

The Roles Of Attention, Awareness, And Memory In Evaluative Conditioning

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Abstract

Evaluative conditioning (EC) is learning that occurs when a neutral conditioned stimulus (CS) is repeatedly paired with a valenced unconditioned stimulus (US) such that the CS takes on the valence of the US. In the current investigation we were interested in investigating the combined and individual effects of attentional resources and contingency awareness on implicit and explicit EC using a disguised conditioning paradigm. We orthogonally manipulate participants' awareness of the contingencies and attentional resources in an EC paradigm. We found mixed evidence for the necessity of higher order resources for EC. Neither orthogonally manipulated awareness nor attention had an effect on EC. Memory of the valance and identity of associations does appear to have an effect, however, on EC effects. Thus, the present research adds to the existing literature on the role of awareness and attention in evaluative conditioning.

Keywords: Evaluative conditioning, attentional resources, contingency awareness, memory

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I. Introduction and General Information

Attitudes play an important role in determining our behavior by influencing which stimuli we interact with and which we avoid. One way attitudes form and change is through evaluative conditioning (EC), which occurs when a neutral conditioned stimulus (CS) is repeatedly paired with a valenced unconditioned stimulus (US) such that the CS takes on the valence of the US. For example, a neutral CS paired with a positive US may be evaluated more positively than it would otherwise be; alternatively, a CS paired with a negative US may be evaluated more negatively.

As the subject of many decades of research, EC has shown that it is a robust effect with a wide range of implication for attitudes towards commercial products (Pleyers, Corneille, Luminet, & Yzerbyt, 2007), social groups (Olson & Fazio, 2006) and prominent political figures (March, Kendrick, Fritzlen, & Olson, 2016). Despite its substantial history, debate remains regarding the mechanisms through which EC affects attitudes. Some argue that EC can occur through purely associative processes that require neither awareness of the CS-US pairings (i.e. contingency awareness) nor full attentional resources (Jones, Olson & Fazio, 2010). Others argue that EC occurs solely through deliberate propositional reasoning, and requires both attentional resources and contingency awareness (Mitchell, De Houwer, & Lovibond, 2009). In the present work, we examine the role of contingency awareness and attentional resources orthogonally to determine their individual and combined contribution to EC effects.

Contingency Awareness and Evaluative Conditioning

One of the most substantial areas of dispute within EC research is in regards to contingency awareness, the knowledge of the relationship between the CS and US. Some studies have found evidence that contingency awareness is necessary for EC effects (Dedonder,

Corneille, Yzerbyt, & Kuppens, 2010; Dedonder, Corneille, Bertinchamps, & Yzerbyt, 2014; Halbeisen, Blask, Weil & Walther, 2014; Hofmann et al., 2010; Pleyers, Corneille, Luminet, & Yzerbyt, 2007; Pleyers, Corneille, Yzerbyt, & Luminet, 2009; Stahl & Unkelbach, 2009; Stahl, Unkelbach, & Corneille, 2009). Other studies have shown that EC effects can occur without participants' awareness (Balas & Gawronski, 2012; Bayens, Eelen, Crombez, & Vanderberg, 1992; De Houwer, Baeyens & Eelen, 1994; De Houwer, Hendrickx, Baeyens, 1997; Field & Moore, 2005; Hofmann et al., 2010; Hütter, Sweldens Stahl, Unkelbach, and Klauer, 2012; Hutter & Sweldens, 2013; Jones, Fazio, & Olson, 2009; Olson & Fazio, 2001, 2002, 2006; Schultz & Helmstetter, 2012; Sweldens et al., 2010).

Those who have attempted to demonstrate EC in the absence of contingency awareness have done so primarily using measures of contingency memory. If a participant shows an EC effect, but no memory, then the case can be made for unaware EC. However, it is difficult to demonstrate a lack of awareness directly. This comes from the difficulty documenting something's absence. Since the nonappearance of awareness does not mean that it is not there, it may be that one does not have the correct tools to detect it. In other words, a failure to find contingency awareness may be because the measure lacked sensitivity to detect it, not that contingency awareness was actually absent. Since the absence of evidence is not sufficient evidence of absence, this ultimately leads to an epistemological dead end.

Although contingency awareness is the term most commonly used to describe the knowledge of the CS-US pairs, most measures of contingency awareness are administered after the EC procedure. Thus, contingency awareness may be best described as contingency memory. Two different forms of memory for the CS-US pairings have been investigated: valence memory and identity memory. Valence memory refers to knowledge of the valence (positive or negative)

of the US paired with the CS. One would be considered valence-aware if one correctly recalled that a given CS was paired with positive or negative US despite not remembering the specific US. Identity memory refers to memory of the specific US paired with the CS or the specific CS paired with each US (depending on how the question is phrased).

Stahl et al. (2009) investigated how valence memory versus identity memory differentially impact EC. After systematically pairing neutral non-words with valenced images, they found that only those who had valence memory showed EC effects (i.e., the difference between ratings of CS paired with positive US and CS paired with negative US). Identity memory did not increase the magnitude of EC. In other words, EC effects emerged only when participants remembered the valence of the US paired with the CS. Memory for the identities of the CS-US pairs did not result in stronger EC effects.

Both valence and identity memory can be used as evidence that EC effects are dependent on memory for the CS-US contingencies. However, research has shown that memory can be overestimated on valence memory tasks. Bar-Anan and Amzaleg-David (2014) manipulated whether participants with induced attitudes towards an object would show memory judgment biases based on their attitudes. They found that individuals' attitudes towards objects did in fact bias their memory of which items these objects were paired with, regardless of whether the attitude was held prior to the EC procedure or was induced after. In other words, participants may infer the valence of the stimuli paired with the CSs based on their acquired attitudes, relying on affect-as-information (Schwarz & Clore, 1983), rather than their explicit memory.

Ultimately, it is empirically impossible to eliminate the possibility that some participants who appear to be "aware" on such measures are actually aware of the valence paired with the CS.

Given problems with measuring CS-US awareness and memory, researchers have advocated experimental approaches to address the question of how awareness contributes to EC (e.g., Gawronski & Walther, 2012; Sweldens et al., 2014). However, most experimental approaches only indirectly manipulate contingency awareness via manipulations of related variables like stimuli presentation duration (Rydell et al., 2006), attention to the CS and US (Blask, Walther, Halbeisen, & Weil, 2012; Field & Moore, 2005; Kattner, 2012), stimulus spatial location (Dedonder, Corneille, Bertinchamps, & Yzerbyt, 2014) and cognitive resources (Fulcher and Hammerl (2001).

To our knowledge, only one published paper has examined how directly manipulating contingency awareness affects EC. Fulcher and Hammerl (2001) manipulated awareness by informing half of the participants of the CS-US contingencies prior to conditioning (awareness-induction group). This group was compared to participants instructed to perform a distractor task, in which they solved arithmetic problems presented acoustically and said the answers aloud, while simultaneously completing the conditioning task (awareness-reduction group). Only those in the awareness-reduction group showed EC effects. When examining contingency memory, none of the participants in the awareness-reduction group showed memory, but only half of those in the awareness-induction group did. Researchers compared EC effects for those in the awareness-induction group who showed memory to those who did not and they found only those who had no contingency memory showed EC, despite having been informed previously of the contingencies.

This study is important in several ways. First, it provides the first experimental evidence that increasing awareness may not increase EC effects, and, likewise, it suggests that *reduced* awareness may result in stronger EC effects. Unfortunately, there was no control condition,

making it impossible to determine whether it was reduced awareness or attentional resources that contributed most to the EC effect. Thus, it is unclear whether it was the lack of awareness, a reduction in attentional resources, or some combination of both, that resulted in greater EC effects in Fulcher and Hammerl's work. As we discuss below, this conflating of awareness and attentional resources highlights a challenge in the EC literature as to how manipulated awareness affects EC independently of the effects of attentional resources.

Attentional Resources and Evaluative Conditioning

In the same way that some researchers have argued that CS-US contingency awareness must be present for EC to occur, others have argued that EC depends on the availability of attentional resources. Only a handful of studies have examined the influence of attentional resources on EC effects (Davies, Deredy, Zandstra & Blanchette, 2012; Field & Moore, 2005; Fulcher & Hammerl, 2001; Gibson, 2008; Pleyers, Corneille, Yzerbyt, & Luminet, 2009; Walther, 2002). Some of this research has found that reducing participants' attentional resources prevents EC from occurring (Davies et al., 2012; Field and Moore, 2005; Pleyers et al., 2009), while other studies find that reducing participants' attentional resources has no effect on attitude formation through EC (Fulcher & Hammerl, 2001; Gibson, 2008; Walther, 2002).

Field and Moore (2005) manipulated attentional resources by having some participants loaded with a secondary task during conditioning (i.e. count back aloud from 300 in intervals of 3). This group was compared to a control group and an attention enhanced group, who were instructed to pay close attention to the images presented during conditioning. Those in the load condition did not show EC effects; only participants instructed to pay attention to the images exhibited EC effects. As all participants showed contingency memory in Study 1, they conducted a second study to assess the role of contingency memory. In order to reduce

awareness and dissociate the effects of attentional resources from memory, they presented US at subliminal durations in some conditions. As in their first study, they only found EC effects in the group that did not have their attentional resources reduced. Consistent with Field and Moore (2005), both Pleyers et al. (2009) and Davies et al. (2012) observed no EC for participants who had their attentional resources reduced with a secondary task, compared to participants who did not (and for whom EC effects were found).

Contrastingly, other studies have found *greater* EC effects in conditions of reduced attentional resources. Walther (2002, Experiment 5) manipulated attentional resources by having some participants remember an eight-digit number during conditioning, and compared them to participants who were given no such instructions. While both groups showed EC effects, she found that these effects were stronger under conditions of reduced attentional resources (i.e. load group) than when attentional resources were intact (i.e. no load group). As discussed earlier, Fulcher and Hammerl (2001) also found EC effects for those who performed a distractor task during conditioning but, it is impossible to determine whether it was reduced attention, reduced awareness, or both that contributed to their findings.

When attentional resources are considered in conjunction with contingency awareness, evidence seems to indicate that attentional resources are the more important factor in determining EC. Some studies found evidence for EC both when participants showed contingency memory and when they did not, but only when they did not have their attentional resources manipulated (Davies et al., 2012; Field and Moore, 2005; Pleyers et al., 2009).

Of the studies finding stronger EC among participants who did not show memory, the majority of these participants were also in the load conditions. This makes it impossible to determine whether the lack of memory had an effect independent of load. While it is clear that

there are mixed findings regarding the role of attentional resources on EC, it is unclear whether these differential results are due to the different conditioning paradigms employed, the nature of the task used to manipulate attentional resources, the measures used to assess EC effects, or some unknown variable.

In previous EC literature, “awareness” and “attention” were often conflated because attention is a prerequisite to awareness: to be aware of something, you must attend to it in some capacity. Although recent research has attempted to distinguish between attention and awareness, empirically, they are often confounded, as in Fulcher and Hammerl’s work. Part of the reason contingency memory and attentional resources have been so confounded in previous research is that most EC paradigms have high default levels of contingency memory, and researchers must actively work to reduce that memory through indirect methods. The problem with such approaches is that it is impossible to definitively say that the manipulation is causing the change in awareness if the variable being manipulated is not awareness itself. Thus, in order to eliminate these possibilities, contingency awareness and attentional resources must be manipulated orthogonally to assess their individual contributions to EC, using a paradigm with low default levels of awareness. We do just this in the present research.

Current Investigation

The current investigation differs from previous research in the type of paradigm utilized, direct manipulation of awareness, and inclusion of implicit measures. We utilize a paradigm characterized by disguised pairings that reduce default levels of awareness, simultaneously presented stimuli and filler stimuli. All of these factors lend themselves to associative mechanisms (Sweldens et al., 2014). Additionally, we are one of the first investigations to orthogonally manipulate awareness and attention to investigate their dissociated effects. Because

the paradigm we utilize offers us relatively low levels of awareness, we employ a straightforward manipulation of awareness: participants are simply told of the contingencies or not. Further, we manipulate 3 levels of attentional load.

Implicit measures are less prone to social desirability and demand effects than explicit measures, and are capable of assessing attitudes participants may be unaware they have acquired (Fazio & Olson, 2003). Previous studies investigating the effects of attentional resource depletion have rarely included implicit measures of attitudes. To our knowledge, only one study examining attentional resources in EC employed implicit measures. Gibson (2008; Experiment 2) measured EC effects using an implicit associations test (IAT) and only found implicit EC effects for participants in the load condition; moreover, implicit effects were stronger for those who showed less contingency memory.

Regarding the potential mechanisms underlying EC effects, each mechanism (e.g., associative, propositional) implies different roles for contingency awareness and attentional load. Propositional mechanisms are argued to require controlled reasoning processes and thus may only contribute to EC effects when attentional resources are untaxed and when awareness of the contingencies is present. If propositional reasoning is the mechanism behind EC effects then there should be no EC effects found in the high load conditions or if participants are unaware of the contingencies. Associative mechanisms are thought to require little in the way of attentional resources and awareness; if simple associative learning is the mechanism behind the EC effects then EC effects should occur regardless of load or awareness.

In the current investigation participants were randomly assigned to 1 of 6 conditions in a 2 (Awareness: instructions vs. no instructions) by 3 (Attentional Load: no vs. moderate vs. high) design. We manipulated contingency awareness by randomly assigning participants to either

receive instructions informing them that certain items would be systematically paired together or not (instructions condition and no instructions condition, respectively). Attentional resources were manipulated by assigning all participants to either a no load or a moderate load or high load condition, in which they performed a performed a secondary task during conditioning.

II. Methods

Participants and Design

304 English-speaking undergraduates students at the University of Tennessee participated for course credit. They were randomly assigned to the six conditions of a 2 (Contingency Instructions: no instructions, instructions) x 3 (Cognitive Load: no, moderate, high) mixed-factorial design with both factors varying between participants.

Stimuli

Stimuli were drawn from preexisting lab databases. A variety of neutral and unrelated filler words and pictures comprised the majority of the stimulus items in the conditioning task (e.g. the words *ashtray*, *adequate*, *book* and the pictures of a basket, airplane, and cowboys). Five different items served as targets, one per block. These consisted of pictures of white male faces of average attractiveness.

CS consisted of two photos of white male faces with non-descript names, Joshua and Michael, one paired with positive US and the other paired with negative US. The faces were pre-rated and matched in terms of attractiveness. US consisted of 20 positively (US+) and 20 negatively (US-) valenced images and words. Prior studies have found more robust EC effects and less contingency awareness when the US are relatively low in evocativeness (Jones et al., 2009). For that reason, the images chosen were those that had been rated as low arousal on a pilot test.

Procedure

Participants were tested in groups of 1 to 5 individuals. They were greeted by an experimenter and seated at an individual computer. Participants were told they would be

completing a study about vigilance to stimuli. All tasks were administered using MediaLab and Direct RT software.

Conditioning Phase

The conditioning phase relied on a procedure similar to the paradigm used by Olson and Fazio (2001), a disguised conditioning task that minimizes contingency awareness. Over the course of 5 blocks, participants were shown a stream of hundreds of images and words, presented for 1.5 seconds each, and instructed to press the space bar as quickly as possible anytime a pre-specified target appeared. Most of the targets, as well as the CS-US pairs, appeared in the center of the screen. Before each block participants were shown the picture of the target. Each target was presented 10 times per block.

Embedded within the stream of images were the critical CS-US pairings. One CS was paired with 20 different negative US and the other CS with 20 different positive US. The valence assigned to each CS was counterbalanced between participants. Each CS was presented with a US 4 times per block, with each US only being presented once. Presentation of the CS-US pairings was evenly spaced throughout the block and presented in an alternated sequence equally on either side of the screen throughout the block. Each CS-US pair was preceded and followed by a blank screen. Sixteen additional blank screens were also randomly dispersed within each block.

Participants in the contingency instructions condition were additionally told, “We have paired Joshua’s [Michael’s] face with positive images and words, and Michael’s [Joshua’s] face with negative images and words.” Those who were in the no contingency instructions condition received no such information before the conditioning task. For those in the high load condition, participants received the following additional instructions “When you complete this task, you

will hear a list of numbers. Please count the number of times you hear the number ‘5’ followed by the number ‘2’. At the end of each block, you will be asked to report this number.” For those in the moderate load condition, participants received the following additional instructions, “When you complete this task, you will hear a list of numbers. Please count the number of times you hear the number ‘2’. At the end of each block, you will be asked to report this number.” For those in the no load condition, they received no additional instructions. After each block, those in the high and low load conditions were asked to report how many times they heard the numbers throughout each block, which served as a manipulation check of the task. All participants were instructed to put on the headphones located next to their computer screen (however, no load participants heard nothing play through the headphones). After the conditioning phase, participants completed unrelated filler questionnaires that took about 10 minutes before completing the attitude change measures and contingency memory tasks.

Dependent Measures

Implicit effects were assessed using an evaluative priming task (Fazio Jackson, Dunton, & Williams, 1995). The task was ostensibly presented as a word processing task and participants were instructed to identify the meaning of the words presented on the screen as quickly as possible and categorize them as positive or negative by pressing one of two corresponding keys. In the critical blocks, the adjectives were briefly (300 ms) preceded by a prime (an image of either a CS or filler image from the conditioning task).

Participants first completed a practice block in which they only categorized adjectives with no pictures before completing the critical test blocks that contained the picture primes. For the critical blocks, participants were given the instructions that this portion of the task was assessing their ability to perform two tasks simultaneously and that previously seen pictures

would be presented preceding the words in order to make the word meaning task more difficult. The practice blocks contained 20 trials and the two critical blocks contained 48 trials each, with 32 of the 48 involving the two critical CS. Response time latencies were recorded for all trials.

After the evaluative priming measure, participants completed a pairwise preference task to assess explicit EC effects. Participants were presented with 20 pairs of faces from the conditioning task and for each pair, instructed to choose their preferred face. Of the 20 pairs, 10 contained at least one of the two critical CS images and two contained both CSs in order to provide a direct comparison of the CS. They were instructed to respond quickly and, if they were unsure which image they preferred, to go with their gut feeling.

Contingency Memory Measures

Finally, participants completed two measures of contingency memory. They first completed a valence memory task in which they were shown an image from the conditioning task and asked to select which valence of stimuli was paired with it (positive, negative, neutral or unknown). Participants were shown 6 different images, two of which were the CSs.

Memory can be overestimated on valence memory tasks because participants may infer the valence of the stimuli paired with the CS based on their acquired attitudes rather than their memory (Bar-Anan, De Houwer, & Nosek, 2010; Bar-Anan & Amzaleg-David, 2014; Hütter, Sweldens, Stahl, Unkelbach, & Klauer, 2012). For this reason, participants subsequently completed a measure of identity memory, that is, their memory for the specific US paired with the CS.

In this task participants were shown an image or word from the conditioning task and asked with which of 6 faces it was paired. There were 20 trials. Half of the images and words were USs and half were other previously presented filler items not paired with the CS. The faces

participants chose from were the same 6 shown during the valence awareness task: 4 target faces and the 2 CSs. Presentation order was randomized.

Our measure of identity memory differs from typical measures in the literature. Typically, participants are presented with a CS and asked to indicate which of several possibly US it had been paired with previously (Sweldens et al., 2014). Instead, we presented participants with a US and asked them to indicate which of several possible CS it had previously been paired with. We chose to present the US and have participants choose between several CS in order to reduce the likelihood that participants would infer the US identity based on the valence that they had chosen in the previous valence memory task.

After the identity memory task, participants were asked some final questions about the experiment, debriefed, thanked, and dismissed.

III. Results

Preliminary Analyses

Implicit Measure

Trials on which participants provided an incorrect response were removed, and any trial with raw latencies shorter than 150 milliseconds or longer than 2500 milliseconds were removed from further analysis. Together this resulted in exclusion of 4.9% of trials across participants. Means for each of the CS-Prime (Positive vs. Negative) X Target Adjective (Positive vs. Negative) combinations were computed for each participant. From these raw latencies a difference score was computed across counterbalancing conditions in which the mean latencies of trials involving congruent Prime-Target combinations (positive CS-prime + positive targets and negative CS-prime + negative targets) was subtracted from the mean of trials involving incongruent Prime-Target combinations (positive CS-prime + negative targets and negative CS-prime + positive targets), with positive numbers indicating stronger EC effects. Results from a one-samples t-test showed an overall conditioning effect on the implicit measure ($M = 21.70$, $SD = 85.44$), $t(303) = 4.428$, $p < .001$, $d = .51$.

Explicit Measure

Responses to the paired-comparisons were analyzed according to whether the participant made choices in accordance with the expected effect of the conditioning procedure. Specifically, if selections were consistent with the contingencies in the procedure, the CS paired with positive USs would be selected when presented with a neutral filler or the CS paired with negative US, and neutral fillers would be selected when presented with the CS paired with negative US. Choices that were consistent with the conditioning procedure received a score of 1, whereas inconsistent choices received a score of 0. The sum of these ten values was computed and then

subtracted by 5 to render 0 the value of chance responding. An overall conditioning effect was observed on the explicit measure ($M = .42$, $SD = 2.35$), $t(303) = 3.129$, $p < .005$, $d = .36$. We found a weak but significant correlation between scores on the evaluative priming measure and scores on the pairwise preference task, $r = .14$, $p < .05$.

Contingency Memory

Valence memory was calculated as the total number of CS for which the valence was correctly reported. Participants were classified as having valence memory and assigned a 2 if they correctly reported both of the valences paired with the two CS; they were classified as having some valence memory and assigned a 1 if they showed correct memory for one of the valences paired with one of the CS, and were classified as valence unaware and assigned a 0 if they showed no memory for the valence paired with either CS. Out of 304 participants, 131 showed valence memory for both CS, 105 showed valence memory for one CS, and 68 showed no valence memory (overall $M = 1.21$, $SD = .783$).

Identity memory was calculated as the total number of CS, out of 12 possible, that a participant was able to correctly identify as being paired with the presented US. Identity memory was overall quite low, with a mean of 3.17 out of a possible 12 ($SD = 3.15$). Valence memory and identity memory showed a strong positive correlation, $r = .588$, $p < .001$.

The Impact of Contingency Instructions and Load on Contingency Memory

To assess the effects of contingency instructions and load on identity and valence contingency memory, we ran a 3 (Load: no, moderate, high) X 2 (Contingency instructions: no instructions, instructions) ANOVA independently for the two memory measures. For valence memory, a significant main effect of contingency instructions emerged, with those in the instructions condition ($M = 1.33$, $SD = .76$) showing more valence memory than those in the no

instructions condition ($M = 1.09$, $SD = .79$), $F(1,301) = 7.669$, $p < .01$. Similar to valence memory, identity memory was higher for those in the instructions condition ($M = 3.556$, $SD = 3.234$) compared to those in the no instructions condition ($M = 2.78$, $SD = 3.03$), $F(1, 301) = 4.607$, $p < .05$. These results showed that the contingency awareness manipulation was successful in increasing participants' valence and identity memory.

Load condition also had a significant impact on valence memory, $F(2,301) = 8.881$, $p < .001$. Post hoc analyses indicated that those in the no load condition ($M = 1.470$, $SD = .7447$) showed significantly more valence memory than those whose attentional resources were depleted in the moderate load condition ($M = 1.10$, $SD = .76$), $p < .005$, and the high load condition, ($M = 1.0594$, $SD = .7851$), $p < .001$. The moderate and high load conditions did not differ significantly, $p = .61$. In other words, participants were less able overall to correctly report the valence of the CS-US pairings when their attentional resources were reduced than when they were not.

An analogous effect of load was found on identity memory, $F(2,301) = 13.229$, $p < .001$. Post hoc analyses indicated that those in the no load condition ($M = 4.44$, $SD = 3.65$) showed significantly more identity memory than those whose attentional resources were depleted in either the moderate load condition ($M = 2.65$, $SD = 2.70$), $p < .001$, or those in the high load condition ($M = 2.44$, $SD = 2.65$), $p < .001$. No significant differences in identity memory were found between the moderate and high load conditions, $p = .721$. A one-samples t-test indicated that identity memory was significantly higher than chance (i.e., 2) in the no load, $t(99) = 6.68$, $p < .001$, and moderate load conditions, $t(102) = 2.44$, $p < .05$, but not in the high load condition, $t(100) = 1.65$, $p = .102$. Overall, as with valence memory, participants were less able overall to correctly report the identity of the CS-US pairings when their attentional resources were reduced

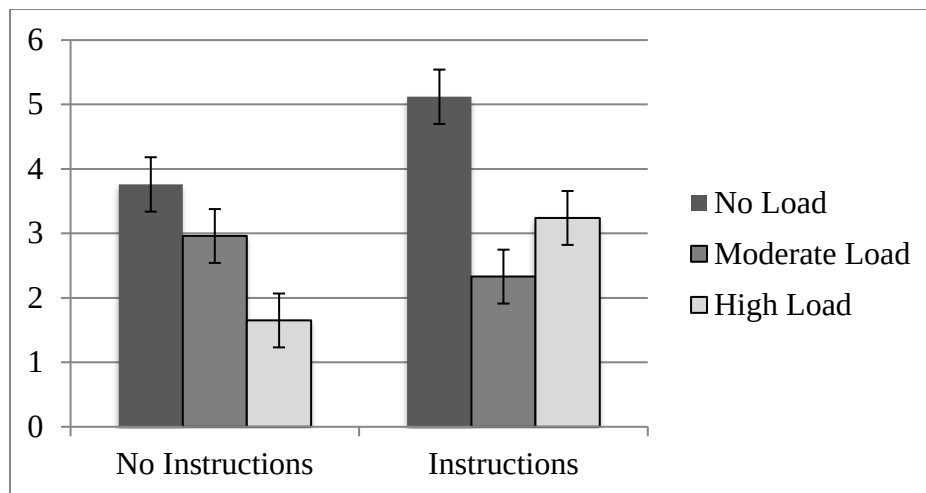


Figure 1: Effects of Contingency Instructions and Load on Identity Memory

than when they were not.

We also found a significant interaction between the contingency instructions and attentional load on identity contingency memory, $F(2, 303) = 4.280, p < .05$ (see Figure 1). Post hoc analyses showed that in the no instructions condition, identity memory was higher for both those in the no load condition ($M = 3.76, SD = 3.70$), $p < .001$, and moderate load condition, ($M = 2.96, SD = 2.92$), $p < .03$, than in the high load condition ($M = 1.65, SD = 1.90$). No differences were found within the no instructions condition between those in the no load and moderate load conditions, $p = .170$. In the instructions condition, the amount of identity memory was higher in the no load condition ($M = 5.12, SD = 3.51$) than either the moderate load condition ($M = 2.33, SD = 2.45$), $p < .001$, or the high load condition, ($M = 3.24, SD = 3.07$), $p < .002$. The moderate and high load conditions did not differ, $p = .136$. For valence contingency memory, no such interaction effect emerged, $F(2,303) = 2.140, p = .119$.

The Impact of Load and Contingency Instructions on EC

A 3 (Load: no, moderate, high) X 2 (Contingency instructions: no instructions, instructions) ANOVA was conducted to examine EC effects on both the implicit and explicit measure as a function of load and contingency instructions. We failed to find significant main effects of contingency instructions, $F(1,303) = 2.280, p = .132$, or load, $F(2,302) = .455, p = .635$, on the implicit measure. Likewise, no significant differences in EC on the explicit measure emerged for either contingency instructions, $F(1,303) = 1.533, p = .217$, or load, $F(2,302) = .228, p = .797$. The interaction between contingency instructions and load was non-significant as well for implicit, $F(2,302) = 1.381, p = .253$, and explicit EC measures, $F(2,302) = .066, p = .937$. In other words, neither load nor contingency instructions affected implicit or explicit EC effects.

It can be surmised that just because one is instructed of the contingencies does not mean one will have memory for them. For that reason, we next examined the effect that the contingency memory had on EC independent of condition assignment.

Effects of Contingency Memory on EC

Despite manipulation checks indicating successful manipulations of load and contingency memory, there was still a great amount of variability with regards to contingency memory within each condition. Although those in the contingency aware condition showed more valence memory than those in the unaware condition, 27 out of 151 participants in the aware condition showed no valence memory and 47 showed valence memory for only one CS. Similarly, of those in the unaware instructions condition, 54 out of 153 showed valence memory for both CS and 58 showed valence memory for one CS. If it is knowledge of the CS-US contingencies that is essential for EC effects, as posited by propositional accounts, then it should be contingency memory that significantly effects EC, not just exposure to information about the contingencies.

In order to assess this possibility we first correlated valence memory scores with EC measures across condition. Valence memory showed a significant positive correlation with both the implicit measure, $r = .132, p < .05$, as well as the explicit measure, $r = .279, p < .001$. Next, we ran a one-way analysis of variance (ANOVA) with 3 levels (No valence memory, Partial valence memory, Full valence memory) to examine the role of valence memory on the magnitude of EC effects. A significant main effect of valence memory emerged for implicit EC effects, $F(2,302) = 5.876, p < .005$. Post hoc analyses revealed implicit EC effects were stronger for participants with full valence memory ($M = 39.02, SD = 91.44$) than those with memory for valence of one of the CS ($M = 3.89, SD = 80.89$), $p < .005$, and marginally larger than those with no valence memory ($M = 15.83, SD = 91.44$), $p = .067$. Table 1 reports t-tests against zero for

Table 1: Effects of Valence Memory on EC

Memory	df	EC effects	
		Implicit t	Explicit t
0	67	1.427	-2.966**
1	104	.493	2.119*
2	130	5.378***	4.482***

Note. * = $p \leq .05$, ** = $p \leq .005$, *** = $p \leq .001$ level.

implicit and explicit measures for the 3 levels of valence memory.

A significant main effect of valence memory also emerged for explicit EC effects, $F(2,301) = 13.130, p < .001$. Post hoc analyses showed those who had valence memory for both CS ($M = 1.02, SD = 2.61$) exhibited stronger explicit EC effects than those who had no valence memory ($M = -.75, SD = 1.96$), $p < .001$, or those who showed valence memory for one CS, ($M = .40, SD = 1.93$), $p < .05$. Those who showed awareness for one CS also showed greater explicit EC effects than those who showed no valence memory, $p < .005$ (see Table 1). Unexpectedly, those with no valence memory showed a reverse EC effect on the explicit measure.

Identity memory was positively correlated with both implicitly-measured EC, $r = .151, p < .01$, and explicitly-measured EC, $r = .204, p < .001$. Recall that identity memory could range from 0 to 12. Some of the sample sizes of the different levels of identity memory were too small to reliably analyze so a two-item identity memory score was computed. Participants were given a '0' if they showed memory at chance level or below (i.e. a score of 2 or less) and the rest were given a '1' indicating they showed identity memory at rates greater than chance (i.e. a score of 3 or above). To investigate the relationship between identity memory and EC effects, a 7 level analysis of variance (ANOVA) was conducted. Results showed a significant main effect of identity memory on EC for both the implicit measure, $F(1,303) = 11.908, p < .005$ and explicit measure, $F(1,303) = 16.335, p < .001$. We then conducted one-sample t-tests for both the implicit and explicit EC measure to determine at which levels of identity memory EC effects occurred. Table 2 depicts the implicit and explicit effects of each level of identity memory.

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Table 2: Effects of Identity Memory on EC

		<i>Implicit</i>		<i>Explicit</i>	
	<i>df</i>	M (SD)	<i>t</i>	M (SD)	<i>t</i>
0	62	18.37 (78.27)	1.863*	.32 (2.29)	1.099
1	58	8.58 (91.12)	.723	-.27 (1.83)	-1.140
2	51	-6.91 (67.64)	-.736	-.23 (2.19)	-.759
3	25	19.27 (92.78)	1.059	1.00 (2.17)	2.409**
4	17	41.99 (97.72)	1.823*	.33 (1.85)	.766
5	20	58.05 (84.78)	3.138***	1.14 (2.37)	2.208**
6-12	64	43.33(86.32)	4.046***	1.23(2.82)	3.524***

Note. * = $p < .1$ ** = $p \leq .05$, *** = $p \leq .005$

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For the implicit measure, results showed that for the 63 participants who showed no identity memory, there was a marginally significant implicit EC effect. Participants who had memory for 1 to 3 CS-US identities did not show significant EC effects. There were too few participants for reliable parametric analyses on memory score higher than 5 despite finding significant EC effects. To account for this and allow for interpretation, those showing identity memory at scores of 6 or higher were combined into one identity memory level. Participants in this group showed significant implicit EC effects.

For the explicit measure, we found significant effects at several levels of identity awareness (i.e. 3, 5, and 6+). Generally speaking, as identity awareness increased so did explicit EC effects.

We ran a 3 (Load: no, moderate, high) x 3 (Valence Memory: 0, 1, 2) ANOVA for both implicit and explicit EC effects. No interactions emerged for implicit EC effects, $F(4,300) = 1.183, p = .319$, but a marginally significant interaction occurred for explicit EC, $F(4,300) = 2.155, p = .074$. Another 3 (Load: no, moderate, high) x 7 (Identity Memory: 7 levels)

ANOVA was conducted for both implicit and explicit effects. No significant interactions with load emerged on either implicit, $F(22,282) = 1.252$, $p = .204$, or explicit EC $F(22,282) = 2.140$, $p = .833$.

Attentional Load Deviation and EC

Additional follow-up analyses took into account whether participants in the load conditions were attentive to the load instructions (i.e., the extent to which their responses on the load items, that is, how far their reported number deviated from the correct answer, were accurate). It is reasonable to assume that participants whose responses deviated from the correct value were less attentive to the numbers played through the headphones, were hence were less able to recall them, and thus experienced less attentional load than participants who showed lower deviation scores, indicating more attention to the secondary task. Hence, deviation scores can be thought of as a continuous proxy for actual load in the load conditions.

We created deviation scores from the load manipulation check questions for participants in the moderate and high load conditions (no deviation score was created for participants in the no load condition since they were not instructed to perform a secondary task). The sum of the 5 manipulation checks was computed for participants in the moderate and high load conditions and then the absolute value of the difference between the correct answers and each participant's mean was calculated. This score indicates how much these participants were or were not attending to the secondary auditory task while completing the conditioning task. Higher scores indicated that the participants paid less attention to the secondary task and were probably less loaded since they likely guessed on the manipulation check questions. Lower scores indicated that participants paid more attention to the secondary task since their answers were consistent with the correct number and thus experienced more attentional load as intended.

Participants in the contingency instruction condition did not differ in their level of deviation in the moderate ($M = 7.52$, $SD = 7.25$) compared to high load condition ($M = 6.65$, $SD = 11.30$), $p = .641$. Similarly, the no instruction condition showed similar amounts of deviation regardless of whether participants were in the moderate load condition ($M = 6.44$, $SD = 7.98$) compared to the high load condition ($M = 7.84$, $SD = 7.52$), $p = .361$.

Examining how these deviation scores varied with EC, we found a marginally significant negative correlation between load manipulation check deviation scores and the implicit measure, $r = -.129$, $p = .07$. This indicates that the less participants allowed their attentional resources to be divided between two tasks (i.e. as deviation scores increased), the weaker the implicit EC effect. Put another way, when participants completed the secondary task as instructed, which put burden on their attentional resources, implicit EC effects increased. The correlation between load deviation scores and the explicit measure did not reach significance, $r = -.081$, $p = .252$.

IV. Discussion

The current investigation focused on the effects of contingency awareness and attentional load on evaluative conditioning (EC). Overall we found both implicit and explicit EC effects. Interestingly, neither the contingency instruction manipulation nor the load manipulation resulted in any differences in these effects, even though manipulation checks indicated successful manipulation of these variables. Such a result is in line with the associative account that posits that EC can occur independent of awareness of CS-US contingencies and attentional resources (Mitchell, De Houwer, & Lovibond, 2009).

Valence memory refers to knowledge of the valence of the US paired with the CS, while identity memory refers to memory of the specific US paired with the CS or the specific CS paired with each US. Both have been the focus of substantial debate in the EC literature, specifically over whether or not they are necessary for EC effects to occur. As we expected, valence and identity memory were higher in the contingency instructions condition than in the no instructions condition. We also found that participants were less able overall to correctly report either the valence or identity of the CS-US pairings when their attentional resources were reduced, indicating that both manipulations were successful.

Although manipulating contingency instructions was the most direct way to determine the role of awareness in EC, not all participants in the instruction condition showed contingency memory. This finding is consistent with Fulcher & Hammerl (2001), who found that only half of those given instructions informing them about the CS-US contingencies actually showed memory for those contingencies. These findings indicate that making participants aware of the contingencies may not be sufficient to make them remember the contingencies. It may be that measures of contingency memory may not fully capture true contingency awareness, implying an

issue with current measures of contingency memory as true determinants of contingency awareness. It may be that since we did not tell participants we were trying to create positive and negative associations with neutral stimuli (i.e., create demand awareness), some participants, not seeing a clear reason to remember this information, simply forgot or ignored it. It is possible that if demand awareness (as opposed to just contingency awareness) was manipulated, more participants would show contingency memory. Future research is needed to investigate how making participants aware of the purpose of the experiment affects their memory of the contingencies compared to those who are made aware of just the contingencies aware or not given any extra information.

A closer look at peoples' actual memory for the pairings (instead of merely looking at their assignment to condition) complicates the story. Significant implicit EC effects were found only for those who showed total valence memory; those who showed partial or no valence memory did not show these effects, which supports propositional accounts of the mechanism underlying EC. Although the implicit EC effect was non-significant for those who showed no valence memory, it was marginally present, indicating that EC effects may still occur for those who are not aware, but maybe to a lesser degree than those who have valence memory.

All levels of valence memory showed explicit EC effects, but the effects for those with no valence memory were in the negative direction while the effects for those with partial or total valence memory showed positive effects. In other words, those who showed no valence memory showed reversed evaluative conditioning compared to if they had not undergone evaluative conditioning while those with some or total memory showed significantly more EC. We do not know what to make of these effects. Previous research has shown that valence memory measures can overestimate awareness (Bar-Anan and Amzaleg-David, 2014) so it is possible that

not all of those who showed valence memory were truly valence aware. In general, as identity memory increased, implicit EC effects increased, which supports the propositional account. That being said, we found that for the 63 participants who showed no identity memory, there was a marginally significant EC effect on the implicit priming measure, supporting the associative account. It seems that for identity memory, both accounts can explain implicit effects. For explicit EC, as identity memory increased, so did the EC effects, which supports the propositional account of EC effects.

Variability in Attentional Load

We created deviation scores from the load manipulation check questions for participants in load conditions to assess their attention to the secondary task. We used this as a continuous proxy for actual load in the load conditions under the assumption that participants whose load responses deviated from the correct value were likely less attentive to the additional task and, thus, under less load. We found that as deviation scores decreased, indicating more compliance with secondary load task and hence more load, that implicit EC scores increased. This relationship was only marginally significant but it indicates that implicit EC effects are occurring increasingly under conditions in which people have taxed resources. This effect would be hard to explain from a propositional account, which argues that fewer cognitive resources would reduce the ability for people to generate conditioning-consistent propositions.

Faces as Special Objects

Previous research has shown that EC effects are stronger for objects that one does not already hold strong attitudes toward (Cacioppo, Marshall-Goodell, Tassinari, & Petty, 1992; Gibson, 2008). The neutral stimuli that we used were neutral white male faces. It may be that these male faces, although pretested, were not truly neutral. People have pre-existing attitudes

towards eye colors, complexion, hair color, and so forth, so it is likely that participants' pre-existing attitudes towards various facial features contributed to their evaluative reactions to the CSs. Thus, the faces may not have been as neutral as assumed.

Another possible explanation as to why we found only weak evidence for unaware EC that faces, compared to other objects, are more easily remembered. Previous research has found that faces are differentially processed. They are evaluated as a whole as opposed to parts like other objects (Farah & Tanaka, 1993) and there is evidence that attention is preferentially directed to faces over other objects (Ro, Russell, & Lavie, 2001; Theeuwes & Van der Stigchel, 2006). This preferential attention and differential processing of faces compared to other objects may help explain the level of contingency memory demonstrated by participants, despite the use of a paradigm that is conducive to low levels of memory. Furthermore, studies have found evidence that while perceptual load interferes with the processing of non-face distractors, load does not interfere with the processing of face distractors (Lavie, Ro, Russell, 2003). This offers a possible explanation for why attentional load had no effect on EC. It is unclear whether it is the neutral stimuli or the learning mechanism that is accounting for the lack of effects of load on EC. A follow-up study using non-face CS is needed to address these possibilities.

Paradigm and Mechanism

Previous research has been relatively silent to mechanism and paradigm considerations. Only recently have researchers begun considering a given EC paradigm's role in the mechanisms underlying EC (Sweldens et al., 2014). There are several experimental paradigms that are commonly used to elicit EC effects and these different paradigms may lend themselves to different mechanisms. For example, conditioning paradigms without filler stimuli and relatively obvious pairings may lend themselves to propositional mechanisms. Alternatively, paradigms

with disguised filler items and non-obvious pairings may lend themselves to more associative mechanisms.

Some previous EC research has addressed this consideration. Hutter and Sweldens (2012) manipulated whether the CS-US pairs were presented sequentially or simultaneously and found that when participants were unaware EC only occurred when the pairs had been presented simultaneously. Jones et al. (2009) manipulated proximity, size, and evocativeness of CS-US pairings in the conditioning procedure we employed in the present work (Olson & Fazio, 2001), which uses a disguised paradigm with filler stimuli. They found that when CS-US pairs were spatially closer together, the CS was larger than the US, and the US was only mildly evocative (as opposed to having a strong affective reaction), EC effects increased for participants who showed no contingency memory. These effects support a particular implicit associative account: misattribution, are difficult to explain with propositional accounts. Pleyers et al. (2007) used a conditioning paradigm in which CS-US pairs were presented simultaneously to participants but no filler stimuli to disguise the purpose of the task. They only found EC effects when participants were contingency aware. Paradigms like this that are not disguised and use obvious pairings seem to be more conducive to propositional mechanisms.

The majority of studies investigating contingency awareness and attentional resources have used paradigms that are conducive to more resource-intensive mechanisms (i.e., propositional learning), namely, the “picture-picture” paradigm popularized by Baeyens and colleagues, which uses a forward conditioning procedure (Baeyens et al., 1992). We were the first to manipulate load and awareness within a paradigm that lends itself to more associative forms of learning, through simultaneous pairings disguised by a cover story and filler items.

Our findings provided mixed support of the mechanisms underlying EC. Some of our findings provide support for an associative learning mechanism while others offer evidence for a propositional learning mechanism. Future research is needed to explore how differential results are due to the different conditioning paradigms employed.

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Vita

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