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Implicit Learning of Evaluative vs. Non-Evaluative Covariations: The Role of Dimension Accessibility

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Abstract

Implicit covariation learning, the development of simple associations without awareness, has been demonstrated repeatedly along the evaluative dimension (De Houwer, Thomas, & Baeyens, 2001), but associations involving other dimensions appear more difficult to learn implicitly. The present research highlights the unique properties of the evaluative dimension that may predispose it to implicit learning. We provide evidence in the first experiment that implicit covariation learning occurs along the evaluative dimension, but does not spontaneously occur along non-evaluative dimensions. In Experiment 2, implicit learning along non-evaluative dimensions occurred when participants were subliminally primed with the to-be-learned dimension. In the discussion, we integrate findings from implicit evaluative conditioning research with the broader implicit learning literature.

Key Words: Attitudes, Implicit learning, Evaluative conditioning, Priming

Implicit Learning of Evaluative vs. Non-Evaluative Covariations: The Role of Dimension Accessibility

What are the limits to our ability to learn implicitly, without conscious awareness of what was learned? The question is a controversial one, with some proponents claiming that much of our general knowledge comes about through implicit learning processes (e.g., Frensch & Rünger, 2003; Reber, 1989, 1993), and others arguing that the evidence for implicit learning is limited, at best (e.g., Shanks & St. John, 1994). The present research aims for a place in this debate by investigating the boundary conditions of implicit covariation learning—the development of associations on the basis of co-occurrences or contiguity between objects. We begin by highlighting the evidence of implicit covariation learning on one dimension in particular: evaluation. We then attempt to generalize this phenomenon to non-evaluative dimensions. In so doing, we delineate some of the conditions that appear necessary for implicit covariation learning to occur in non-evaluative domains.

Evidence for Implicit Attitude Learning

There has been a recent surge of interest in the origins of “implicit attitudes” (e.g., Rudman, 2004). Much of this research has centered on the phenomenon of evaluative conditioning (EC), in which an object comes to take on the valence of items with which it is repeatedly paired (De Houwer et al., 2001). Procedurally, EC largely resembles traditional classical conditioning, in that a CS (the attitude object) is paired repeatedly with USs that already evoke positive or negative reactions. Over time, the CS comes to elicit the response originally elicited by the US; its presentation causes an evaluative response.

Research across varied EC paradigms indicate that attitudes can form and change through conditioning-like procedures (De Houwer et al., 2001). For example, Olson & Fazio (2001, 2002) presented participants with a stream of non-rhythmic words and images under the guise of an experiment about "attention and rapid responding." Most of the items were filler words and images that were unrelated to the conditioning itself; some appeared alone and others appeared in pairs. Participants were instructed to be vigilant for a pre-specified target item (which was not itself a CS) that appeared randomly throughout the procedure. Embedded in this task were critical pairings of novel objects (CSs) and other valenced words and images (USs). One CS consistently appeared with positive items, and another with negative items. Later in the experiment, participants reported their evaluations of some of the items, including the two CSs. On average, participants preferred the CS paired with positive items over the CS paired with negative items (see also Baeyens, Eelen, Crombez, & Van den Bergh,1992; De Houwer, Hendrickx, & Baeyens, 1997; Hammerl & Grabitz, 2000; Kim, Allen, & Kardes, 1996; Walther, 2002). Participants also completed a measure of their memory of the pairings after the conditioning procedure and responded at chance levels. Moreover, open-ended questionnaires also indicated that participants were unaware of the pairings.

There must certainly be limits to humans' tendency to unconsciously absorb environmental covariations into their psyches. One question that arises is whether implicit covariation detection—like what is seen in EC research—occurs for non-evaluative dimensions. In raising this question, it is important to note that implicit learning research in the cognitive tradition tends to focus on novel dimensions with little hedonic meaning; it does not typically address the importance or salience of the learning dimensions. Instead, most implicit learning paradigms involve mundane perceptual dimensions, where emphasis is placed on the learning of novel associations in artificial language, spatial locations of objects, and so on (Frensch & Rünger, 2003; Seger, 1994). The question of *what kinds* of covariations might be best learned, and along *what kinds of dimensions*, is seldom addressed (although one can find allusions into these issues in preparedness research (e.g., Ohman & Mineka, 2001). As we describe next, unlike the sorts of learning dimensions typically considered in the cognitive tradition, the dimension of evaluation has unique properties that might make it especially conducive to implicit covariation learning.

Implicit Covariation Learning in the Evaluative Dimension

Attitudes are important; knowing whether something is good or bad can be critical to survival. As summaries of positive and negative information about objects that can either hurt us or help us, they provide perhaps the most important information one can know (Fazio & Olson, 2003). Indeed, evaluation captures more "meaning" of the objects in our worlds than other dimensions do (Osgood, Suci, & Tannenbaum, 1957), and our evaluations of objects can be automatically-activated upon perceiving them (Fazio, 2000).

In evaluative conditioning research, the USs are by definition attitude-evoking—they automatically elicit evaluative responses. Two empirically established properties of such attitude-evoking stimuli may facilitate implicit learning: their abilities to attract attention and to facilitate categorization.

As evidence of attitudes' attention-grabbing qualities, Roskos-Ewoldsen and Fazio (1992) demonstrated that objects toward which participants held accessible attitudes were more likely to attract attention when located in a complex visual array, even when their attention to those objects was not relevant to their task. Research in the cognitive domain tends to show that selective attention to the to-be-learned information enhances implicit learning (e.g., Jiang & Chun, 2001; Jimenez & Mendez, 1999; Nissen & Bullemer, 1987; Pacton & Perruchet, 2008; Stadler, 1995, but see Cohen, Ivry, & Keele, 1990). Thus, because evaluative information automatically attracts our attention, it might be considered "pre-disposed" to implicit learning.

Second, valenced information also promotes categorization along the evaluative dimension. Stimuli typically can be categorized or construed in multiple ways. However, of all the potential categorizations of a given stimulus, the more attitude-evoking is at an advantage and more likely to determine the categorization process (Smith, Fazio, & Cejka, 1996). For example, a Black male professor is more likely to be categorized as a Black by someone who is racially prejudiced (Fazio & Dunton, 1997). If some novel object is paired with clearly valenced objects, we can be relatively certain that those valenced objects will be categorized according to their valence, and hence that regularity in the environment will more likely be encoded. Thus, two related processes facilitate the impact of the US in EC procedures: the US attract attention and they are likely to construed or categorized in a hedonically meaningful manner.

Consider the example of a novel object paired with objects that share a dimension that does not spontaneously attract attention or promote categorization, say, "large objects." A real-world covariation between some novel object and, say, an ocean liner, a truck, and other large stimuli, might be presented, but those large objects may not be consistently categorized as large. As a result, the novel object might merely appear to have been paired with a series of unconnected stimuli, instead of "large" items. Hence, unlike valence, when the dimension along which some novel object is paired repeatedly is not spontaneously categorized as such, we cannot be certain that that regularity in the environment will be encoded.

Consistent with this reasoning, previous research using EC paradigms has shown that people tend to learn covariations involving non-evaluative dimensions only when they become aware of the contingencies. For example, Meersman, De Houwer, Baeyens, Randell, and Eelen (2005) valiantly attempted, across numerous studies, to use an EC procedure to create associations involving the gender of infants. Their procedure involved the repeated pairing of images of gender-ambiguous infants with clearly male or female infants. However, both direct and indirect measures of associations indicated that the gender-ambiguous infants failed to acquire the gender of their paired associates in the minds of participants who were unaware of the pairings. The same pattern of findings emerged when Japanese names (whose gender was unknown to the participants) were associated with typical known male and female names. Meersman and colleagues also cite numerous studies (many unpublished) that failed to demonstrate implicit covariation learning in non-evaluative dimensions.

The Present Research

We have argued that the evaluative dimension is particularly conducive to implicit covariation learning. However, we do not mean to imply that implicit covariation detection is *limited* to the evaluative dimension. As we describe later, non-evaluative dimensions can lend themselves to such learning under the appropriate circumstances. The point we wish to make is that the evaluative dimension appears uniquely conducive to implicit covariation learning, and the experiments we report aim to provide empirical evidence to this effect. Moreover, we also hope to capitalize on the unique features of the evaluative dimension to demonstrate how implicit covariation learning in non-evaluative domains can be enhanced.

More specifically, we pursued two goals in the experiments we report here. First, we hoped to demonstrate the superiority of the evaluative dimension in implicit covariation learning. To this end, Experiment 1 compared implicit covariation learning along evaluative versus non-evaluative dimensions. In choosing among the myriad non-evaluative dimensions, we reasoned that a strong test of our predictions would entail the use of common and easily discernable non-evaluative dimensions. We chose “size” in Experiment 1a, and “speed” in Experiment 1b. Second, we hoped to use what we have argued is unique about the evaluative dimension to uncover the requirements for implicit covariation learning in non-evaluative dimensions. To this end, in Experiment 2 we attempt to create conditions that will foster non-evaluative covariation learning.

Experiment 1

Participants

Eighty-nine (Experiment 1a) and 92 (Experiment 1b) undergraduate females at a large Midwestern university completed the experiment in order to meet course requirements.

Materials and Procedure

Participants completed the experiment in groups of 1 to 4. After arriving, they were seated in individual cubicles equipped with video monitors and response boxes. They were informed that the experiment related to attention, vigilance, and rapid responding, and that their role could be likened to a security guard whose job is to be alert for suspicious activity. They were told that they would be viewing a series of random images on the computer screen, and that their task would be to hit a response key as quickly as possible whenever a target item appeared.

After receiving these general instructions, participants were then shown a page that depicted the name and image of their first target. They were further instructed that the target would appear among a series of distractor images and words that were included to make the task more challenging. In order to insure that participants attended to both the image and word stimuli, they were instructed to respond whenever they saw either the name or a visual depiction of the target. After answering any questions, the experimenter then initiated the vigilance task.

The task consisted of 5 blocks, each with 86 trials of 1.5 second duration (0 second inter-trial interval). Each block utilized a different target, and participants were allowed to rest between blocks, when they were shown the target for the next block. All targets were lesser-known Pokemon cartoon characters which were not themselves the subjects of conditioning. Each target appeared in both word and image form 10 times in its assigned block. Filler images consisted of a variety of words (e.g., *concrete*, *farming*, *books*) and images (other Pokemon characters, a woman writing a letter, a motorcycle, a fire hydrant), as well as 16 randomly dispersed blank screens per block to reduce the rhythmic nature of the presentation. Images appeared sometime alone, sometimes in pairs, and in varying locations on the screen.

Embedded in this random-seeming string of stimuli were critical pairings of 2 CS Pokemon (Metapod and Shelder) and their associates. The evaluative condition followed the procedure of Olson & Fazio (2001) described earlier. In this condition, one CS was paired with US images and words that were clearly positive, and the other CS was paired with negative USs. No single US was repeated. Each CS appeared 4 times in each block for a total of 20 CS-US pairings per CS across blocks.

Size was chosen as the non-evaluative dimension for Experiment 1a, and speed was chose for Experiment 1b. Prior to the experiment, pilot participants (n = 22) were asked to generate a list of "things that are generally seen as small and large (and slow and fast)." The 10 most frequently listed items of each were selected, and appropriate visual representations were used as USs (e.g., an ant, button, and chipmunk for small items, a truck, ocean-liner, and hippo for large items, a snail, tugboat, and sloth for slow items, and a race car, marathon runner, and motorcycle for fast items). Additionally, participants were asked to generate synonyms for "small", "large," "slow" and "fast," and the 10 most frequently mentioned words of each were selected for word USs (e.g., *tiny*, *miniscule*, and *little* for small, *huge*, *gigantic*, and *mammoth* for large, *leisurely* and *unhurried* for slow, and *swift* and *rapid* for fast). As in the evaluative condition, the two CSs were paired with either small or large items in Experiment 1a, or slow or fast items in Experiment 1b. Thus, the only difference between the two conditions was whether the two CSs were paired with valence-related USs or USs of a non-evaluative dimension. Which of the 2 CSs was assigned to negative/slow/small USs versus positive/fast/large USs was counterbalanced.

After the conditioning procedure participants completed a series of unrelated questionnaires for approximately 10 minutes. They were then told we were interested in their impressions of some of the "filler" items from the vigilance task. Twenty-eight fillers and the 2 critical CS Pokemon were selected for them to rate. Participants were told that we were interested in either how pleasant or unpleasant they found the images, or their impressions of how large/fast or small/slow they were, depending on the condition. They were instructed to "follow their gut impressions," even if they weren't sure how to respond. On a given trial, an item was presented on the screen, and participants were required to make their response within a 5-second window on a 7-point scale, anchored by either *extremely unpleasant* and *extremely pleasant*, *extremely small* and *extremely large*, or *extremely slow* and *extremely fast*, depending on the condition.

After the evaluation task participants completed an open-ended measure of their contingency awareness, just as in past research (e.g., Olson & Fazio, 2001). The first item inquired as to whether they noticed anything unusual about the way the images were presented in the vigilance task. The second item asked them to report whether they noticed anything in particular about the words and images that were presented with the 2 CSs. The third item asked participants whether they thought they were supposed to respond to the judgment items in a particular way, and the final item asked them what they thought the purpose of the experiment was. Participants were then debriefed, thanked, and dismissed.

Results and Discussion

Responses on the awareness measure were first analyzed to identify participants who became contingency aware. In Experiment 1a, no one correctly reported the true purpose of the experiment or indicated that they thought they were supposed to respond in a certain way to the judgment items. However, 5 participants (6%; 3 from the Evaluation condition and 2 from the Size condition) were able to report at least one correct contingency when prompted to remember what they could about the items paired with the two CSs. In Experiment 1b, 4 participants (4%; 2 from each condition) were able to accurately report at least one of the CS-US pairings, and 2 (2%; both from the evaluation condition) correctly guessed the experimental hypothesis. These participants were excluded from further analyses, although their exclusion did not affect the pattern of results.

Responses to the 2 CSs were standardized within each condition. After controlling for counterbalancing (which yielded no effects in this or subsequent experiments), these ratings were then submitted to a 2 (Covariation type: Evaluative vs. Non-Evaluative) X 2 (CS: CS 1, the CS paired with positive or large/fast US, vs. CS 2, the CS paired with negative or small/slow US) mixed ANOVA with repeated measures on the latter factor.

Experiment 1a. The ANOVA revealed the expected 2-way interaction, which was nearly significant at conventional levels, F (1, 77) = 3.53, p = .06. To examine the nature of this effect, a difference score was computed between participants' standardized ratings of the two CSs within each condition such that higher numbers indicated a greater conditioning effect (that is, a more positive evaluation of the Pokemon paired with positive CSs relative to the Pokemon paired with negative items, or a greater size/speed estimate of the Pokemon paired with large/fast items relative to the Pokemon paired with small/slow items; see Table 1). These analyses verified that the conditioning effect was apparent in the evaluative condition, t (42) = 2.00, p = .05, M = .30, SD = 1.07, d = .62, but not the non-evaluative condition, t (41) = -.07, *ns*, M = .00, SD = .92, d = .07).

Experiment 1b. The expected interaction was found, F (1, 84) = 5.82, $p < .05$. As described above, a difference score comparing participants' standardized responses to the 2 critical CSs was computed for each condition. Subsequent analyses confirmed that participants in the evaluation condition evidenced significant conditioning, t (38) = 2.26, $p < .05$, M = .40, SD = 1.07, d = .73, whereas participants in the non-evaluative condition did not, t (46) = - 1.23, *ns*, M = -.23, SD = 1.26, d = .06.

Thus, our predictions were confirmed. Implicit learning was evident in the evaluative domain but not in the non-evaluative domains of size and speed. This is consistent with our reasoning that properties of the evaluative dimension make it more conducive to implicit covariation detection.

Experiment 2

As discussed earlier, attitude-evoking stimuli attract attention, which promotes categorization along the evaluative dimension. Implicit covariation learning involving a non-evaluative dimension may be more likely when one is attentive to the dimension and likely to categorize objects along it. If so, then increasing the accessibility of that dimension should encourage the formation of associations involving such information. In Experiment 2, we attempted to increase the accessibility of a non-evaluative dimension, but we wanted to do so in a way that it did not encourage the development of contingency awareness.

Priming has long been known to increase the accessibility of the primed construct and, hence, to influence attention, perception, and judgment (Bruner, 1957; Higgins, 1996). For example, priming increases the attention given to stimuli that are clearly related to the primed construct (e.g., Sherman, Mackie, & Driscoll, 1990), as well as the categorization of ambiguous semantic or visual information that is open to multiple construals (e.g. Higgins, Rholes, & Jones, 1977; Balcetis & Dale, 2007). More recently, subliminal priming has been shown to affect goal pursuit, which may involve an attentional component (e.g., Bargh, Gollwitzer, Lee-Chai, Barndollar, & Troetschel, 2001). For example, in a recent study, Eitam, Hassin, and Schul (2008) found enhanced implicit learning after priming participants with an achievement motive. These authors argue that their priming manipulation may have led to increased attention to the to-be-learned information, thus increasing learning of it. Thus, for the present purposes, it appears that priming is able to influence both categorization and attention.

We hypothesized that increasing the accessibility of the non-evaluative dimension via a subliminal priming manipulation would enhance the processing of the US in terms of that dimension and, hence, lead to successful implicit covariation learning.

Participants

One-hundred twenty-one undergraduate females at a large southeastern university completed the experiment in order to meet course requirements.

Materials and Procedure

The conditioning procedure was identical to that of the non-evaluative (size) condition of Experiment 1a. However, prior to the conditioning procedure, participants completed a subliminal priming task. It was introduced as a lexical decision task that was independent of the vigilance task they would be completing later. Participants were seated in individual cubicles and told that they would be viewing letter strings on the computer screen, and their task was to decide whether the letter string formed an actual word or not by pressing a corresponding key. On a given trial, a string of asterisks appeared on the screen for 56 milliseconds. This string was followed by a prime for 28 milliseconds. In the experimental condition, primes consisted of 20 words related to the size dimension that were not themselves used as USs in the actual conditioning procedure (e.g., *huge, giant, big, dwarf, teeny, undersized*). In the control condition, primes consisted of non-word letter strings. In both conditions, the prime was followed by another string of asterisks for 42 milliseconds, and then the actual target to which participants were to respond, which remained on the screen until a response was made. Targets consisted of neutral words and non-words formed from rearranged letters from the target words (e.g., *clock*, *kcloc*). Thus, to participants each trial seemed only to begin with a string of asterisks, which they were told indicated that a letter string was about to appear (previous research verifies that these timing parameters insure that participants do not consciously notice the primes; see Olson & Fazio, 2002). Participants underwent 2 blocks of 20 trials each, and each prime appeared once per block. Thus, experimental participants were presented with a total of 40 size-prime trials, and control participants were exposed to an equivalent number of non-word primes. The size conditioning procedure immediately followed the priming task.

Finally, participants completed the size estimation task just as in the non-evaluative condition of Experiment 1a, followed by the open-ended measure of contingency awareness. They were then debriefed, thanked, and dismissed.

Results and Discussion

Participants who exhibited contingency awareness were excluded from analyses. Fourteen participants, (12%; 6 in the control condition and 8 in the size-primed condition) met these criteria based on their responses to the question regarding the particular items presented with the 2 CSs, and 1 participant (in the size-primed condition) reported awareness of the nature of the research and indicated that they felt they were supposed to respond to the judgment items in a particular way. These participants were excluded from analyses, although their exclusion did not influence the results.

Our primary interest was in examining the effects of the priming manipulation on conditioning. Thus, participants' standardized ratings were submitted to a 2 (Prime type: Size vs. Control) X 2 (CS: CS 1 vs. CS 2) X mixed ANOVA with repeated measures on the latter factor. The expected interaction was found, F (1, 106) = 5.26, $p < .05$. To investigate the nature of this interaction, a conditioning score was computed whereby larger values indicated size estimates for the CSs that correspond to their respective size associations, and therefore greater conditioning, just as in experiment 1. As expected, participants primed with size-related terms evidenced conditioning along the non-evaluative dimension, t (45) = 2.44, $p < .05$, M = .40, SD = 1.10, d = .73, while participants exposed to control primes demonstrated no conditioning, t (58)=.77, *ns*, M = -.13, SD = 1.32, d = .73 (see Table 1). These results support our hypothesis that conditioning can be observed when the dimension being implicitly learned is made more accessible.

General Discussion

We began this research by highlighting the unique features of the evaluative dimension that may lend it to implicit covariation learning. Specifically, we argued that because evaluative information attracts attention and promotes categorization along the evaluative dimension, it is more conducive to implicit covariation learning. Consistent with this reasoning, Experiment 1 demonstrated that an implicit conditioning procedure resulted in effective change of perceptions of an object's valence, but not its size or speed. These findings converge with other research demonstrating that people are less capable of implicitly learning associations involving non-evaluative dimensions (Meersman et al., 2005). Moreover, we attempted to transplant these unique qualities of evaluation onto a non-evaluative dimension in order to foster implicit covariation learning in such a domain. Thus, in Experiment 2, we subliminally primed some participants with size in order to increase the accessibility of that dimension. As predicted, only those primed with the dimension-to-be-learned evidenced implicit learning.

We have argued that such priming may have led a normally-non-attention-grabbing dimension to attract attention, as well as encourage participants to categorize the USs in terms of the dimension to-be-learned. While we believe that the natural tendency to categorize along an evaluative dimension is likely to enhance the implicit learning of evaluative information, we have reason to suspect that it may have played less of a role in the present studies. Recall that we employed unambiguous word USs (e.g., "tiny") , as well as more complex image USs (e.g., a photo of a hippo). Presumably no additional prompt would have been necessary to promote categorization of our word USs in terms of the size category. Hence, the role for differential categorization is limited to only half the CS-US pairings presented in the present experiments. Moreover, recall that Meersman and colleagues (2005) failed to find implicit covariation learning along a non-evaluative dimension that is likely to prompt spontaneous categorization: gender. Indeed, along with race and age, gender is a "natural category" into which perceivers sort people. While we cannot know whether Meersman and colleagues' participants naturally categorized the stimuli they presented by gender, much theory and research on impression formation would imply that they probably did (Brewer & Lui, 1989). It would appear then, that implicit covariation learning is unlikely to occur even along salient dimensions that perceivers are accustomed to using for social categorization processes.

These factors lead us to suggest that the priming manipulation promoted implicit covariation learning by enhancing attention to size-related information. Of course, we have provided no direct evidence that it was an attentional process per se that led to the effects reported here, and we believe that attention and categorization are closely related mechanisms that are likely to play a role in enhancing implicit learning in non-evaluative dimensions. Future research might attempt to disentangle the contribution of each.

A Place for Evaluative Conditioning in Implicit Learning Research

In the same way that De Houwer (2007) recently conceptualized EC as a phenomenon potentially produced by a diverse family of processes, the phrase “implicit learning” has been applied to a host of heterogeneous processes. When EC occurs without verbalizable knowledge of the contingencies that result in attitude formation and change, it begins to share the implicit learning literature’s signature description: learning without awareness.

As we reviewed earlier, there is consistent evidence that valenced associations can be acquired in the absence of conscious awareness. Oddly, implicit evaluative conditioning is rarely included in reviews of implicit learning more generally (e.g., French & Cleeremans, 2002; Seger, 1994; Shanks, 2005; Stadler & Frensch, 1998). This may be for definitional reasons—some researchers have historically considered simple associative learning processes to be outside the scope of the traditional domains of implicit learning research (such as general statistical and language learning; Seger, 1994), but it may also be because much evaluative conditioning research is conducted within social psychology and marketing. Thus, comparisons between the paradigms typically employed in evaluative conditioning research and those used in other implicit learning research are not often made. However, such a comparison is warranted here because there appears to be an inconsistency between the present findings and other implicit learning research. Research conducted in the domain of evaluative conditioning would lead one to believe that implicit learning with non-evaluative dimensions is a special case, whereas the broader implicit learning literature indicates that all sorts of non-evaluative information can be learned without awareness. For example, there is consistent evidence that grammar rules, spatial locations of objects, and other perceptual information can be learned implicitly (e.g., French & Cleeremans, 2002; Reber, 1989; Seger, 1994; Stadler & Frensch, 1998). This discrepancy begs the question of what might lead to this apparent inconsistency between the two literatures.

While an exhaustive comparison between evaluative conditioning research and other implicit learning research is certainly beyond the scope of the present research, the current findings may provide some insight in resolving the discrepancy. We have argued that evaluative information is particularly conducive to implicit covariation learning because of its unique attention-grabbing and categorization-inducing properties. Indeed, in most EC research implicit learning occurs after exposure to as few as 10 to 20 CS-US pairings (De Houwer et al., 2001). Because evaluative information automatically attracts attention, thus making it more susceptible to encoding, and is readily categorized as such, fewer exposures are required for associative learning to occur. On the other hand, the vast majority of other implicit covariation learning research subjects participants to many times this number of associations before implicit learning is evident (e.g., Chun & Jiang, 1998, 1999, Jiang & Chun, 2001; Hoffman & Sebald, 2005; Nissley & Schmitter-Edgecombe, 2002). Perhaps it is the case that because non-evaluative dimensions neither spontaneously attract attention nor readily prompt the appropriate categorization of stimuli, a greater number of associations are required before relevant contiguities are attended to at all.

Recently, Pacton and Perruchet (2008) provided empirical support for attention's critical role in the learning of contiguous events. These authors demonstrated effective learning of contiguities between events when participants were prompted to attend to them, even when these events were disparate in space and time. They conclude that attention is not merely necessary, but is actually sufficient for learning to occur. More relevant to the present research, they argue that future research needs to uncover the sorts of environmental features that attract attention and hence create opportunities for learning. Pacton and Perruchet speculate that evolutionarily relevant stimuli might most easily be learned, and indeed, the classic research by Ohman and colleagues we cited earlier demonstrates just this (Ohman & Mineka, 2001). The same point can be made regarding evaluation, as attitudes are first and foremost functional in navigating one's environment (Fazio, 2000).

Conclusion

We have argued that because evaluative information attracts attention and automatically prompts categorization, it is more likely to enter into associations with contiguous objects implicitly. Past failures to replicate implicit learning effects have led to repeated calls for a greater understanding of the boundary conditions of implicit covariation learning, and by highlighting the unique properties of the evaluative dimension, we believe the present research makes progress in our understanding of just when implicit covariation learning occurs.

References

Baeyens, F., Eelen, P., Van den Bergh, O., & Crombez, G. (1992). The content of learning in human evaluative conditioning: Acquired valence is sensitive to US-revaluation. *Learning and Motivation, 23*, 200-224.

Balcetis, E., & Dale, R. (2007). Conceptual set as a top-down constraint on visual object identification. *Perception, 36*, 581-595.

Bargh, J.A., Gollwitzer, P., Lee-Chai, A., Barndollar, K., & Troetschel, R. (2001). The automated will: Nonconscious activation and pursuit of behavioral goals. *Journal of Personality and Social Psychology, 81*, 1014–1027.

Brewer, M. B., & Lui, L. N. (1989). The primacy of age and sex in the structure of person categories. *Social Cognition, 7,* 262-274.

Bruner, J. S. (1957). On perceptual readiness. *Psychological Review, 64,* 123-152.

Chun, M. M., & Jiang, Y. (1998). Contextual cueing: Implicit learning and memory of context guides spatial attention. *Cognitive Psychology, 36*, 28-71.

Chun, M. M., & Jiang, Y. (1999). Top-down attentional guidance based on implicit learning of visual covariation. *Psychological Science, 10,* 360-365.

Cohen, A., Ivry, R. I., & Keele, S. W. (1990). Attention and structure in sequence learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16,* 17-30.

De Houwer, J. (2007). A conceptual and theoretical analysis of evaluative conditioning. *The Spanish Journal of Psychology, 10*, 230-241

De Houwer, J., Hendrickx, H., & Baeyens, F. (1997). Evaluative learning with "subliminally" presented stimuli. *Consciousness and Cognition*, *6*, 87-107.

De Houwer, J., Thomas, S., & Baeyens, F. (2001). Associative learning of likes and dislikes: A review of 25 years of research on human evaluative conditioning. *Psychological Bulletin, 127,* 853-869.

Dijksterhuis, A. (2004) I like myself but I don't know why: Enhancing implicit self- esteem by subliminal evaluative conditioning. *Journal of Personality and Social Psychology, 86,* 345-355.

Eitam, B., Hassin, R. R., & Schul, Y. (2008). Nonconscious Goal Pursuit in Novel Environments: The Case of Implicit Learning. *Psychological Science, 19*, 261-267.

Fazio, R. H. (2000). Accessible attitudes as tools for object appraisal: Their costs and benefits. In G. R. Maio & J. M. Olson (Eds.), *Why we evaluate: Functions of attitudes* (pp. 1-36). Mahwah, NJ: Erlbaum.

Fazio, R. H. (2001). On the automatic activation of associated evaluations: An overview. *Cognition and Emotion, 15,* 115-141.

Fazio, R. H., & Dunton, B. C. (1997). Categorization by race: The impact of automatic and controlled components of racial prejudice. *Journal of Experimental Social Psychology, 33,* 451-470.

Fazio, R. H., & Olson, M. A. (2003b). Attitudes: Foundations, Functions, and Consequences. In M. Hogg & J. Cooper (Eds.), *The Sage Handbook of Social Psychology* (pp. 139-160). London: Sage Publications.

French, R. M., & Cleeremans, A. (2002). *Implicit learning and consciousness.* New York: Taylor & Francis.

Frensch, P. A., & Rünger, D. (2003). Implicit learning. *Current Directions in Psychological Science, 12,* 13-18.

Hammerl, M, & Grabitz, H.-J. (2000). Affective-evaluative learning in humans: A form of associative learning or only an artifact? *Learning and Motivation. 31,* 345-363.

Hermans, D., Vansteenwegen, D., Crombez, G., Baeyens, F., & Eelen, P. (2002). Expectancy-learning and evaluative learning in human classical conditioning: Affective priming as an indirect and unobtrusive measure of conditioned stimulus valence. *Behaviour Research and Therapy, 40,* 217-234.

Higgins, E. T. (1996). Knowledge activation: Accessibility, applicability, and salience. In E. T. Higgins and A. W. Kruglanski (Eds.), *Social Psychology: Handbook of Basic Principles* (pp. 133-168), New York: Guilford.

Higgins, E. T., Rholes, W. S., & Jones, C. R. (1977). Category accessibility and impression formation. *Journal of Experimental Social Psychology, 13,* 141-154.

Hoffman, J. & Sebald, A. (2005). When obvious covariations are not even learned implicitly. *European Journal of Cognitive Psychology, 17,* 449-480.

Jiang, Y., & Chun, M. M. (2001). Selective attention modulates implicit learning. *Quarterly Journal of Experimental Psychology, 54,* 1105-1124.

Jiang, Y., & Leung, A. W. (2005). Implicit learning of ignored visual context. *Psychonomic Bulletin and Review, 12,* 100-106.

Jimenez, L., & Mendez, C. (1999). Which attention is needed for implicit sequence learning? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25,* 236 –259.

Kim, J., Allen, C. T., & Kardes, F. R. (1996). An investigation of the mediational mechanisms underlying attitudinal conditioning. *Journal of Marketing Research, 33,* 318-328.

Meersman, T., De Houwer, J., Baeyens, F., Randell, T., & Eelen P. (2005). Beyond evaluative conditioning? Searching for associative transfer of non-evaluative stimulus properties. *Cognition and Emotion, 19,* 283-306.

Nissley, H.M., & Schmitter-Edgecombe, M. (2002). Perceptually-based implicit learning in severe closed head-injury patients. *Neuropsychology, 16,* 111-122.

Nissen, M. J., & Bullemer, P. (1987). Attentional requirements of learning: Evidence from performance measures. *Cognitive Psychology, 19,* 1-32.

Ohman, A. & Mineka, S. (2001). Fears, phobias, and preparedness. Toward an evolved model of fear and fear learning. *Psychological Review, 108,* 483-522.

Newport, E. L. (1990). Maturational constraints on language learning. *Cognitive Science, 14,* 11–28.

Olson, M. A., & Fazio, R. H. (2001). Implicit attitude formation through classical conditioning. *Psychological Science, 12,* 413-417.

Olson, M. A., & Fazio, R. H. (2002). Implicit acquisition and manifestation of classically conditioned attitudes. *Social Cognition, 20,* 89-103.

Olson, M. A. & Fazio, R. H. (2006). Reducing automatically activated racial prejudice through implicit evaluative conditioning. *Personality and Social Psychology Bulletin, 32,* 421-433.

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1957). *The measurement of meaning.* Chicago: University of Illinois Press.

Pacton, S., & Perruchet, P. (2008). An attention-based associative account of adjacent and nonadjacent dependency learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 34,* 80 –96.

Reber, A.S. (1989). Implicit learning and tacit knowledge. *Journal of Experimental Psychology: General, 118,* 219-235.

Reber, A.S. (1993). *Implicit learning and tacit knowledge: An essay on the cognitive unconscious.* New York: Oxford University Press.

Roskos-Ewoldsen, D. R., & Fazio, R. H. (1992). On the orienting value of attitudes: Attitude accessibility as a determinant of an object's attraction of visual attention. *Journal of Personality and Social Psychology, 63,* 198-211.

Rudman, L. A. (2004). Sources of implicit attitudes. *Current Directions in Psychological Science, 13,* 80-83

Seger, C. A. (1994). Implicit Learning. *Psychological Bulletin, 115,* 163-196.

Shanks, D. R. (2005). Implicit learning. In K. Lamberts and R. Goldstone (Eds.), *Handbook of Cognition* (pp. 202-220). London: Sage.

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

Sherman, S., Mackie, D., & Driscoll, D. (1990). Priming and the differential use of dimensions in evaluation. *Personality and Social Psychology Bulletin, 16,* 405–418.

Smith, E. R., Fazio, R. H., & Cejka, M. A. (1996). Accessible attitudes influence categorization of multiply categorizable objects. *Journal of Personality and Social Psychology, 71,* 888-898.

Stadler, M. A. (1995). Role of attention in implicit learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21,* 819-827.

Stadler, M. A., & Frensch, P. A. (Eds.) (1998). *Handbook of implicit learning.* Thousand Oaks, CA: Sage Publications.

Walther E. (2002). Guilty by mere association: Evaluative conditioning and the spreading attitude effect. *Journal of Personality and Social Psychology, 82,* 919-934.

Table 1.

Conditioning effect means and effect sizes

	M	*SD*	*Effect Size (d)*
Experiment 1a			
Evaluative Dimension (*n=43*)	.30*	1.07	.62
Size Dimension (*n=42*)	.00	.92	.07
Experiment 1b			
Evaluative Dimension (*n=39*)	.40*	1.07	.73
Speed Dimension (*n=47*)	-.23	1.26	.06
Experiment 2			
Size-primes (*n=46*)	.40*	1.10	.73
Neutral primes (*n=59*)	-.13	1.32	.20

* $p<.05$