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The Symmetric Nature of Evaluative Memory Associations: Equal Effectiveness of Forward Versus Backward Evaluative Conditioning

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Abstract

Changing attitudes by repeated co-occurrences of initially neutral stimuli (conditioned stimuli [CSs]) with affective entities (unconditioned stimuli [USs]) is called evaluative conditioning (EC). The vast majority of EC procedures in the literature are "forward" in nature, presenting the CS before the US. Scant empirical research into the issue has argued that forward procedures are more effective than backward procedures, but this research suffers from methodological issues while a meta-analysis indicated no difference. Two experiments show that backward conditioning procedures are equally effective in changing attitudes as forward conditioning procedures. Memory measures show that memory associations are equally strong from the CSs to the USs as from the USs to the CSs, irrespective of the presentation order (forward vs. backward) of the stimuli. Together the data support the proposition that the associations generated by EC are symmetric and bidirectional, rather than unidirectional, in nature.

Keywords

evaluative conditioning, associative learning, memory, attitudes

One basic condition through which attitudes are formed and changed is the mere co-occurrence of stimuli. When initially neutral stimuli co-occur repeatedly with valenced stimuli, attitudes toward the neutral stimuli change in a valence-consistent manner. This is known as an evaluative conditioning (EC) effect. There is little doubt regarding the effectiveness of EC as a nearly universal mechanism of attitude change since a large body of research spanning more than three decades has shown it affects attitudes in a wide array of domains, for example, brand attitudes, everyday objects, other people, and even the self (for reviews, see De Houwer, Thomas, & Baeyens, 2001; Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010; Jones, Olson, & Fazio, 2010). Much more uncertainty surrounds the psychological process(es) through which the effect is produced, as mechanisms ranging from automatic association formation (aka referential learning, Baeyens & De Houwer, 1995; Baeyens, Eelen, Vandenbergh, & Crombez, 1992; Gawronski & Bodenhausen, 2006), over propositional reasoning (De Houwer, 2009; Gawronski & Bodenhausen, 2006; Mitchell, De Houwer, & Lovibond, 2009) to implicit misattribution of evaluative responses (Jones, Fazio, & Olson, 2009; Jones et al., 2010; Sweldens, van Osselaer, & Janiszewski, 2010), have been proposed.

Despite decades of empirical work, the effect of one of the most basic determinants of EC effects is still uncertain. Specifically, it is unclear whether the initially neutral stimulus (called the "conditioned stimulus" or CS) should best be presented *before* or *after* the affectively valenced stimulus (aka the "unconditioned stimulus" or US).[1] Conditioning procedures where the CS is presented before the US are called *forward* conditioning procedures, whereas those featuring the reversed presentation order are called *backward* conditioning procedures.

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Literature Review

There has been surprisingly little research on the effect of presentation order in EC, as virtually all of the sequential conditioning procedures in the literature have been forward in nature. In one of the earliest demonstrations of EC, Levey and Martin (1975) investigated both types of procedures and found that backward conditioning was effective. Hammerl and Grabitz (1993) on the other hand found backward conditioning to be inferior to forward conditioning. Both studies suffered, however, from extremely small sample sizes (<10 participants per cell). Stuart and colleagues (1987; Experiment 4) compared different kinds of procedures directly, finding significant backward EC effects that were smaller in size than some but not all forward presentation conditions in their experiment. In fact, only one of their four conditioning measures showed a significant difference. Nevertheless, the authors concluded that forward conditioning is superior over backward conditioning. This conclusion has subsequently been incorporated in several major review articles that document the procedural determinants of EC effects. These articles generally share the conclusion that although backward EC might be effective, it appears inferior to forward EC (De Houwer, 2011; De Houwer et al., 2001). This conclusion has also been popularized in several textbooks on consumer behavior, which argue that advertising effectiveness depends on the presentation order of brands and affective stimuli, recommending forward over backward conditioning to change brand attitudes (Hoyer, MacInnis, & Pieters, 2013; Kardes, 2001; Mowen & Minor, 1998).

We believe one reason this conclusion has been so readily accepted is that EC was long considered an instance of classical Pavlovian conditioning (CC), where the superiority of forward over backward conditioning procedures has been well established (McSweeney & Bierley, 1984; Pavlov, 1927). However, a fundamental difference between CC and EC is that the associations in EC are not predictive but referential in nature (De Houwer et al., 2001). Due to the lack of a predictive component, several hallmark characteristics of CC such as its sensitivity to extinction, blocking, and (more disputed) the requirement for contingency awareness are absent in EC (Beckers, De Vicq, & Baeyens, 2009; De Houwer et al., 2001; Hütter, Sweldens, Stahl, Unkelbach, & Klauer, 2012; Sweldens, Corneille, & Yzerbyt, 2014). Importantly, the lack of a predictive function in EC removes one obvious reason for why forward conditioning would be superior to backward conditioning.

A first important empirical indication that casts doubt on the superiority of forward EC comes from the meta-analysis conducted by Hofmann, De Houwer, Perugini, Baeyens, and Crombez (2010), who found no significant difference in the effect sizes generated by backward versus forward EC procedures. However, this evidence is not conclusive for two reasons. First, it does not contain a controlled comparison of both types of procedures. For example, the forward EC estimate was based on a large number of effect sizes obtained from different sensory modalities, presentation schedules, and so on, whereas the backward estimate was derived from just a few observations, from a much more restricted set of procedures and modalities. Second, the uncertainty (standard error [*SE*]) surrounding the backward conditioning effect size is almost 5 times larger than the uncertainty regarding the forward effect size, reflecting the limited amount of work that has studied this issue. This leaves open the possibility that the lack of a significant difference is caused by the unreliability of the effect size estimate for backward procedures.

Theoretical Relevance

In any learning process, understanding the nature of the formed memory associations is of primary theoretical importance (Rescorla, 1988). However, until now, little is known about the nature of the associations formed in EC.[2] In other fields of associative learning (e.g., learning of word pairs or triplets), research has focused on illuminating whether memory associations are *bidirectional* (symmetric) *versus unidirectional* (independent; Yang et al., 2013). After learning an association between two stimuli, the association can be retrieved in the initial direction (i.e., in the same order as the learning) or by the opposite direction (in the reversed order). According to the *independent association hypothesis*, the direction of learning has an essential influence on the nature of the learned associations, such that associations in the direction of learning are formed along with, but are better remembered than, associations in the reversed direction (Kahana & Caplan, 2002; Yang et al., 2013). In EC, this would imply that forward conditioning procedures (where the CS precedes the presentation of the US) result in the formation of both a forward CS–US association and a weaker backward US–CS association in memory. Conversely, the *associative symmetry hypothesis* states that both stimuli are encoded as a single compound, and the association has the same strength whether it is recalled forwardly or backwardly (Kahana, 2002; Yang et al., 2013). In EC, this would mean that independent of the presentation order of CS and US, a symmetric CS = US association compound is formed.

Overview of Studies and Predictions

In the current research, we juxtapose and test predictions from the independent association hypothesis and the associative symmetry hypothesis with both attitudinal and memory measures. We present two experiments which manipulate between subjects: (1) the forward versus backward presentation order of CS and US and (2) whether memory is assessed in the direction from CS to US or from US to CS. We collect both memory and CS attitude data. The predictions are as follows.

Effects on CS Attitude

If the independent association hypothesis were correct, a forward EC procedure would form strong CS–US associations but weak US–CS associations. Conversely, a backward EC procedure would form strong US–CS associations but weak

CS–US ones. As indicated by studies on US revaluation effects, CS evaluations are dependent on the extent to which they activate the US representation in memory (i.e., on the CS–US association strength; Baeyens et al., 1992; Walther, Gawronski, Blank, & Langer, 2009), at least in sequential conditioning procedures (Sweldens et al., 2010). Therefore, the independent association hypothesis would predict that a forward EC procedure has a greater effect on CS attitudes, as it generates stronger CS–US associations than a backward EC procedure. Conversely, if the associative symmetry hypothesis were correct, presentation order would not influence the effectiveness of EC in changing CS attitudes, as symmetric CS = US association compounds are formed irrespective of the presentation order.

Effects on Memory From CS to US or From US to CS

The independent association hypothesis predicts better performance on memory tests in which the direction at test (e.g., CS →?) is consistent with the direction at learning (e.g., CS → US in a forward EC procedure) compared with when the test direction (e.g., US →?) is opposite to the direction of learning. Therefore, forward conditioning procedures should lead to better performance in forward memory tests (CS →?) than in backward memory tests (US →?) and the reverse should hold for backward conditioning procedures. The associative symmetry hypothesis, on the other hand, predicts equivalent performance in forward versus backward memory tests, irrespective of the direction of learning.

Experiment 1

Method

Participants and Design

Eighty-one German university students (39 female) participated in the experiment. The experiment employed a 2 (Presentation Order: Forward vs. Backward) × 2 (Memory Test: Forward vs. Backward) × 2 (US Valence: Neutral vs. Positive) mixed design with the first two factors manipulated between participants and the last factor manipulated within participants. The experiments were run on computers in a behavioral lab.

Stimuli

Belgian beers unknown to the participant population were chosen to serve as CSs. Eight beers with the most neutral and most normally distributed attitudes from a pretest were selected to serve as CSs. As USs, we selected four positively valenced images and four neutrally valenced images from the international affective picture system (IAPS; Lang, Bradley, & Cuthbert, 2005). Positive images depicted adults having a good time in various ways such as waterskiing or cuddling, whereas neutral images depicted adults with neutral expressions engaging in everyday activities such as reading a newspaper. On the IAPS's 9-point affective rating scale, all positive images scored above 7.0 for both male and female raters, whereas neutral images scored between 4.5 and 5.5 for both genders.

Procedure

The cover story was adapted from Sweldens, van Osselaer, and Janiszewski (2010): Participants were informed that the experiment was about investigating consumers' spontaneous attitudes toward hitherto unknown Belgian beers and to familiarize themselves with the brands they would see a slideshow of beers with images. Afterward, participants went through different phases in the experiment, that is, a conditioning phase, CS attitude assessment, a memory test, and questions assessing demand awareness and demographics. The order between CS attitude assessment and memory test was counterbalanced, such that half of the participants answered the CS attitude assessment measure first, followed by the memory test, whereas the other half completed the memory test before answering CS attitude assessment.

Conditioning Phase

For every participant, four (out of eight) beer brands were randomly selected to be paired with neutral (vs. positive) USs. The conditioning procedure consisted of five rounds of pairings. The eight CSs appeared once in every round and were consistently paired with the same US. Therefore, the total procedure consisted of 40 CS–US pairings. In the forward presentation order condition, the CS was presented before the US, whereas in the backward presentation order condition, the CS was presented after the US. In the forward (backward) condition, the CS (US) was presented in the center of the screen for 1.5 s, followed by an interstimulus interval of 0.5 s, followed by the US (CS) presented for 1.5 s. The intertrial interval was 2 s.

Attitude Assessment

For every CS, participants were asked to provide their global attitude toward the beer on a 9-point scale (1—*extremely negative*, 9—*extremely positive*). Next, participants indicated how appealing they found the beer to be (1—*totally unappealing*, 7—*very appealing*) and their likelihood of buying the beer if it were available at a reasonable price (1—*extremely unlikely*, 7—*extremely likely*) using a 7-point scale.

Memory Test

In the *forward memory condition*, participants went through eight consecutive recognition questions in which the CS was presented on the left-hand side of the screen, with the eight possible US images presented on the right. Participants indicated for each CS, which US they thought it was presented with in the conditioning phase. In the *backward memory condition*, participants went through eight consecutive recognition questions in which the US was presented on the left-hand side of the screen, with the eight possible CS images presented on the right.

Results

Brand Attitudes

The attitudes toward the positively versus neutrally CS in this and the next experiments were computed by standardizing the three measures (global attitude measure, appeal measure, and likelihood to buy measure) and averaging them together (Cronbach's $\alpha = .90$). The counterbalancing factor showed neither main nor interaction effects with the other variables (all $p > .38$) and is therefore disregarded. A 2×2 mixed analysis of variance (ANOVA) analyzed the attitudes toward positively and neutrally CS as a function of the presentation order condition. Presentation order (forward vs. backward) did not have a main effect on attitudes, $F(1, 79) = 0.09$, $p = .77$, $\eta_p^2 = .001$. There was, however, a strong EC effect, and CS paired with positive images were evaluated more favorably than CS paired with neutral images, $M_{pos} = .45$, $SD_{pos} = 1.28$, $M_{neu} = -.45$, $SD_{neu} = 1.19$, $F(1, 79) = 23.80$, $p < .0001$, $\eta_p^2 = .232$. Importantly, this EC effect was not moderated by the presentation order of CS and US, $F(1, 79) = 0.00$, $p = .95$, $\eta_p^2 = .000$, indicating that forward and backward EC procedures were equally effective in inducing CS attitudes. Means (and their *SE*s) are displayed in Figure 1.

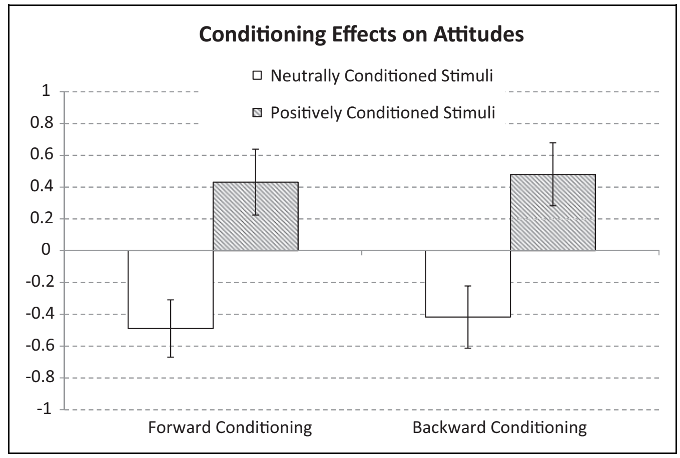

Figure 1. Standardized means and standard errors of conditioned stimulus attitudes in Experiment 1.

Memory

A 2×2 ANOVA analyzed performance in the memory test (number of correct identifications) as a function of presentation order (forward vs. backward conditioning) and memory test order (forward vs. backward memory). We discarded the data of six outliers whose responses differed significantly from the other participants (studentized deleted residuals differed significantly from zero, $p < .05$; on average, they scored only 0.33 on the memory test, i.e., significantly below chance level, $t(5) = -3.16$, $p = .025$; and results do not change when outliers are not removed). On average, participants identified 5.96 pairs (out of a maximum of 8) correctly, well above the chance level of 1, $t(74) = 22.62$, $p < .0001$, Cohen's $d = 2.62$. Memory performance was unaffected by the direction of learning, $F(1, 71) = 0.57$, $p = .45$, $\eta_p^2 = .008$, unaffected by the direction of the memory test, $F(1, 71) = 0.10$, $p = .75$, $\eta_p^2 = .001$, and, most importantly, unaffected by the interaction between these factors, $F(1, 71) = 0.76$, $p = .38$, $\eta_p^2 = .011$. Means and *SE*s are shown in Figure 2.

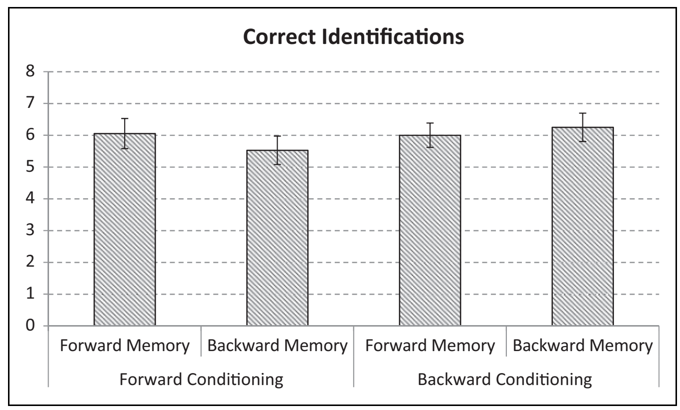

Figure 2. Means and standard errors of correct identifications in the memory test of Experiment 1.

Discussion

Both the attitudinal and the memory data disconfirmed predictions made by the independent association hypothesis, yet were in accordance with the symmetric association hypothesis. However, several caveats are in order. First, do the findings generalize to other conditioning procedures? Second, were our tests sufficiently powerful to detect meaningful variations in the EC or memory effects? Third, could the relatively high performance levels on the memory test have caused a ceiling effect? To address these concerns, we conducted a second experiment.

Experiment 2

We doubled the number of CSs from 8 to 16 to make the memory test more difficult. In addition, we changed the CS category from beer brands to a variety of consumer goods and used negative US instead of neutral US to add power to the tests on attitude effects. Other elements of design, procedure, and analysis were analogous to Experiment 1.

Method

Participants and Design

Eighty German university students (56 female) participated in a behavioral lab study. The design mirrored Experiment 1.

Stimuli

Sixteen fast-moving consumer goods (FMCGs) brands (e.g., hand soap or cereal) unknown to the participant population were chosen to serve as CSs. As positive (negative) USs, we selected eight smiling (frowning) faces of female Caucasian women. On a pretest, smiling faces were found to elicit more feelings of happiness than frowning faces, $t(1,21) = 8.87$, $p < .0001$, but they did not differ in arousal ($t < 1$). On a 9-point happiness scale, positive USs scored above 6.7, whereas negative USs scored between 3.0 and 4.3.

Conditioning Phase

Procedure and the cover story were analogous to Experiment 1. Eight of the 16 FMCG brands were randomly selected to be paired with the negative USs and the other eight brands were paired with the positive USs. The total conditioning procedure consisted of 80 CS–US pairings: 16 brands (CSs), each of which would be paired with the same US 5 times. We also shortened the intertrial interval (from 2 to 1.5 s) and interstimulus interval (from 0.5 to 0.3 s) to keep total duration of the conditioning phase limited to 375 s (compared to 218 s in Experiment 1). The next three phases—the assessment of CS attitudes, memory, and demand awareness—were analogous to the first experiment.

Results

Brand Attitudes

The attitude measures were standardized and averaged analogously to Experiment 1 (Cronbach's $\alpha = .80$). A 2 × 2 mixed ANOVA again revealed a strong EC effect. Brands that were paired with positive USs were evaluated more favorably than brands that were paired with negative USs, $M_{pos} = .55$, $SD_{pos} = 1.06$, $M_{neg} = -.55$, $SD_{neg} = 1.41$, $F(1, 78) = 27.85$, $p < .0001$, $\eta_p^2 = .263$. As in the first experiment, presentation order of CS and US did not have a main effect on attitudes, $F(1, 78) = 0.10$, $p = .76$, $\eta_p^2 = .001$ nor did it interact with the EC effect, $F(1, 78) = 0.12$, $p = .73$, $\eta_p^2 = .002$. Means and *SE*s are presented in Figure 3.

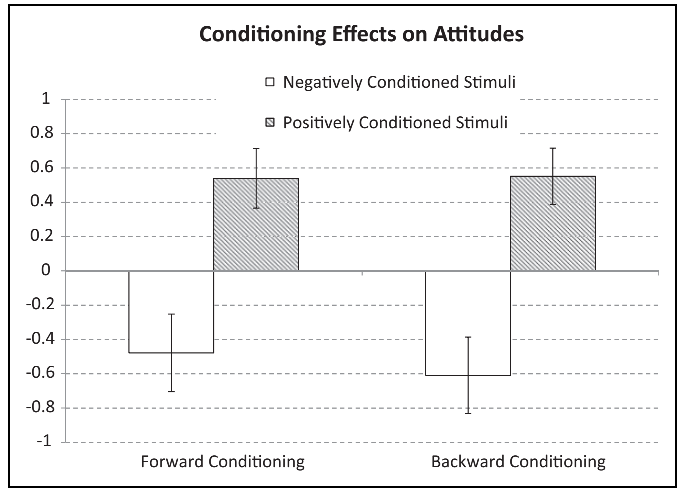

Figure 3. Standardized means and standard errors of conditioned stimulus attitudes in Experiment 2.

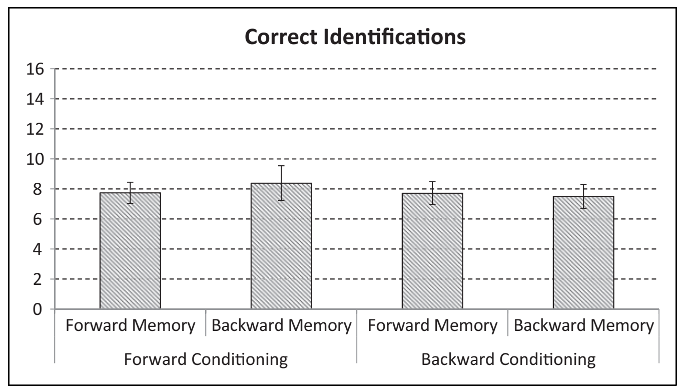

Figure 4. Means and standard errors of correct identifications in the memory test of Experiment 2.

Memory Test

As in the first experiment, we analyzed performance in the memory test as a function of direction of learning and direction of test with a 2 × 2 ANOVA. The analysis revealed the presence of five outliers (studentized deleted residuals differed significantly from zero, $p < .05$; one participant had zero correct identifications, four achieved a perfect score; and results do not change when outliers are not removed). On average, participants had 7.78 correct identifications (out of a maximum of 16) well above the chance level of 1, $t(74) = 16.81$, $p < .0001$, Cohen's $d = 1.94$. Memory performance was unaffected by the direction of learning, $F(1, 71) = 0.29$, $p = .59$, $\eta_p^2 = .004$, unaffected by the direction of the memory test, $F(1, 71) = 0.07$, $p = .80$, $\eta_p^2 = .001$, and, most importantly, unaffected by the interaction between these factors, $F(1, 71) = 0.26$, $p = .61$, $\eta_p^2 = .004$. Means and *SE*s are displayed in Figure 4. As the number of correct identifications in this experiment is around the scale average, floor or ceiling effects are unlikely to account for the lack of variability.

Interpreting Null Effects

Results from two experiments disconfirm predictions made by the independent association hypothesis and are consistent with the associative symmetry hypothesis. However, support for associative symmetry stems from (1) finding *no* effect of presentation order on CS attitudes and (2) finding *no* interaction between presentation order and memory test order on performance in the memory test. To ensure the validity of conclusions which are essentially based on null effects, we took two additional steps. First, we pool the data from both experiments to achieve maximal power on these crucial tests and follow the recommendations outlined by Frick (1995) for accepting a null hypothesis. Second, we conducted a Bayesian analysis to assess the likelihood that the null hypothesis is correct (Rouder, Speckman, Sun, Morey, & Iverson, 2009).

Frick (1995) argues that to accept a null hypothesis, the associated p value should not just be larger than .05, it should be larger than .50 to be unambiguous. We analyzed the pooled *attitude* data with a 2 (Experiment Factor) × 2 (Presentation Order) × 2 (US Valence) mixed ANOVA. The analysis revealed a highly significant EC effect of US valence, $F(1, 157) = 51.19$, $p < .0001$, $\eta_p^2 = .246$, and a marginally significant effect of the experiment factor, $F(1, 157) = 3.65$, $p = .06$, $\eta_p^2 = .023$ (attitudes toward beers in Experiment 1 were slightly higher than attitudes toward FMCGs in Experiment 2). Most importantly, the EC effect was not moderated by the presentation order of CS and US, $F(1, 157) = 0.04$, $p = .85$, $\eta_p^2 = .000$. To pool the *memory* data, we transformed the number of correct identifications into a ''percentage correct score,'' excluding the outliers identified earlier. A 2 (Experiment Factor) × 2 (Presentation Order) × 2 (Memory Test Direction) ANOVA revealed only a significant effect of the experiment factor, $F(1, 142) = 44.45$, $p < .0001$, $\eta_p^2 = .238$, indicating better memory performance in Experiment 1 (74.5% correct) than in the more complex Experiment 2 (48.7% correct). Most importantly, consistent with the associative symmetry hypothesis, there was no interaction between the direction of learning and the direction of the memory test, $F(1, 142) = 0.08$, $p = .78$, $\eta_p^2 = .001$.

Frick (1995) further outlines six important criteria to accept a null hypothesis. First, he recommends using many subjects. Our pooled analysis contains approximately 40 participants per cell. Second, he urges to have many trials per subject. Our attitude and memory data are based on 8 (Experiment 1) or 16 (Experiment 2) trials per participant. These repetitions of the EC effect across multiple stimuli guarantee high power for the tests on the EC effects. Third, major sources of variance should be controlled for. Both studies were run in a well-controlled environment (behavioral lab) and outliers were screened for and removed. Fourth, Frick advises to use large and effective manipulations. Our manipulations of presentation order and memory test direction are unambiguous manipulations of the constructs of interest and are not subject to concerns that they might have been ''too subtle'' to have an effect. Fifth, the measurement should be as sensitive as possible. Our attitude and memory measures are clearly sensitive to other manipulations. The attitude measure is sensitive to the manipulation of US valence, demonstrating the EC effect. The memory measure is sensitive to the complexity of the learning phase as reflected by the effect of the experiment factor in the pooled analysis. Furthermore, as memory measure, we relied on recognition tests which are more sensitive than, for example, free or cued recall measures of memory (Tulving & Craik, 2000). Lastly, in order to accept a null hypothesis, floor and ceiling effects should be avoided. Apart from the memory data in Experiment 1, all condition means were situated around the midpoints of their respective scales.

Next, we calculated the Bayes Factor B_{01} to compute the posterior odds of the null hypothesis over the alternative hypothesis, that is, $\Omega = \Pr(H_0|\text{data})/\Pr(H_1|\text{data})$. As recommended by Rouder, Speckman, Sun, Morey, and Iverson (2009), we follow the *objective* Bayes school and use a prior that imposes a minimum of assumptions on the a priori likelihood of these hypotheses (i.e., the Jeffreys-Zellner-Siow prior). The outcome $\Omega = 5.614$ indicates that, given our data, it is 5.6 times more likely that there is no effect of presentation order on EC than that there would be an effect.

Finally, it is worth noting that the effect size estimates (η_p^2) indicate that changing the presentation order of the stimuli impacts less than 0.1% of the variance in the memory and attitude data. This is well below Cohen's (1988) cutoff value of 1%, the value required to consider an effect to be scientifically interesting, though practically small. The basic EC effect in our studies, on the other hand, is considered a ''large'' effect, explaining more than 20% of the variance ($\eta_p^2 = .238$, exceeding the lower limit of .14 for large effects).

General Discussion

Despite decades of research, one of the most basic determinants of attitudinal conditioning effects—the presentation order of the stimuli—has received very limited attention. Based on a few underpowered studies and an overgeneralization from the Pavlovian conditioning literature, several review articles and textbooks concluded that a forward presentation order (in which the neutral stimulus precedes the affective stimulus) generates stronger EC effects than a reversed, backward procedure. However, previous research has also shown that, contrary to Pavlovian conditioning, EC is not a form of predictive learning, so the CS does not need to acquire ''signal value'' for the US (De Houwer et al., 2001). Furthermore, a recent meta-analysis indicates that previous literature, in fact, contains insufficient support to sustain the hypothesis that forward presentations are superior to backward presentations (Hofmann et al., 2010). Therefore, we decided to put this issue under renewed empirical scrutiny.

Two experiments featuring different sorts of CSs (beer brands vs. a variety of consumer goods), USs (IAPS pictures vs. faces), and levels of complexity indicate that the EC effects generated by forward versus backward conditioning procedures are indistinguishable. While both types of procedures generated large EC effects in each experiment, the effect of presentation order is virtually zero. We implemented Frick's (1995) criteria, as well as a Bayesian analysis, to ensure the validity of the conclusion that in this case, the null hypothesis should be accepted.

The experiments also investigate whether EC procedures generate memory associations that are unidirectional or bidirectional in nature. Although a free recall task could be considered a stronger test of the theory, in the current research, we used a recognition test because we suspected that free recall of novel stimuli would be too challenging for participants, leading to floor effects. To the degree that recognition tests offer accurate reflections of memory associations, our results suggest that EC procedures create symmetric CS = US associations that are bidirectional. Theoretically, this provides important information regarding the content of learned associations (Rescorla, 1988) and answers recent calls to study the direction of learned associations in a variety of learning contexts (Yang et al., 2013).

Apart from their theoretical significance, these findings have important practical ramifications. In consumer contexts, EC procedures are most frequently applied to create favorable brand associations through advertising (Hoyer et al., 2013). The finding that EC creates symmetric CS = US associations has at least two important implications. First, textbook prescriptions which hold that EC is more effective with forward than backward conditioning procedures need to be revisited, as both types of procedures are equally effective at changing brand attitudes. Practically, this implies that brands can be effectively placed at the end of television commercials and not necessarily need to occur in the beginning. Second, the symmetric nature of brand associations implies that consumers are as likely to think of affective entities (e.g., celebrity endorsers) when they encounter a brand, as they are to think of brands when they see an affective entity. In normal circumstances, this can be beneficial for brands (e.g., activation of the endorser when encountering the brand underlies brand liking; Sweldens et al., 2010). However, the symmetry of the association also means this can backfire in two different ways when endorsers fall from grace. Consider the case of Tiger Woods' sexual escapades in 2010, which cost his main sponsors (Nike, Electronic Arts, and PepsiCo) about 2% or US$2.7 billion of their market value (Knittel & Stango, 2014). These detrimental effects can be partly explained by the symmetry of the created memory associations: Not only will consumers think of Woods when seeing Nike, they will be equally likely to think of Nike when reading the negative press stories about Woods.

Authors' Note

Jeehye Christine Kim and Steven Sweldens contributed equally to this manuscript. The experiments were conducted when Mandy Hütter was still at the University of Heidelberg, Germany.

Declaration of Conflicting Interests

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Notes

1. It is also possible to present conditioned stimulus (CS) and unconditioned stimulus (US) simultaneously. This investigation is limited to sequential conditioning procedures for two reasons. First, sequential procedures are the most prevalent, accounting for two thirds of the EC effects in the literature (Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010). Second, recent research indicates that simultaneous conditioning procedures are different from sequential procedures as they would allow for an implicit misattribution of affect from US to CS, without the requirement of establishing intermediating CS–US associations or requiring memory for the pairings (Hütter & Sweldens, 2013; Jones et al., 2009; Sweldens, van Osselaer, & Janiszewski, 2010). As we will outline below, one of our primary interests in this research project is to investigate the effect of presentation order on the memory representations of CS–US contingencies.
2. Please note that we use the terms "associative learning" and "association" here in the broadest possible sense to refer to the genesis of knowledge structures that are linked in any way in memory. In other words, our usage of these terms is *not* meant in a strict sense as referring to memory structures that are established by automatically or unconsciously operating associative learning processes which generate unqualified or uninterpreted links between concepts (e.g., the referential learning model; Baeyens, Eelen, Vandenbergh, & Crombez, 1992; De Houwer, Thomas, & Baeyens, 2001). While we do not denounce the possibility of such processes operating, the current research is equally open to the possibility that these memory structures would be generated by propositional reasoning processes and contain qualifiers about the relation between CS and US (Mitchell, De Houwer, & Lovibond, 2009).

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