, 1999).

Notwithstanding these problems, EC is intriguing theoretically because, despite being a paradigmatic example of classical conditioning, it appears prima facie to have several unusual characteristics; the two most important being that unlike conventional autonomic conditioning in humans, EC can occur without participants possessing awareness of the learning contingencies involved (Baeyens, Eelen & Van den Bergh, 1990) and responses acquired through EC appear to be resistant to extinction (Baeyens, Crombez, Van den

Bergh & Eelen, 1988; Diaz, Ruiz & Baeyens, this issue). Conditioning without contingency awareness is particularly important theoretically because, as Lovibond and Shanks (2002) point out, it rarely—if ever—occurs in autonomic conditioning. Lovibond and Shanks distinguish single process models, in which propositional learning causes contingency awareness which in turn causes the conditioned response, from dual-process models, in which propositional learning causes contingency awareness, but conditioned responding is caused by some nonpropositional system (so contingency awareness and learning need not correlate). If EC can occur without awareness then a dual process model is implied—EC would be a nonpropositional learning process. One further inference might, therefore, be that EC is a qualitatively distinct form of Pavlovian learning. Indeed, Baeyens, Eelen and Crombez (1995) and Baeyens and De Houwer (1995) suggest that EC is a form of learning in which CS-US associations are merely referential connections between stimuli: so, according to Baeyens et al. (1995), unlike Pavlovian learning it is not critical that the CS be accompanied by a genuine expectancy that the US will shortly follow.

However, the true value of work into EC using visual stimuli has been diminished by the criticisms alluded to earlier. Fortunately, some progress has been made in the visual domain; for example, Diaz et al. (this issue) incorporated between-group controls and replicated the finding that conditioned evaluative responses were resistant to extinction; Field (2003) has likewise shown evaluative conditioning to visual stimuli compared to such controls. To date though, few studies using visual stimuli have used the counterbalanced CS-US allocations suggested by Shanks & Dickinson (1990). Paired with the ubiquitous reports of failures to replicate EC effects in a variety of laboratories (Field & Davey, 1999; Rozin et al., 1998; Field et al., 2003), the cloud of doubt hanging over EC has still yet to fully disperse. The apparent fragility of the EC phenomenon has led some (Rozin et al.,1998; De Houwer et al., 2000, 2001) to allude to the possibility of boundary conditions that moderate conditioned responding, however, likely moderator variables have yet to be proposed or tested empirically. One such boundary condition could be attention.

In general terms, dividing attention seems to attenuate learning: Nissen and Bullemer (1987) demonstrated that under dual task conditions participants could not learn a repeating sequence (as measured by the serial reaction time task, which they characterise as associative learning)—see also Shanks and Channon (2002). In addition, although divided attention did reduce conscious awareness of the sequence being learnt, Nissen and Bullemer concluded that it was not the lack of awareness that caused the lack of learning: amnesic patients could learn the sequence despite having no awareness of it (see also Reber & Squire, 1994, 1998).

Attention might also have a more specific role to play. The Rescorla-Wagner model (1972) formalises the idea that associations are formed between cues and surprising outcomes. This model famously incorporates a term representing a cue's individual associability, which represents an individual learning rate that the model acknowledges stems from differential attention. Mackintosh (1975), in a seminal paper, extended these ideas to suggest that the attention devoted to a given cue is a function of its importance in predicting an outcome: that is, animals will attend to relevant stimuli at the expense of not attending to irrelevant ones. Both models formalise learning in terms of a change in the association weights (associative strength) of a CS. Kruschke (2001) has followed up Mackintosh's ideas by proposing an attentional system involved in learning that has two goals: the first is to implement the assumption that any CS should receive some attention, and the second is to decide how attention should be distributed over multiple CSs. Kahneman's (1973) suggestion that attentional resources are finite is upheld in this model such that increased attention to one CS necessarily implies less attention to another. The system receives feedback and shifts attention in such a way as to reduce error, these shifts in attention lead to changes in the association weights (of the CSs), which themselves act to reduce the error in learning.

Interestingly, these attentional models provide explanations of failures to learn such as blocking (in which an organism fails to acquire a conditioned response to a stimulus, A, if it is presented in compound with another stimulus, B, that already predicts the US, Kamin, 1969) and latent inhibition (in which pre-exposure to a stimulus retards subsequent learning of a conditioned response to that stimulus during conditioning). Blocking, for example, results from learning not to attend to the stimulus A (Mackintosh, 1975) and has garnered empirical support (Krushke & Blair, 2000) and latent inhibition can be explained in terms of inattention (Kruschke, 2001). Lubow and Gerwitz (1995), in a review of latent inhibition, report that latent inhibition is strongest when a masking task is presented during pre-exposure; however, if this task is absent or is too difficult then latent inhibition will be small or non-existent. Kruschke (2001) argues that these results can be explained in terms of attentional load: only when the pre-exposed cue competes with the masking task for attention will subsequent latent inhibition occur. If the masking task is too difficult then it requires full attention and so none is available for the pre-exposed stimulus when it appears alongside the task.

The importance of both blocking and latent inhibition to failures to obtain EC is that they involve *failures to learn*. Learning fails because of a CS attracting insufficient attention. Based on this, one general explanation of the inconsistencies in EC research could, therefore, be that in some experiments the CSs are sufficiently attention-grabbing for learning to occur, whereas in others learning fails because the CSs do not attract attention.

Given that divided attention reduces awareness of what is being learnt (see Nissen & Bullemer, 1987, above), attention may also go some way to explaining inconsistent findings with regard to contingency awareness and EC. There is evidence that contingency awareness *facilitates* conditioning, does not influence learning one way or another, and *impedes* learning (see Field, 2000 and 2001a for reviews). Contingency awareness has been defined (at least at the operational level) variously as the knowledge that a particular CS precedes a particular US (Field, 2000; Baeyens et al., 1990 for example), or that a particular CS precedes a US that evokes a particular emotional response (e.g. Baeyens et al., 1990). If, as Mackintosh (1975) and Rescorla-Wagner (1972) suggest, attention to a

CS increases the strength of the associative connection between that CS and its US, then this may well have a knock on effect in terms of contingency awareness. Nevertheless, it is conceivable that contingency awareness can be dissociated from attention: Nissen and Bullemer 'emphasize the importance of distinguishing between attending to the task itself and being aware of information carried by the task' (p. 29).

The current study looks at these issues by manipulating general aspects of attention in an EC task using visual stimuli. In addition to this, it takes the novel step of using fully counterbalanced CS-US allocations to eliminate the artefact described by Field and Davey (1999) and uses comparison groups in which CSs and USs cannot be associated.

EXPERIMENT 1

In the first experiment an attempt was made to manipulate the attentional load during a visual EC task. This is comparable to the dual task conditions described by Nissen and Bullemer and seeks to reduce the attention paid to the task itself. It is predicted that in dual task conditions, EC will be attenuated. In addition, contingency awareness should be reduced in the dual-task condition, but based on other associative learning tasks (like sequence learning) it should be attention to the task, and not awareness of the contingencies that attenuates learning.

Method

Participants

Ninety-six paid volunteers were used as participants (32 per condition) and were tested individually. Their ages ranged from 19 to 55 years. The majority (76) were students from various disciplines at Sussex University and the remaining 20 were members of the general public. In the awareness-enhanced condition, 10 were male, 22 were female, 6 were members of the general public and the mean age of the group was 22.41 (SD = 5.10). In the distraction condition, 10 were male, 22 were female, 8 were members of the general public and the mean age of the group was 28.00 (*SD* = 11.29). In the control condition 11 were male, 21 were female, 6 were members of the general public and the mean age of the group was 23.50 (*SD* = 3.51).

Stimuli

Fifty colour photographs were taken from the International Affective Picture System CD-ROM (Lang, Bradley & Cuthbert, 1997a), which contains a set of emotional stimuli with normative affective ratings collected over 10 years (Lang, Bradley & Cuthbert, 1997b). The pictures chosen for this study had received similar ratings from both genders (and were, therefore, not gender specific) and had elicited either neutral, very positive or very negative pleasure ratings. Four pictures were chosen as CSs based on them having completely neutral IAPS ratings (from Lang et al., 1997b). The USs consisted of two pictures that had very positive IAPS ratings and two that had very negative IAPS ratings. A list of CS and US pictures and their IAPS ratings are in Appendix A. The remaining 42 pictures contained a range of positive, negative and neutral pictures.

To avoid the artefact described by Field and Davey (1999), CSs were allocated to USs using a Latin-square counterbalancing order. There were four different CS-US allocations ensuring that each CS was paired with all four USs across participants.

Apparatus

The experiment was run on a Pentium PC using custom written computer software: *Ectests version 1.2* (Stevens, Lascelles, Field, Matthias, Siddens-Corby & Ives, 1999). The experimental cubicle contained a table, a chair and the computer, monitor and mouse.

Procedure

Before the experiment, participants were randomly allocated to one of three groups (attention-enhanced, distraction, BSB control) that differed in the instructions that they received (see stage 2 below).

All participants were initially given written instructions. Once the experimenter was satisfied that the instructions had been understood and that the participant was able to use the mouse to operate the on-screen rating scale, the participant was left alone in the room to complete the experiment. The experiment consisted of four stages, with instructions appearing on the screen before each stage to remind the participant of what to do.

Stage 1: Baseline Assessment (pre-conditioning)

In this stage, the 50 IAPS photographs were randomly presented to participants. Each picture appeared in the centre of the computer screen, directly above a rating scale. The scale ranged from −100 (disliked) through 0 (neutral) to +100 (liked), in intervals of five. Using the mouse, a pointer on the scale could be dragged along the scale to the point that indicated the participant’s feelings towards the picture. Below the scale, a screen button displayed the value indicated by the pointer. Participants moved the pointer until satisfied with their rating, after which they clicked on the on-screen button to proceed to the next picture. This encouraged participants to pay attention to the rating they had given a particular picture. It was emphasized to participants that they should rely on their spontaneous, instinctive reaction to the picture. The ratings given at this stage were the pre-conditioning ratings.

Stage 2: Acquisition

Attention-enhanced and distraction groups received the same stimulus presentation schedule at this stage. The only difference between the groups was in the alleged aim of the experiment conveyed by the instructions. All participants were told to attend carefully to a series of pictures on the screen. However, the attention-enhanced group was told that the experiment examined memory and was asked to try to memorise the order of the pictures. The distraction group was led to believe the experiment was investigating multitasking and was correspondingly instructed to count backwards from 300, aloud, in intervals of 3 for the duration of the stage. (This task was intended to reduce attention to the CS-US contingencies). The instructions stressed the importance of both attending to the screen and counting backwards. Both groups were asked to think about how the pictures made them feel.

During this stage, each participant saw four CS-US pairings: two CSs paired with positive USs (Neutral-Like, N-L) and two CSs paired with disliked USs (Neutral-Dislike, N-D). Each CS-US pairing was presented 10 times, and the presentation order was randomised with the restriction that no CS-US pairing could appear consecutively more than twice. Each stimulus appeared for 1s, the interval between the CS and US (the trace interval) was set at 100ms, and the interval between CS-US pairs (the inter-trial-interval, ITI) was 4s. The trace interval was considerably shorter than the intervals used in early EC studies (e.g. Baeyens *et al*., 1988 and 1990).

The BSB control group were told to attend carefully to a series of pictures on the screen and to think about how the pictures made them feel. They were not told to memorise the order of pictures or asked to do the distracter task. The pictures were then presented in a BSB control procedure (Field, 1996, 1997) in which CSs and USs were selected and matched together using the same counterbalancing schedule as in the two experimental groups. However, during conditioning the CSs and USs were not presented in a contiguous or contingent pattern. Instead, participants saw 5 pairings of a stimulus with itself (so participants saw each stimulus presented 10 times—as in the experimental conditions), using the same timing parameters as the experimental conditions. Thus, a stimulus appeared for 1s, followed by a blank screen for 100ms, followed by the same stimulus presented for 1s, followed by a blank screen for 4s, and so on until that stimulus had appeared 10 times. This set of self-presentations can be thought of as a block of pairings; because there were four different CS-US pairs in the experimental conditions, this control condition contained four CS blocks and four US blocks.

Half of the participants saw the four CS blocks presented in random order followed by the four US blocks, also in random order, and half saw the US blocks before the CS blocks. Keeping the CS blocks separate from the US blocks ensured that participants never saw a

CS appearing contingently with a US. By randomising the presentation order of the blocks the possibility that participants could detect the US that corresponded to a CS was eliminated: because, for example, a CS might appear as the first CS-block, whereas the corresponding US might appear as the third US-block presented. So, even if participants were aware that there were CS-US pairings, which is unlikely, it is improbable that they could determine exactly which CS was assigned to which US. If no conditioning effects are observed in this condition, then nonassociative accounts of the effects observed in the experimental condition can be ruled out.

Stage 3: Postacquisition Assessment (post-conditioning)

Participants were informed that they would be presented with another set of photographs, and that they must rate each one along a rating scale to indicate the degree to which they liked, disliked or felt neutral about it. The same 50 pictures as in stage one were shown in random order and re-rated. The ratings in this stage are the post-conditioning ratings.

Stage 4: Measurement of Contingency Awareness.

Manipulations to attention will invariably enhance or hinder contingency awareness and these effects need to be examined, so three measures of contingency awareness were used in this stage in counterbalanced order across participants. The first two were the so-called strong and weak measures used in much of the EC literature (e.g. Baeyens *et al*. 1988, 1989a, 1990, 1992; Hammerl & Grabitz, 1993) and the third was the recognition measure described by Field (2000). This stage of the experiment typically took participants 1-3 minutes to complete.

Strong Measure: This measure of contingency awareness is so called because it measures precise knowledge of contingencies: participants must know exactly which US was paired with which CS. In this procedure one randomly selected CS appeared on the left side of the computer screen and all four USs appeared on the right (in random positions). Participants were asked to click on the picture on the right that they believed always followed the picture on the left during stage two of the experiment. After selecting a picture, four buttons (Completely Sure, Rather Sure, Rather Unsure, and Completely Unsure) appeared at the bottom of the screen for participants to indicate their confidence in their decision. Following this selection, one of the remaining CSs appeared on the left of the screen, and the four USs appeared on the right (in a different random position). The participant repeated the selection process until a US had been selected for each of the four CSs.

Weak Measure: This procedure measures knowledge of only the valence of the US paired with a CS, and as such is considered weak. In this measure, one randomly selected CS appeared in the centre of the screen above three on-screen buttons (Liked, Disliked, and Neutral). Participants used these buttons to indicate whether they believed the picture (CS) had been followed by a picture that they liked, disliked or felt neutral about during stage two of the experiment. Following this choice, participants indicated their confidence in the decision using one of four on-screen buttons (Completely Sure, Rather Sure, Rather Unsure, and Completely Unsure). This process was repeated for the three remaining CSs.

Recognition Measure: This measure of awareness is described by Field (2000) and required participants to discriminate actual CS-US pairings from decoy pairings in which the US is replaced with a picture from stage one that had the same valence as the US that was actually used. These decoy USs appeared in the baseline phase, but not in the acquisition stage. Participants saw eight CS-US pairs in random order (four actual CS-US pairings and four decoy pairings). Underneath each CS-US pair there were three on-screen buttons labelled Remember, Know, and No. For each pair of pictures participants were asked whether the pair of pictures had always appeared together (sequentially) during stage two of the experiment. Participants could respond that they (1) actually remembered seeing the pairing (remember), (2) had a feeling that they had seen the pairing (know), or (3) definitely did not see the pairing during stage two (no).

Criteria for Contingency Awareness: Participants were deemed to be aware of a given contingency if they met the following criteria. For the strong measure, participants had to correctly identified the US with which a CS was paired and be either completely or rather sure of their answer. For the weak measure, participants had to correctly identified the valence of the US with which a CS was paired and be either completely or rather sure of their answer. For the recognition measure, two conditions had to be met: participants had to correctly recognised the actual contingency (either by indicating that they remembered seeing it, or had a feeling that they had seen it) and also had to indicate that they had not seen the relevant decoy pairing.

For group analysis, a participant was classified as contingency aware for a given measure if they were aware of 2 or more of the 4 contingencies based on the relevant criteria for the measure. This criterion is based on the fact that for all three measures, by guessing alone, a participant should only be deemed aware of 0 or 1 of the four contingencies (to the nearest contingency). The final decision as to whether a participant was classified as aware was based on the majority decision of the three awareness measures: if two or more of the measures classified the participant as aware then that individual was deemed aware of the contingencies, if two or more of the measures classified a participant as unaware then that person was classified as unaware.

Results

All statistical tests used a cut-off point of $p = 0.05$ for significance and, where relevant, effect sizes are reported as Pearson's r.

Awareness Measures

In the attention-enhanced condition all 32 participants were classified as contingency aware based on the criteria above. In the distraction condition 10 participants were deemed unaware; the remainder were contingency aware. For the analysis, the distracter condition was broken down into contingency aware and contingency unaware sub-groups.

US Ratings

The liked USs were rated positively in the attention-enhanced group (M = 49.87, SE = 6.49), the distraction group (M = 45.00, SE = 10.76), and the BSB control (M = 55.20, SE

= 6.09). The disliked USs were rated very negatively in the attention enhanced group (*M* = –82.73, *SE* = 4.75), the distraction group (*M* = –66.56, *SE* = 7.88) and the BSB control (*M* = –78.60, *SE* = 4.46). Using a probability of .05, a three-way 4 (group: attention-enhanced, distraction (aware), distraction (unaware) or BSB control) × 2 (US type: liked or disliked) × 2 (picture: picture 1 or picture 2) ANOVA on the US ratings revealed a highly significant main effect of US type, $F(1, 66) = 479.69$, $r = .94$ but no other significant main effects or interactions. These results indicate that liked USs were rated significantly more positively than disliked USs across all three groups.

CS Ratings

One consideration with using a counterbalanced design is that it is assumed that CSs (neutral pictures) that are selected based on their IAPS ratings (Lang et al., 1997b) are actually perceived as neutral by the participants in the experiment. It also assumes that the US pictures are perceived as liked and disliked (which we have just demonstrated). However, not all participants found the CSs neutral to begin with (using Baeyens et al.'s 1988, 1989a, 1990, 1992 criterion of ratings between ±20) which left two options: exclude their data (11 participants from the attention enhanced condition, 3 from the distracter aware condition, 5 from the distracter unaware condition, and 7 from the BSB control) or include CS neutrality (the initial ratings of the CSs) as a covariate within the analysis. To avoid data exclusion, CS neutrality was included as a covariate.

Within each level of the type of US two stimuli were used (pictures of rabbits and a seal for positive USs, and a mutilated head and hand for the disliked ones), and each of these stimuli has a unique CS neutrality variable that needs to be covaried out. To achieve this, it was necessary to incorporate a variable called picture, which compares the two pictures within each type of US. Therefore, the data were analysed with a three way 4 (group: attention-enhanced, distraction (contingency aware), distraction (contingency unaware) or BSB control) × 2 (US type: liked or disliked) × 2(picture: picture 1 or picture 2) ANOVA with repeated measures on the last two variables, CS neutrality was a varying covariate for each CS and the change in evaluative responses (post-conditioning minus pre-conditioning) was the dependent variable.

There were no significant main effects of US type, $F(1,91) < 1$, group, $F(3, 91) = 2.39$, stimulus, $F(1, 91) < 1$. All interactions involving the stimulus variable were non-significant also, showing that the picture used as particular CS had no effect on change in rating.

The crucial group × US type interaction was significant, $F(3, 91) = 4.94$, indicating that the US type did affect changes in CS ratings, but these changes depended on the group to which participants belonged. Contrasts revealed a significant difference between N-L and N-D pairs in the attention enhanced group compared to the BSB control ($CI_{.95} = -23.83$ (lower), -3.43 (upper), $t = -3.26$, $r = .32$), but not between the distracter (aware) and the BSB control ($CI_{.95} = -9.67$ (lower), 12.74 (upper), $t < 1$, $r = .03$) or the distractor (unaware) and the BSB control ($CI_{.95} = -18.57$ (lower), 11.06 (upper), $t < 1$, $r = .06$).

Figure 1 shows the mean evaluative ratings of the CS at pre-conditioning and post-conditioning dependent on the type of US with which they were paired and whether participants were part of the BSB control or were distracted and were aware or unaware of the contingencies. In the attention enhanced condition the valence of the CSs paired with positive USs increased and the ratings of CSs paired with negative USs decreased. However, in all other conditions these effects were not present.

Insert Figure 1

Per-Contingency Analysis

As Field (2000, 2001a) has suggested, the analysis of awareness at a group level is problematic. Therefore, further analyses were conducted that included awareness at a per-contingency level (that is analysing the data by assigning each contingency a covariate that specifies the level of awareness of that particular contingency). For each CS, two awareness variables could be calculated: a dichotomous dummy variable (aware or unaware) or a continuous variable constructed from a combination of the correct response and the level of confidence in the response. For the strong and weak awareness measures, this continuous variable ranged from 0 (an incorrect response of which the participant was completely sure) to 7 (a correct response of which they were completely sure). The steps in between reflect varying degrees in confidence: 0 = incorrect and completely sure, 1 = incorrect and rather sure, 2 = incorrect and rather unsure, 3 incorrect and completely unsure, 4 = correct and completely unsure, 5 = correct and rather unsure, 6 = correct and rather sure, 7 = correct and completely sure. For the recognition measure, the continuous variable ranged from 0 (any combination of responses in which participants said they had not seen the actual pairing), through 1 (if they recognised or knew they had seen the actual pairings, but also recognised the decoy pairing) and 2 (they recognised the actual pairing and only had a feeling they had also seen the decoy pairing, or they had a feeling they had seen the actual pairing and reported not seeing the decoy pairing) to 3 (they recognised the actual pairing and reported that they hadn't seen the decoy pairing).

As before, the change in evaluative responses (post-conditioning minus pre-conditioning) were analysed. The analysis looked at the type of US used (liked or disliked) and, because within each of these levels two stimuli were used, another variable called picture was incorporated. The awareness measure could then be introduced as a covariate at each repeated level. Finally, a group variable was included (distraction task or no distraction task) and data from the BSB group were excluded (because this group would confound with contingency awareness because of the large amount of contingency awareness across experimental groups and the universal absence of contingency awareness in the control group because they experience no contingencies). The analyses were, therefore, a 2 (US type: liked or disliked) $\times$ 2 (picture: picture 1 or picture 2) $\times$ distracter (distracter task or not) ANCOVA with four covariates representing the awareness of each of the four contingencies. Initial CS ratings were also included as covariates (CS Neutrality). In this analysis a main effect of US type reflects a conditioning effect, and an interaction between

US type and distracter will indicate a different effect when a distracter task was not used. If awareness moderates the change in CS responses then this should show up as a significant covariate. The analysis was repeated using covariates based on the measures of awareness derived from the strong, weak and recognition awareness measures. The effect of US type was significant in all analysis yielding effect sizes of r = .38 (weak dichotomous), .37 (weak continuous), .37 (strong dichotomous), .36 (strong continuous), .35 (recognition dichotomous), and .34 (recognition continuous). These effect sizes are not significantly different using Hedges' homogeneity of effect size test, $\chi^2 = 0.087$, $p = 1$ (see Field, 2001b for computational details). The US type effect significantly interacted with whether or not a distracter task was used in all cases, r (listed in the same order as above) = .38, .36, .41, .38, .41, and .40 (again these effect sizes are not significantly different, $\chi^2 = 0.17$, $p = 1$). The covariate effect of awareness was non-significant in all analyses and yielded effect sizes of r (listed in the same order as above) = .19, .17, .18, .15, .17, and .16. In no analysis did the type of picture of CS neutrality have an effect.

Discussion

This study has two important findings: (1) evaluative conditioning effects could be found compared to non-paired control and these effects could not be prone to the artifact unearthed by Field and Davey (1999) and so reflect associative learning; and (2) distracting participants during conditioning eliminates conditioning effects.

On the first of these findings, Field and Davey (1999) discovered that when CSs and USs are selected based on an individual participant's subjective evaluation of them and are then paired based on perceptual similarity, evaluative-conditioning type effects are found even when participants see no conditioning trials. The conditioning-type effects were found to arise from an interaction between this stimulus selection procedure and participants tendency to engage in similarity-based category learning during the experiment. The current experiment eliminates this possibility by using the same CSs and USs for all participants and counterbalancing them across groups.

Given the controversy surrounding EC, these findings are very important because this study is one of the first to replicate the basic visual evaluative conditioning paradigm but with CSs and USs fully counterbalanced across participants[1] (although counterbalanced designs have been used in EC experiments using tastes). Shanks & Dickinson (1990) have suggested that a paradigm in which CSs and USs are counterbalanced across participants is a good control for nonassociative effects because all CSs enter into associations with all USs and so observed effects cannot possibly be attributed to stimulus properties. Field and Davey (1997, 1998, 1999) have taken a slightly stronger view. Essentially they agree with Shanks and Dickinson but note that in autonomic paradigms some CSs are not paired with USs (so there is a discrimination between CSs that enter into associations and ones that do not). In EC studies this is typically not so because all CSs enter into associations with some form of US (be it liked, disliked or neutral). Field and Davey (1998), therefore, argue that a non-paired control (the BSB control) is a necessary additional control that allows comparison between CSs that enter into associations and those that do not. In terms of isolating cause and effect, this comparison of an association and no-association condition is necessary. As such, Experiment 1 has made important steps towards demonstrating EC using visual stimuli using a very strict methodology.

The most striking result is that a distraction task eliminated conditioning. There are two explanations: (1) the distraction task interfered with contingency awareness resulting in a failure to condition, or (2) the distraction task does not prevent contingency awareness, but prevents conditioned responding. The former is supported by evidence from the autonomic conditioning literature suggesting that repetitive CS-US pairings do not produce

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[1] Some studies in the visual domain have used random CS-UCS allocations (e.g. De Houwer et al., 2000), which reduces the possibility of artefacts, but fully counterbalancing eliminates any remote possibility that effects are stimulus-specific.

autonomic CRs when contingency awareness is prevented by using distracting masking tasks (Dawson, 1970; Dawson & Reardon, 1971; Dawson, Catania, Schell, & Grings, 1979). Dawson and Schell (1982) showed that in individuals who could not shift attention from a distraction task (in one ear) to a previously conditioned CS (presented in the opposite ear) no conditioning effects were observed. Although in this study CS-US relations were learnt without a distracter task, the results show that engaging in dual-tasks interferes with conditioned responses by distracting attention from the conditioning task. However, this explanation is unlikely because the distraction task prevented awareness in only 1/3 of the participants. Also, participants aware of the contingencies who were distracted showed no evidence of conditioning. This suggests that distracting participants interfered with conditioning without necessarily reducing contingency awareness.

A final possibility is that participants in the attention-enhanced condition were simply demand aware, whereas those in the distraction condition were not. For demand awareness to explain conditioned responding participants need to be aware of the contingencies and to have an expectation that the experimenter wants CS ratings to change in the direction of the US with which it was paired. Without contingency awareness, any expectation that CS ratings should change in the direction of the US cannot translate into behaviour because the participant does not know on which US to base the change. Therefore, to explain the current results would require an explanation of why the distraction task eliminated demand awareness in those participants who were contingency aware. Although it is not self-evident why demand awareness might have been present in the attention-enhanced group but not in the contingency aware distraction task group it, nevertheless, remains a possibility. One solution would be to reduce contingency awareness in both distracted and non-distracted participants: because then even if demand awareness survives, it cannot translate into responses without contingency awareness.

EXPERIMENT 2

The exact role of contingency awareness and distraction were inseparable in Experiment 1 because (1) non-distracted participants were always aware of contingencies, and relatively few distracted participants were unaware of the contingencies; (2) no baseline for the effects of distraction was available because BSB control participants did not engage in a distraction task; and (3) the spectre of demand awareness was not fully banished.

Experiment 1 looked at EC under dual-task conditions, but did not make specific attempts to reduce contingency awareness. Experiment 2 aims to replicate the basic finding that dual-task performance inhibits EC, while dissociating these effects from those of contingency awareness. Specifically, attention will be manipulated, as before, by using distracter tasks for half of the experimental and control participants. However, each person will receive normal presentations of CS-US contingencies and presentations in which the US is rapidly presented. By manipulating the speed at which the US is presented contingency awareness should be reduced *without* interfering with attention to the CS (and in models of associative learning it is the CSs that seem to vie for attentional resources). It is predicted that dual-task conditions will result in attenuated learning, whereas reduced contingency awareness will not.

Participants

One hundred and thirty one paid volunteers were used as participants (35 in the conditioning group with the distraction task and 32 in the other three groups) and were tested individually. Their ages ranged from 18 to 53 years. All participants were students from various disciplines at Sussex University. In the paired-distracter group, 10 were male and 25 female, with mean age of 21.91 (*SD* = 4.25). In the paired-no distracter group, 9 were male and 23 female, with mean age of 25.03 (*SD* = 8.25). In the BSB-distracter group, 8 were male and 24 female, with mean age of 21.38 (*SD* = 4.10). In the BSB-no distracter group, 13 were male and 19 female, with mean age of 22.63 (*SD* = 5.25).

Stimuli

The 50 colour pictures used in Experiment 1 were again used in this experiment.

Apparatus

The apparatus were the same as for Experiment 1 except that new software was written (ECAwarenessAttention version 1.0 by Field & Field, 2000).

Procedure

The procedure was, in essence, the same as that used in Experiment 1 except that within paired and BSB control groups half of the participants performed a distraction task during the acquisition stage. In addition, a within-participant manipulation of contingency awareness was achieved by using backward-masked fast-presented USs for half of the stimulus pairs (for convenience the pairings with masked USs will be referred to as subliminal pairs).

Stage 1: Baseline Assessment (pre-conditioning)

This stage was identical to that described for Experiment 1.

Stage 2: Acquisition

All participants viewed 10 semi-randomised presentations of 4 CS-US pairs: 2 × N-L pairings and 2 × N-D pairings. One N-L and one N-D pair had a backward-masked subliminal US, the remaining pairs had normal US presentations (with parameters identical to Experiment 1). As in Experiment 1, the four different CSs were counterbalanced across the four USs across participants, but in addition the decision of which pairings had backward-masked USs was also counterbalanced across participants. All combinations of CSs and USs and masking arrangements were used resulting in 16 different counterbalancing conditions. For normal pairings the presentation rates were identical to Experiment 1 (the US was presented for 1s), however, in the subliminal pairings the US and mask appeared over a 1s interval with the US occupying 1 refresh rate of the monitor (17ms approx.) of the interval and the mask occupying the remaining 983ms. It was important for the subliminal awareness check (see stage four) that each US had a unique mask, therefore, 4 masks were constructed that consisted of a constant pattern of noise (random colour dots) that had either a green, blue, red or yellow filter. As such the masks had no recognisable features or similarity with the US that it masked.

Participants were split into one of four groups: (1) Paired-No Distraction in which participants viewed contingent CS-US presentations as described in the previous experiment; (2) Paired-Distraction, which was the same but participants counted backwards from 300, aloud, in intervals of 3 for the duration of the stage; (3) BSB-No Distraction in which participants viewed CS and US block presentations as described in Experiment 1; and (4) BSB-Distraction, which was the same as the previous group but participants counted backwards as in the paired-distraction group.

Stage 3: Postacquisition Assessment (post-conditioning)

This stage was exactly as described for Experiment 1.

Stage 4: Measurement of Contingency Awareness.

Subliminal Awareness:To assess awareness of the pairings in which the US was masked, participants were shown each mask used (the order of presentation was randomised) and asked to 'Think back to the second stage of the experiment when you were simply looking at images (but not rating them). Did you notice what image came IMMEDIATELY before the one above?' Participants could respond yes or no. If responding positively they were asked 'What was the picture of?' and 'How did the picture make you feel?' For each of these questions participants could type responses into a text box next to the question or click on a button labelled 'Don't Know'. A US was deemed to be undetected if participants answered no to the first question or incorrectly named the US picture or its valence.

Recognition Awareness: In Experiment 1, the three awareness measures showed substantial correspondence (a meta-analysis of effect sizes from the different methods revealed considerable homogeneity); therefore, only one measure (the recognition measure) was used as a manipulation check in this experiment. This procedure was essentially the same as for Experiment 1 but with some subtle changes. Participants again saw eight CS-US pairs in random order (four actual CS-US pairings and the same CSs accompanied by 4 decoy USs). In the previous experiments participants could conceivably discriminate real from decoy pairings on the basis of identifying US pictures they saw during stage two from those that they did not (remember the decoy USs were not from the conditioning stage). In this experiment the decoy US was always the US of the same valence that was not paired with that CS. All other aspects of this stage were the same as in Experiment 1 and a participant was again deemed aware of a given contingency if (1) they correctly recognised the actual contingency (either by indicating that they remembered seeing it, or had a feeling that they had seen it); (2) they correctly indicated that they did not see the relevant decoy pairing.

Results

All statistical tests used a cut-off point of $p = 0.05$ for significance and, where relevant, effect sizes are reported as Pearson's r.

Awareness Measures

For the backward masked pairings 130 of 131 participants were deemed unaware (i.e. unaware on both the subliminal awareness and recognition awareness measures) of the N-D pairing and 128 were unaware of the N-L pairing that they experienced. Therefore, in total 127 participants were unaware of the subliminal pairings. For the normal pairings we are interested only in the experimental group (because those in the control did not receive pairings and so could not be aware), of the 67 in the experimental group 51 were aware of the N-D pairing and 42 were aware of the N-L pairing.

US Ratings

The liked USs were rated positively in the paired-no distraction (M = 64.66, SE = 5.78), the paired-distraction (M = 63.29, SE = 5.44), BSB-no distraction (M = 48.19, SE = 5.98) and the BSB-distraction (M = 58.08, SE = 5.69). The disliked USs were rated very negatively in the paired-no distraction (M = −78.13, SE = 5.18), the paired-distraction (M

= –84.74, *SE* = 4.87), BSB-no distraction (*M* = –81.52, *SE* = 5.35) and the BSB-distraction (*M* = –83.47, *SE* = 5.10). A three-way 2 (group: paired or BSB) × 2 (distract: distraction task or not) × 2 (US type: liked or disliked) ANOVA on the US ratings revealed a highly significant main effect of US type, $F(1, 123) = 1059.32$, $r = .95$ but no significant main effect of group, distract or any interactions. As such, liked USs were rated significantly more positively than disliked USs and that this was true across all conditions.

CS Ratings

Figure 2 shows the mean evaluative ratings of the CS at pre-conditioning and post-conditioning dependent on the type of US with which they were paired, whether these pairings had a normal or subliminally-presented US, whether participants were part of the paired or BSB control groups and whether they were distracted or not. In the distracted conditions there were no substantial changes to any of the CS ratings in either the paired or BSB groups. However, in the non-distracted groups a differential shifts in CS ratings across the type of US were observed in the paired group but not the BSB control.

Insert Figure 2

The change in CS ratings (post-conditioning ratings minus pre-conditioning ratings) were analysed using a four way 2 (group: paired or BSB control) × 2 (distraction: distraction task or not) × 2 (US type: liked or disliked) × 2(US speed: Subliminal or normal) mixed ANOVA with repeated measures on the last two variables. The initial rating of the CS (CS neutrality) was entered as a varying covariate for each of the CSs, as was awareness of the contingency into which a particular CS entered (as measured by the recognition measure). As such, this analysis takes into account per-contingency awareness, and CS neutrality.

Rather than list all of the effects from this analysis, all main effects and interactions were nonsignificant unless otherwise stated. To demonstrate a basic conditioning effect CS ratings should change across time depending on the type of US with which it was paired

(US type) and whether the CS and US were paired or not (group). Therefore, the dependent variable (the change in CS ratings) should be affected by the group $\times$ US type interaction and any higher-order interactions involving this term. The group $\times$ US type interaction was significant, $F(1, 125) = 6.15$, $r = .22$. Distraction seemed to moderate this effect though as shown by a significant group $\times$ US type $\times$ distraction interaction, $F(1, 122) = 7.08$, $r = .23$. The final issue is whether US speed had any effect. The group $\times$ distracter $\times$ US type $\times$ US speed was non-significant, $F(1, 125) < 1$, $r = .06$. This indicates that the three way interaction results described above were not influenced by the speed of US presentation. The CS neutrality and contingency awareness regression terms were non-significant throughout this analysis.

To break down the group $\times$ distracter $\times$ US type interaction, two way 2 (group: paired or BSB) $\times$ 2 (US type: liked or disliked) mixed ANOVAs with repeated measures on the later variable were conducted separately for distracted and non-distracted groups and within these groups for normal and subliminal pairings. In all four analyses, the change in CS ratings was the outcome and CS neutrality and per-contingency awareness were entered as varying covariates for each CS. The crucial effect in each analysis is the group $\times$ US type interaction. For the distracted groups, this interaction was non-significant for normal pairs, $F(1, 63) < 1$, $r = .12$, and subliminal pairs, $F(1, 63) < 1$, $r = .02$. In the non-distracted groups, the group $\times$ US type interaction was significant for the normal pairings, $F(1, 60) = 4.06$, $r = .25$. Specifically, the effect of US type was significant in the paired, $F(1, 60) = 7.23$, $r = .33$, but not the BSB group, $F(1, 60) < 1$, $r = .01$. Also in the non-distracted groups, the group $\times$ US type interaction was significant for the subliminal pairings, $F(1, 60) = 4.55$, $r = .27$. Specifically, the effect of US type was significant in the paired group, $F(1, 60) = 4.35$, $r = .26$, but not in the BSB control, $F(1, 60) = 1.09$, $r = .13$.

Figure 3 illustrates the dissociation between conditioning and awareness by plotting the size of the conditioning effect (changes in N-D and N-L pairings in experimental groups compared to the controls), and the percentage of participants aware of the contingencies for distracted and non-distracted participants, when USs were presented normally (un-shaded bars and circles) and subliminally (shaded bars and triangles). A clear dissociation emerges: when No Distraction Task was used, conditioning occurred as indexed by medium effect sizes) regardless of whether Subliminal/Normal pairs were used, and correspondingly, regardless of whether contingency awareness was extremely low or high. When Distraction was used, no conditioning occurred, regardless of whether contingency awareness was extremely low or intermediate/high.

Insert Figure 3

Discussion

Experiment 2 sought to dissociate the effects of awareness from the effects of distraction. The results demonstrated three very important points: (a) differential conditioning could be observed compared to an unpaired control condition; (b) this conditioning was eliminated by a distraction task, (c) the effect of distraction could not be explained by a reduction in contingency awareness.

One concern that could be raised with the data from Experiment 2 is that pre-conditioning ratings were sometimes quite different across conditions. In particular, one possible explanation of the observed effects when masked USs were used and there was no distraction task (top right panel of Figure 2) is that exposure to these stimuli during conditioning merely exaggerated the pre-conditioning ratings in a particular direction: when the pre-conditioning ratings were negative, exposure made them more negative and when pre-conditioning ratings were positive exposure make them more positive. This would be rather like the artifactual process found by Field & Davey (1999). There are several reasons why this explanation is unlikely. The most important point is that CSs were fully counterbalanced across USs. This is important because it makes it improbably that the effects were a product of a particular stimulus interacting with exposure effects (see Shanks & Dickinson, 1990). In addition, in Figure 2, all pre-conditioning ratings (16 in total) reflect averaged ratings of the same 4 CSs, and across conditions similar levels of pre-conditioning ratings can bee seen to give rise to both positive and negative changes in ratings. Furthermore, the fact that CS neutrality did not feature as a significant variable in any analysis also suggests that these differences in baseline ratings were not responsible for the observed effects (remember that the effects observed controlled for CS neutrality). However, to further investigate this possibility statistically pre-conditioning ratings for trials involving 'subliminal' USs and no distraction task were correlated with the change in evaluative ratings. If the explanation above is correct then high pre-conditioning ratings should create positive changes in evaluative ratings, and negative pre-conditioning ratings should create negative shifts in evaluative ratings. In short, a positive correlation should be observed. In fact, pre-conditioning ratings had a negative relationship with changes in evaluative ratings (r = –.34). If pre-conditioning ratings were contributing to the pattern of observed results (rather than the association into which a CS enters) then this would predict the exact opposite to the pattern of results shown in the top right panel of Figure 2 (if preconditioning ratings are above zero then ratings should fall, and if preconditioning ratings are below zero then they should rise). Nevertheless, these differences in baseline ratings across groups illustrate how difficult it is to find universally neutral stimuli.

Others might also suppose that demand awareness had a role to play in Experiment 2. However, for this to be true, it would be necessary to assume that the absence of contingency awareness did not imply the absence of demand awareness. The rationale for this second experiment was partly based on the idea that this cannot be the case. Although it is, of course, possible for participants to be aware that their ratings of CSs are expected to change, and that these changes depend upon the liked and disliked images that they have seen, without knowledge of which CS was paired with which US it is not so easy to imagine how this demand awareness would translate into behaviour. For demand awareness to explain these results, participants would have to know, at the very least, the valence of the US paired with a given CS. Given that when USs were rapidly presented the vast majority of participants could not identify them, this greatly reduces the credibility of a demand awareness explanation (at least for these pairings).

GENERAL DISCUSSION

The main finding in these experiments is that distraction has an effect on conditioning independent of contingency awareness. One obvious explanation of this finding is in terms of attentional resources being drawn away from the conditioning procedure. Kahneman (1973) has suggested that humans have limited attentional resources that are divided between tasks, as such, difficult tasks will consume the most attentional resources, and interference on difficult tasks will be less than on easy tasks (Zelniker, 1971). Pashler and colleagues have shown that when two tasks require different responses task performance will be limited because responses to both tasks are fighting for limited memory retrieval capacity (Pashler, 1990; Fagot & Pashler, 1992; Carrier & Pashler, 1995). Related to this evidence, studies on the psychological refractory period suggest that there is a fundamental limit on the performance on concurrent tasks such that if the first task is occupying a central processing mechanism, then the second task will be put on hold (see Styles, 1997 for a review).

The role of attention in models of associative learning (e.g. Rescorla-Wagner, 1972 and Mackintosh, 1975) can be easily extended to fit the evaluative conditioning effects in Experiments 1 and 2: participants may have found the distraction task (counting backwards) more cognitively demanding than watching the CS-US pairings. As a consequence, the limited attentional resources of these individuals may have been allocated to the counting task (the primary task) leaving few (if any) attentional resources for the processing of the emotional content of the CSs and USs. In Zelniker's (1971) terms, the greater distraction was observed on the easier task. In terms of Mackintosh's and Kruschke's formalizations of associative learning, this reduced attention would have an impact on the association weights of the CSs in these experiments.

However, the picture is probably more complex than this, because in both Experiments 1 and 2, contingency awareness remained relatively unaffected by distraction; therefore, attention clearly was being paid to the CS-US contingencies at some level. Therefore, it is not simply the case that participants ignored all of the CSs and USs because their attention was focussed on the distraction task. One clue to what could be happening comes from recent findings from Katkin, Weins and Öhman (2001) that 'gut-feelings' to emotional stimuli may be based primarily on the perception of internal cues (such as heart beats). Katkin et al. found that when an aversive US was used learning was best predicted by an ability to sense internal cues. Evaluative responses are based on such gut-feelings (at least in terms of how they are operationalised in evaluative conditioning experiments), and so may be moderated by individuals' abilities to sense internal responses to the experimental stimuli. As such, the distraction task in Experiments 1 and 2 may not have distracted participants from the stimuli per se (as indicated by the failure to reduce contingency awareness), but may have distracted them from processing the emotional content of these pictures by preventing them from paying attention to visceral cues. Of course, this explanation is tentative, but future work might look to explore the role of visceral cues in evaluative conditioning. Interestingly, one study using haptic stimuli did show conditioning effects relative to a BSB control when a very similar distracter task to the one employed in the current studies was used to inhibit contingency awareness (Hammerl & Grabitz, 2000). The difference between the current finding and theirs probably lies in the modality of the task. Hirst, Spelke, Reaves, Caharack and Neisser (1980) have shown that dual processing is possible and in Hammerl and Grabitz participants the CS-US pairings, and the visceral cues they elicit, may simply have been more attention grabbing than in the current study (because they elicited a sensation on the skin). However, this does not explain why Hammerl and Grabitz only found EC when a distracter task was used.

A final consideration is what these results tell us at a process level and the implications for EC's status as a unique form of Pavlovian conditioning. In general terms, the results have some interesting implications for process models of associative learning such as those discussed by Lovibond and Shanks (2002). Lovibond and Shanks make the point that contingency awareness is interesting at a theoretical level because it may allow researchers to discount certain models of learning. In particular they make two quite strong predictions about a single process model: (1) this model predicts a close correspondence between awareness and the production of a CR; and (2) an adequate demonstration of conditioning without contingency awareness falsifies the single process model because contingency awareness is assumed to directly cause the CR. They go on to suggest that in a single process model a dissociation between conditioning and contingency awareness is unlikely to result from measurement error and so is the most theoretically interesting of the models. Although Lovibond and Shanks' logic is impeccable, they place the relationship between contingency awareness and conditioned responding in a vacuum. That is, they assume that other factors could not moderate the relationship between awareness and conditioned responding. The experiments presented in this paper shows that attention affected both contingency awareness (to some degree) and conditioned responding. This demonstrates how a single causal connection between awareness and learning could be moderated by some external factor. This perhaps suggests that a single process model is an overly simplistic view of associative processes, and that conditioning without awareness does not rule out such a process (because a single causal link may exist between conditioning and learning, but both are also influenced by other factors that are not part of a second process). Interestingly, the eventuality of external influences on learning and awareness opens up many possibilities for explaining the mass of conflicting evidence for the relationship between contingency awareness and conditioning, especially in evaluative conditioning (Field, 2001a).

Nevertheless, although the finding that conditioning effects did not seem to depend upon contingency awareness lends further support to the idea that evaluative conditioning is both associative and can occur without contingency awareness, these results need to be treated cautiously. Although these experiments attempted to account for contingency awareness at a per-contingency level, the data highlight the many problems faced by researchers trying to answer questions about awareness. For example, participants will never be aware or unaware of all contingencies, if only because of the degrees of error inherent in measuring awareness. As Shanks and St. John (1994) point out, measures need to be relevant to the conditioning effect, should assess awareness at the same time as conditioned responses, and should be comparably sensitive to measures of the conditioned response. The current experiments measured contingency awareness after evaluative responses were recorded, and even with a variety of measures it's unclear whether their sensitivity is comparable to that of the measures of conditioning. As such, no strong claims should be made about the role of contingency awareness.

APPENDIX A

Stimulus Type	Image	IAPS Number	IAPS Pleasure Rating[2]
CS (Neutral)	Mug	7009	4.93
CS (Neutral)	Mushroom	5532	5.19
CS (Neutral)	Filing Cabinet	7225	4.45
CS (Neutral)	Tissues	7950	4.95
US (Positive)	Seal Pup	1440	8.19
US (Positive)	Puppies	1710	8.34
US (Negative)	Mutilated Hand	9405	1.83
US (Negative)	Mutilated Head	3010	1.79

[2] IAPS ratings range from 1 (unpleasant) to 9 (pleasant), with 5 representing neutral.

FIGURE CAPTIONS

Figure 1 Graph showing the mean CS ratings (and SE) pre- and post-conditioning for liked, disliked and no USs according to whether participants were in the attention enhanced (contingency aware), distracted (contingency unaware and aware) or in the BSB control.

Figure 2 Graph showing the mean CS ratings (and SE) pre- and post-conditioning for liked, disliked and no USs according to whether stimuli were paired of unpaired (BSB), had backward masked subliminal USs, and participants were distracted or not during conditioning.

Figure 3: Graph showing the percentage of participants aware of contingencies (bars) and the size of the conditioning effect, *r* (lines), when distracted or not and when USs were presented normally (not shaded bars and circles) or subliminally (shaded bars and triangles).

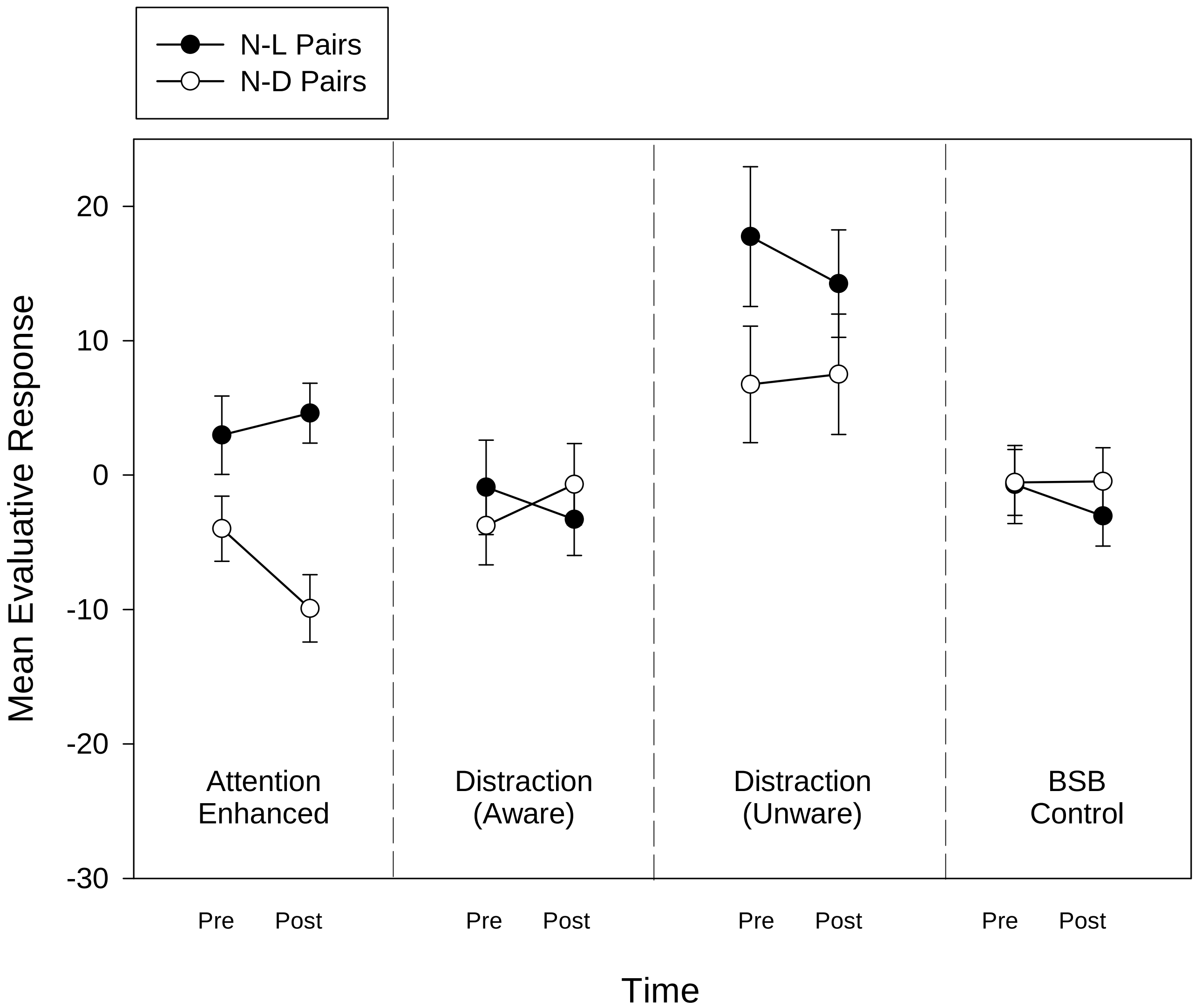

N-L Pairs
N-D Pairs
Mean Evaluative Response
20
10
0
-10
-20
-30
Attention Enhanced
Distraction (Aware)
Distraction (Unware)
BSB Control
Pre
Post
Pre
Post
Pre
Post
Pre
Post
Time

Figure 1

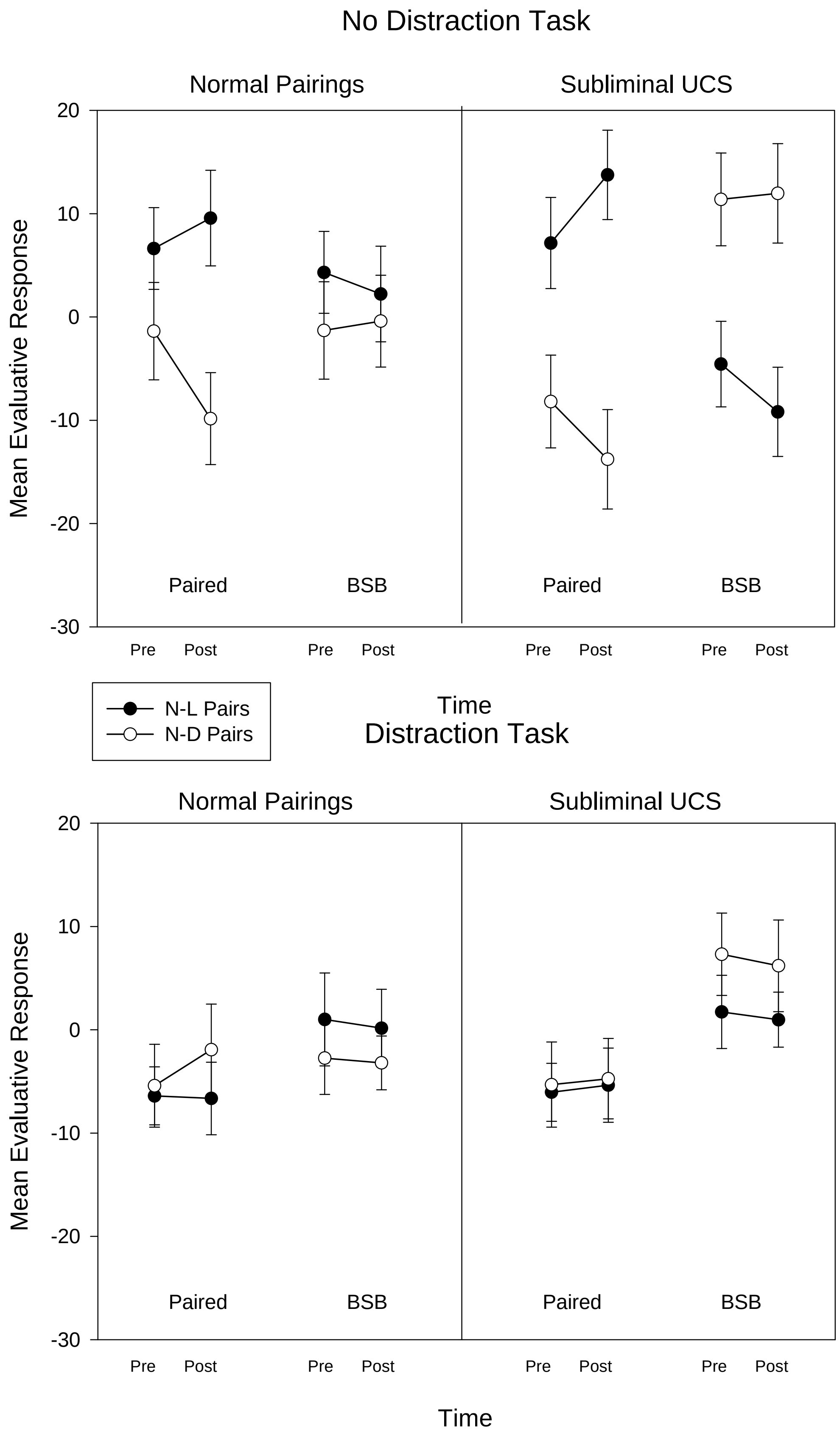
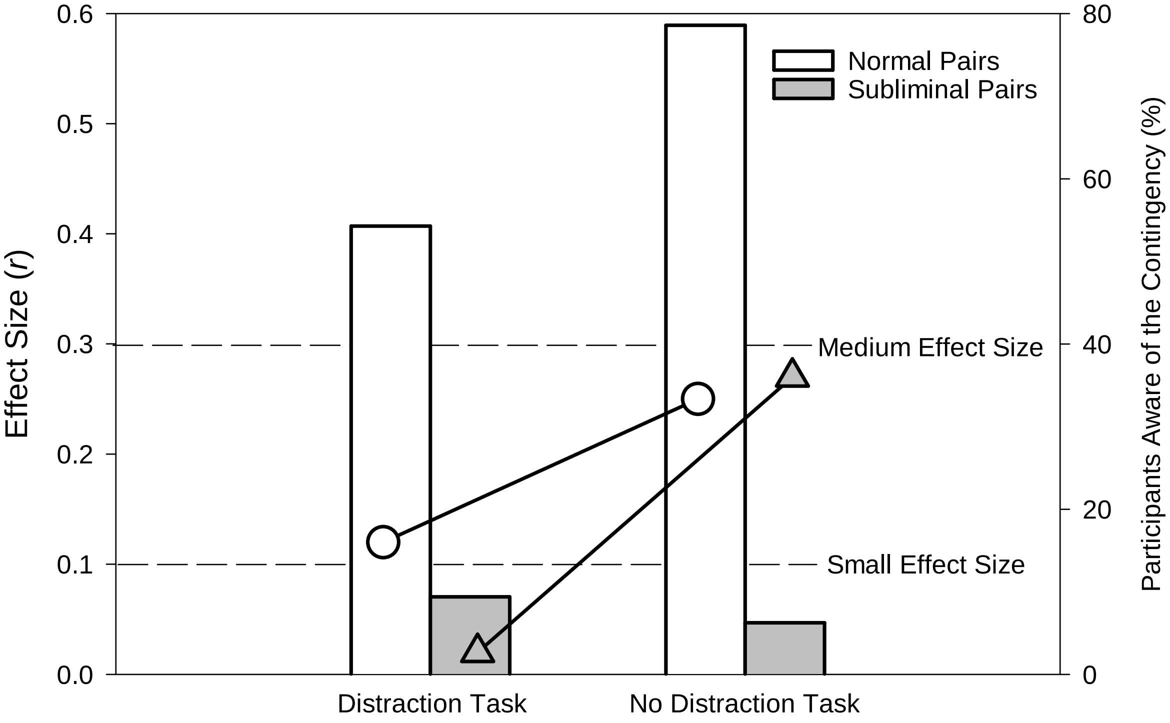

No Distraction Task
Normal Pairings
Subliminal UCS
20
10
0
-10
-20
-30
Mean Evaluative Response
Paired
BSB
Paired
BSB
Pre
Post
Pre
Post
Pre
Post
Pre
Post
N-L Pairs
N-D Pairs
Time
Distraction Task
Normal Pairings
Subliminal UCS
20
10
0
-10
-20
-30
Mean Evaluative Response
Paired
BSB
Paired
BSB
Pre
Post
Pre
Post
Pre
Post
Pre
Post
Time

Figure 2



Effect Size (r)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
80
60
40
20
0
Participants Aware of the Contingency (%)
Normal Pairs
Subliminal Pairs
Medium Effect Size
Small Effect Size
Distraction Task
No Distraction Task

Figure 3

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