Approach –Avoidance Training effects are Moderated by Awareness of Stimulus-Action Contingencies

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Abstract

Prior research suggests that repeatedly approaching or avoiding a stimulus changes the liking of that stimulus. In two experiments, we investigated the relationship between, on the one hand, effects of approach-avoidance (AA) training on implicit and explicit evaluations of novel faces and, on the other hand, contingency awareness as indexed by participants' memory for the relation between stimulus and action. We observed stronger effects for faces that were classified as contingency aware and found no evidence that AA training caused changes in stimulus evaluations in the absence of contingency awareness. These findings challenge the standard view that AA training effects are (exclusively) the product of implicit learning processes, such as the automatic formation of associations in memory.

Keywords: approach, avoidance, training, contingency awareness, implicit attitudes

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Actions of approach and avoidance (AA) are assumed to be closely linked to the evaluation of a stimulus as good or bad. First, evaluative stimuli are thought to automatically evoke approach (in the case of positive stimuli) or avoidance responses (in the case of negative stimuli; e.g., Chen & Bargh, 1999; but see Rotteveel et al., 2015). Second, AA movements have also been used to change the evaluation of stimuli. For instance, Kawakami, Phills, Steele, and Dovidio (2007) demonstrated that participants who repeatedly approached photographs of Black people exhibited more positive evaluations of Black people on the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) than participants who repeatedly avoided photographs of Black people. Recent research indicates that AA training causes changes in the evaluations of a variety of well-known stimuli, such as familiar alcoholic drinks (Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011), insects and spiders (Jones, Vilensky, Vasey, & Fazio, 2013), or contamination-related objects (Amir, Kuckertz, & Najmi, 2013).

Researchers have considered whether AA training procedures can also be used to establish evaluations of novel stimuli. Woud, Becker, and Rinck (2008) reported that participants who repeatedly performed AA movements in response to pictures of faces with neutral emotional expressions exhibited a preference for approached faces on an implicit measure of evaluation (the evaluative priming task; Fazio, Sanbonmatsu, Powell, & Kardes, 1986). A growing number of studies have provided evidence that AA training causes changes in implicit (e.g., Woud, Maas, Becker, & Rinck, 2013) and explicit evaluations (e.g., Huijding, Muris, Lester, Field, & Joosse, 2011; Laham, Kashima, Dix, Wheeler, & Levis, 2014) of novel stimuli. Vandenbosch and De Houwer (2011), however, failed to find any evidence for AA training effects on evaluations of novel faces in five experiments and failed to reproduce the effect reported by Woud et al. (2008) when reanalyzing their data, suggesting that AA training effects may be subject to subtle boundary conditions or moderators that yet have to be identified.

The aim of the present study was to investigate the role of one possible moderator, namely contingency awareness. The role of contingency awareness has been an important topic in research on the acquisition of preferences via conditioning procedures. In evaluative conditioning (EC) studies, neutral conditioned stimuli (CSs) are repeatedly paired with positive or negative unconditioned stimuli (USs), resulting in changes in liking of the CSs. Some have argued that EC differs from other variants of conditioning in that EC can occur in the absence of conscious awareness of the contingency between CS and US (e.g., Baeyens, Eelen, & van den Bergh, 1990; Olson & Fazio, 2001). However, a number of studies have challenged this view and provided evidence that EC effects can be observed only when participants are able to report the contingency between CS and US (e.g., Pleyers, Corneille, Luminet, & Yzerbyt, 2007; Gast, De Houwer, & De Schryver, 2012). Though there is still debate about the necessity of the awareness of the CS-US contingencies in EC effects (see for instance, Hütter, Sweldens, Stahl, Unkelbach, & Klauer, 2012), there is general consensus that contingency awareness is an important moderator of EC effects (Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010; Sweldens, Corneille, & Yzerbyt, 2014).

AA training effects resemble EC effects in that a change in liking is observed that results from a contingency between a neutral stimulus and a valenced event. Whereas in EC studies, the valenced event is typically conceived of as the presentation of a stimulus (De Houwer, 2007; but see Gast & Rothermund, 2011), in AA studies the valenced event corresponds to the execution of a valenced action (De Houwer, 2007). Hence, the role of contingency awareness can be studied also in AA training research. Examining this issue is bound to have important theoretical implications. Most importantly, traditional associative theories of AA training imply that contingency awareness might not be critical. These accounts postulate that AA behavior activates specific AA motivational orientations (Cacioppo, Priester, & Berntson, 1993; Markman & Brendl, 2005; Neumann & Strack, 2000). AA training effects are thought to arise as a result of the gradual formation of an association between the activated motivational state and the stimulus representation (Woud et al., 2013). In line with the idea that approach and avoidance are primitive behavioral tendencies that are tightly linked with an impulsive, associative system (Strack & Deutsch, 2004), these accounts attribute AA training effects to automatic associative processes. From this perspective, the processes underlying AA training effects might differ from those involved in EC in that they provide a more low-level route to changing stimulus evaluations. Attesting to the dominance of this low-level associative view on AA training, factors that indicate the involvement of high-level controlled processes, such as participants' awareness of the contingency between the AA action and the stimulus, have received little or no attention in AA training research.

There are, however, reasons to believe that contingency awareness is a key factor in establishing AA training effects. First, AA training procedures that allow participants to become aware of the stimulus-action contingencies typically produce more robust AA training effects. Effects of AA training are consistently reported when participants receive instructions about the crucial stimulus-action contingencies (e.g., Kawakami et al., 2007) or when the target stimuli or stimulus features (i.e., the stimuli or stimulus features whose valence is registered and targeted for change) are specified in the instructions (e.g., Wiers et al., 2011). In contrast, when targets are not specified in the instructions, effects sizes tend to be small at best. In the studies by

Vandenbosch and De Houwer (2011), for instance, AA training consisted of the repeated approach or avoidance of individual stimuli (i.e., pictures of 12 novel faces). Importantly, these faces had a subtle brown or red filter placed over them and participants were instructed to approach or avoid on the basis of the color of the presented face. Unbeknownst to the participants, some stimuli were always presented in the to-be-approached color whereas other stimuli were always presented in the to-be-avoided color. The fact that the target feature of the stimuli (i.e., stimulus identity) was not specified in the instructions probably reduced the chance that participants realized that there were specific stimulus-action contingencies and thus that they identified those contingencies (e.g., approach Face 1, avoid Face 2, …). The lack of contingency awareness could have been responsible for the lack of AA training effects. Finally, in a recent study by Laham et al. (2014), participants repeatedly performed AA actions in response to unfamiliar shapes, which resulted in a preference for the approached stimuli. Importantly, this effect was observed only if participants performed the AA movements in a motivating context (i.e., collecting or discarding fruits in a foraging context). As a possible explanation for their results, the authors suggested that elaborated framing instructions increased the likelihood that participants became aware of the stimulus-action contingencies.

A second line of research that points at the importance of contingency awareness in AA training focused on the effects of instructions. In a recent set of studies that were conducted at our laboratory, we observed typical AA training effects even when participants did not perform AA actions but were merely instructed that they would later on have to perform these actions (Van Dessel, De Houwer, Gast, & Smith, 2015). Participants who received instructions to approach one fictitious social group (e.g., Niffites) and avoid another fictitious social group (e.g., Luupites) exhibited a preference for the former group both on implicit and explicit measures of evaluation.

These findings suggest that the acquisition of conscious propositional knowledge about stimulus-action regularities can cause changes in liking. Although these findings do not allow for the conclusion that all AA training effects are based on conscious propositional knowledge, they at least support the idea that the acquisition of contingency information can be an important factor also during regular AA training.

In the present studies, we used a variant of the procedure introduced by Woud et al. (2008) that allowed us to investigate effects of AA training on implicit and explicit evaluations of novel faces. More specifically, we used both a correlational and an experimental approach to address the importance of contingency awareness in AA training effects. First, we tried to capture participants' awareness of the experienced face-action contingencies by measuring participants' memory about the relation between faces and actions. We compared AA training effects for faces that were correctly linked to the action they were paired with, faces that were linked to the incorrect action, and faces for which participants did not remember the correct action. Second, in our first study, we manipulated contingency awareness by providing one group of participants with instructions that specified the face-action contingencies whereas a second group did not receive these instructions. We examined whether this manipulation caused changes in contingency awareness and whether these changes affected AA training effects.

Experiment 1

Method

Participants. Sixty-three native Dutch-speaking undergraduates (51 women) participated in exchange for a monetary reward of 5 euros. All participants had normal or corrected-to-normal vision and were naive with respect to the purpose of the experiment. We excluded the data from one participant whose error rate in the evaluative priming task was more than 2.5 standard deviations above the population mean (population mean = 5.41 %, *SD* = 4.01%).

Apparatus and Materials. Eight photographs of faces (four men and four women) served as stimuli[1]. Pictures were selected from the Radboud Faces Database on the basis of a validation study conducted by Langner et al. (2010) in which participants indicated the emotional expression of the face by choosing between nine possible expressions and provided ratings for valence of the face on a five-point Likert scale ranging from “1” (negative) to “5” (positive). Two selection criteria were used. First, the emotional expression of the face was correctly identified as neutral (i.e., more than 85 % correct identifications) in the validation study. Second, the mean rating for the valence of the face was near the nominal midpoint of the rating scale (range: 2.85 – 3.25).

In the evaluative priming task, four positive words (the Dutch words for HAPPY, HONEST, NICE, and SINCERE), and four negative words (the Dutch words for MEAN, BRUTAL, AGGRESSIVE, and FAKE) were presented as target stimuli. The eight faces were used as primes. All words were presented in uppercase letters in Arial Black font with font size 36.

The experiment was programmed in C-language and presented using the C-library Tscope package (Tscope 1.0.171.) on a Tori PC with a 19-inch monitor (80 Hz refresh rate), a keyboard and a joystick (Wingman Attack 2) attached to it.

Procedure. After participants had given informed consent, they were seated in front of a computer screen on which instructions for the AA training task appeared. Participants were informed that they would see pictures of different faces and that they would have to make a

[1] To increase the possibility that participants would identify some of the stimulus-action contingences we used a smaller number of evaluative stimuli than Woud et al. (2008).

certain action each time a picture was presented, depending on the color of the frame that was presented around the picture. Half of the participants were told that they would have to approach photos that had a blue frame by pulling the joystick towards them and avoid photos with a green frame by pushing the joystick away from them. The other half received the opposite instructions. Orthogonal to this manipulation, participants were randomly assigned to receive instructions about stimulus-action contingencies or no contingency instructions. Participants in the 'contingency instructions group' were shown the eight faces they would see during the task and were told which four faces they would approach and which four faces they would avoid. They were asked to make sure that they would not forget which action belonged with each face. Participants assigned to the 'no contingency instructions group' were merely shown the eight faces they would see during the task without any information about face –action contingencies.

The AA training task consisted of two blocks of 96 trials. During each training block, each of the eight faces was presented on 12 trials and was always presented with either a blue or a green frame, indicating that it had to be approached or avoided. For each participant four faces were always approached and four faces were always avoided. We randomized the assignment of faces to the approach or avoidance action. Each trial started with the presentation of a white fixation cross presented in the centre of the screen. After 500 ms the fixation cross was replaced by the picture of a face surrounded by a colored frame. This picture was randomly presented in four different sizes (i.e., 6.08 cm high x 4.56 cm wide; 6.40 cm high x 4.80 cm wide; 6.72 cm high x 5.04 cm wide; 7.04 cm high x 5.28 cm wide) to prevent participants from performing the task by focussing on a specific point on the screen in order to process the color of the frame, thereby limiting picture content processing (see Huijding & De Jong, 2005). The face disappeared as soon as participants responded correctly with the joystick by performing a vertical movement towards the screen or away from the screen.[2] After 200 ms the next trial started. Note that Woud et al. (2008) included a phase in which participants performed both approach and avoidance movements in response to each stimulus. This provided an additional index of learning because it allowed Woud et al. to check whether performance was better on trials that respected the initial stimulus-action contingencies. We decided not to include such a phase in order to allow participants to experience a perfect contingency between face and action and to increase the possibility that participants would identify these contingencies.

In the evaluative priming task, participants categorized target words as either "positive" or "negative" using the ‘E’ and ‘I keys of a computer keyboard. The assignment of the response keys to either the positive or negative category was counterbalanced across participants. Participants were instructed to perform this categorization task as quickly as possible, while making as few mistakes as possible. Participants were further told that they would see pictures of faces presented before the words and that they could look at these pictures, but that their task was simply to respond on the basis of the valence of the positive or negative word. A single trial consisted of a fixation cross presented for 500 ms, a blank screen for 500 ms, a face for 200 ms (i.e., prime), a post-prime pause of 50 ms, and the target word in white font for 1500 ms or until participants had given a response. Error feedback was presented on the screen (i.e., the Dutch word for ‘Wrong’ presented in red font) for 250 ms if participants made an error. The inter-trial interval was set to vary randomly between 500 ms and 1500 ms. Participants completed 128 trials separated into four blocks of 32 trials, each containing two trials with each of the faces as prime and a positive or negative word as target presented in random order.

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[2] In contrast to the procedure by Woud et al. (2008), performing the AA action resulted in the immediate disappearance of the stimulus. We decided not to include a zoom effect (i.e., an effect where pictures become smaller while pushing and larger while pulling the joystick) on the basis of an initial study with 20 participants where we observed a significant AA training effect only when the training did not involve a zoom effect.

After the priming task, we registered explicit evaluations of the faces. Participants indicated whether they liked the person in the photo and whether they thought the person in the photo was friendly on two nine-point Likert scales (0 = not liked at all/not friendly at all; 8 = liked a lot/very friendly). For each face, we collapsed these score ratings into one explicit rating score by averaging the respective ratings. The internal consistency of this measure was moderate (mean Cronbach’s Alpha = .62, SD = 0.12).

Participants then completed questions assessing awareness of the stimulus-action contingencies. Each of the faces was presented in a random order. Participants were asked to indicate what action they had performed most often in response to this picture by choosing from three options (i.e., approach’, ‘avoid’, or ‘both actions the same number of times’). Participants were asked to report their confidence in each of their answers on a 3-point Likert scale ranging from 1 (i.e., unsure) to 3 (i.e., very sure).

Results

Contingency awareness. On average, participants in the contingency instructions group selected the correct action for 77% of the faces (SD = 27%). Participants who had not received contingency instructions indicated the correct action for fewer faces (M = 54%, SD = 27%), $t(60)$ = 3.34, p =.001. In contrast, participants in the no contingency instructions group indicated more often that they had performed both actions an equal number of times in response to the face stimulus (contingency instructions: M = 8%, SD = 12%; no contingency instructions: M = 26%, SD = 27%), $t(60)$ = -3.44, p =.001. We observed no significant differences in the number of times participants chose the incorrect action (contingency instructions: M = 15%, SD = 23%; no contingency instructions: M = 20%, SD = 15%), $t(60)$ = -0.91, p =.37. Importantly, participants in both the contingency instructions and the no contingency instructions group correctly identified the action more often than they chose the incorrect action, *ts* > 5.68, *ps* < .001, indicating that they were able to identify some of the stimulus-action contingencies.

Linear mixed effects models analysis. The analyses of the explicit rating scores and evaluative priming task data were performed with item-based linear mixed effects models (multilevel model analysis) as implemented in R package lme-4 (Bates, Maechler, Bolker, & Walker, 2014). Linear mixed effects models allow us to base the analyses on items (rather than participants' means) and simultaneously control for random effects of participants and items while assessing relevant (fixed) factors of interest (Baayen, Davidson, & Bates, 2008; Hoffman & Rovine, 2007; Locker, Hoffman, & Bovaird, 2007). Linear mixed effects regression (lmer) analyses are preferred over standard analyses of variance (ANOVA) in studies that use item-based analyses of awareness because they are better able to deal with unbalanced data (see also Gast et al., 2012). In our study, they prevent the substantial data loss that would result from analysing the influence of the contingency awareness factor with a repeated measures ANOVA because for many participants at least one of the cells involving the interaction between contingency awareness and AA action was empty.

Evaluative priming task. In line with standard procedures for analyzing evaluative priming reaction time data (e.g., Spruyt, De Houwer, & Hermans, 2009), trials with an incorrect response were dropped (4.8 %) as well as any trials in which reaction times (RTs) were at least 2.5 standard deviations removed from an individual's mean (2.8 %). To perform the lmer analysis on evaluative priming task RTs we defined a model with the grouping variables *Participant* and *Target Word* as random factors. The random effect of *Face* was not included in the model because including this factor did not significantly improve model fit, *p* > .99.

To find out whether a standard AA training effect was obtained, we tested a model that contained Prime Face Type (approached, avoided), Target Type (positive, negative) and Contingency Instructions (yes, no) as fixed factors. We observed a main effect of Target Type, $\chi^2(1) = 4.82$, $p = .028$, indicating that participants were faster to respond to positive target words ($M = 560$, $SD = 140$) than to negative target words ($M = 587$, $SD = 154$). More importantly, this main effect was qualified by an interaction effect of Prime Face Type and Target Type, $\chi^2(1) = 8.62$, $p = .003$. RTs on trials with a positive target and approached face prime ($M = 556$, $SD = 141$) were faster than RTs on trials with a positive target and avoided face prime ($M = 563$, $SD = 139$), $\chi^2(1) = 3.36$, $p = .067$, 95 % confidence interval (CI) = [-14.16, 0.47], whereas RTs on trials with a negative target were slower when the prime was an approached face ($M = 592$, $SD = 159$; avoided face: $M = 582$, $SD = 150$), $\chi^2(1) = 5.40$, $p = .020$, 95% CI = [1.48, 17.37]. We observed no main or interaction effects involving the Contingency Instructions factor, $\chi^2 s < 0.59$, ps > .44.

To investigate the role of contingency awareness, we added a Contingency Awareness factor to our model. For each participant, we classified each face as contingency aware, contingency indiscriminate (i.e., faces for which participants had indicated they had performed both actions an equal number of times) or contingency reversed[3]. This analysis corroborated the main effect of Target Type, $\chi 2(1) = 5.18$, $p = .023$. However, we did not observe a significant interaction effect of Prime Face Type and Target Type, $\chi^2(1) = 1.78$, $p = .18$. Importantly, the predicted three-way interaction effect Prime Face Type x Target Type x Contingency Awareness was significant, $\chi^2(2) = 8.31$, $p = .016$ (Table 1). Further inspection of this interaction, showed that the two-way interaction effect of Prime Face Type and Target Type was significant only for

[3] This classification was based on participants’ responses to the question what action they had performed most often in response to a face. Note that this question actually registers participants’ memory of co-occurrences between action and stimuli, which is merely an indication of participants’ contingency awareness (see Gast et al., 2012).

trials with contingency aware faces, $\chi^2(1) = 10.91$, $p < .001$, indicating faster RTs on positive target trials with approached primes (*M* = 546, *SD* = 134) than with avoided primes (*M* = 554, *SD* = 133), $\chi^2(1) = 4.53$, $p = .033$, 95 % CI = [-17.99, -0.74], and slower RTs on negative target trials with approached primes (*M* = 586, *SD* = 161) than with avoided primes (*M* = 569, *SD* = 144), $\chi^2(1) = 4.63$, $p = .031$, 95 % CI = [0.96, 20.39]. This interaction effect was not observed on trials with contingency indiscriminate faces, $\chi^2(1) = 2.01$, $p = .16$, or contingency reversed faces, $\chi^2(1) = 1.72$, $p = .19$. For contingency reversed faces, however, we did observe a Prime Face Type x Target Type x Contingency Instructions interaction effect, indicating that only participants who had received contingency instructions exhibited a Prime Face Type x Target Type interaction effect, $\chi^2(1) = 4.75$, $p = .029$. However, post-hoc tests showed that for these faces participants who had received contingency instructions were significantly faster on *negative* target trials with approached primes (*M* = 614, *SD* = 153) compared to avoided primes (*M* = 671, *SD* = 202), $\chi^2(1) = 5.49$, $p = .019$, 95 % CI = [-82.70, -7.34], but not on positive target trials with approached primes (*M* = 620, *SD* = 187; avoided primes: *M* = 629, *SD* = 163), $\chi^2(1) = 0.85$, $p = .36$, 95 % CI = [-58.41, 21.84], indicating a preference for avoided faces. This Prime Face Type x Target Type x Contingency Instructions interaction effect was observed only for contingency reversed faces, and produced a four-way interaction effect, $\chi^2(2) = 11.06$, $p = .004$. All other main or interaction effects were non-significant, $\chi^2s < 0.59$, *p*s > .44.

Explicit rating scores. We defined a model with the grouping variables *Participant* and *Face* as random factors. To find out whether a standard AA training effect was obtained, we tested a model that contained only Face Type (approached, avoided) and Contingency Instructions (yes, no) as fixed factors. This revealed a main effect of Face Type, $\chi^2(1) = 14.30$, $p < .001$, indicating that participants preferred approached faces (*M* = 4.03, *SD* = 1.28) over avoided faces (*M* = 3.68, *SD* = 1.27), 95 % CI = [0.17, 0.55]. Similar to the results for evaluative priming RTs, we observed no main or interaction effects involving the Contingency Instructions factor, χ^2s < 0.07, *ps* > .79.

Analyses on the model that included the Contingency Awareness factor did not corroborate the main effect of Face Type, $\chi^2(1) = 0.09$, *p* = .76, but did show a significant interaction effect of Contingency Awareness and Face Type, $\chi^2(2) = 17.74$, *p* < .001 (Table 2). To investigate this interaction, we performed separate analyses for faces in each of the three different awareness categories. These analyses revealed a significant main effect of Face Type for contingency aware faces, $\chi^2(1) = 25.34$, *p* < .001, indicating a preference for approached faces (*M* = 4.26, *SD* = 1.31) over avoided faces (*M* = 3.47, *SD* = 1.33), 95 % CI = [0.40, 0.90]. The main effect of Face Type was not significant for contingency indiscriminate faces, $\chi^2(1) = 0.38$, *p* = .54. For contingency reversed faces we observed a marginally significant main effect of Face Type, $\chi^2(1) = 3.62$, *p* = .057. In contrast to the effect for contingency aware faces, participants preferred the avoided faces (*M* = 4.16, *SD* = 1.04) over approached faces (*M* = 3.35, *SD* = 1.19), 95 % CI = [-0.81, 0.01]. We observed no other main or interaction effects, χ^2s < 1.08, *p*s > .29. [4]

Discussion

Experiment 1 provided clear evidence that AA training caused changes in implicit and explicit evaluations of novel faces. Most importantly, however, our data indicate that contingency awareness is an important moderator of these AA training effects. Specifically, item-based

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[4] Both the evaluative priming task RTs and explicit rating scores were also analyzed with a standard repeated measures ANOVA. The results were similar to the reported effects with the exception that the interaction effect of Face Prime Type x Target Type x Contingency Awareness was not significant for the evaluative priming task RTs. In contrast to the lmer-analyses, we observed a marginally significant AA training effect for contingency indiscriminate faces. However, this analysis involved the data of only 25 participants because most participants did not have both an approached and an avoided face for which they indicated that both actions were performed an equal number of times. Because lmer analyses include all available data, while controlling for by-subject and by-item variation, we believe that these analyses provide more reliable information about the absence or presence of AA training effects and the factors that moderate these effects.

analyses of awareness showed that participants exhibited a preference for approached faces over avoided faces only if they were able to correctly identify what action the stimulus had been paired with. In contrast, our manipulation of contingency awareness, which involved providing participants with information about the stimulus-action contingencies, failed to produce any evidence that contingency awareness influenced AA training effects even though the manipulation did influence measured contingency awareness.

Because our item-based analyses indicated that contingency awareness moderated AA training effects, it seems strange that AA training effects were not enhanced for participants who received contingency instructions. Some aspects of our data provide us with information that may help explain this data pattern. First, participants who did not receive contingency information correctly identified the face-action contingency above chance level. This indicates that, even in AA training studies where the target feature of the stimuli (e.g., identity) is task-irrelevant, participants can identify some of the stimulus-action contingencies. Consequently, contingency awareness may have influenced AA training effects even for participants who did not receive contingency information. The between-subjects analyses may simply have lacked the power to identify an added effect of instructions. In contrast, our contingency awareness analyses allowed us to gain more power because awareness was based on items rather than on participants (see Pleyers et al., 2007, for an argumentation why such item-based contingency awareness analyses are methodologically more sound than participant-based analyses). Second, participants who received contingency instructions exhibited an implicit preference for avoided faces over approached faces if they had incorrectly remembered the face-action contingencies. Because this contrast effect reduces the overall AA training effect and because this contrast effect occurred only if participants receive contingency instructions, this may have impeded the detection of a stronger overall AA training effect for participants who received contingency instructions compared to participants who did not receive contingency instructions.

In Experiment 1, we observed a preference for approached faces only if participants indicated correct awareness for the stimulus-action contingencies. This suggests that AA training effects occur only in the presence of contingency awareness. However, an alternative explanation is that our item-based contingency awareness measure was biased towards the conclusion that AA training requires awareness because participants relied on their liking of the stimulus to answer the contingency awareness questions (see Hütter et al., 2012). Contingency awareness questions asked participants to indicate whether they most often performed (a) approach actions, (b) avoid actions or (c) both actions an equal number of times in response to a face stimulus. The questions did not include a response option with which participants could indicate that they did not remember or had not identified the stimulus-action contingencies. In the absence of contingency awareness, this may have encouraged participants to search for other information that could help them answer these questions, including their liking of the stimuli. Importantly, what participants like could have been influenced by the (unconscious effects of) AA training. Hence, participants would select the correct response on the contingency awareness questions if they would select the response that has the same valence as the stimulus (i.e., select “approach” for liked stimuli and “avoid” for disliked stimuli). These responses would, however, not indicate actual contingency awareness but unconscious effects of AA training on liking (see Bar-Anan, De Houwer, & Nosek, 2010, and Hütter et al., 2012, for a similar argument in the context of EC).

Experiment 2

In Experiment 2, we sought to extend the findings in Experiment 1 in three ways. First, to reduce the possibility that participants base their answers to the contingency awareness questions on other information, we provided participants with the opportunity to indicate that they did not know the stimulus-action contingency. Second, we counterbalanced the order of the evaluative priming task and the explicit rating task to exclude the possibility that performing the implicit evaluation task first, changed the effects on explicit evaluations (see Perugini, Richetin, & Zogmaister, 2014). Third, to focus and allocate test power to the question whether contingency awareness moderates AA training effects even if participants are never told that contingencies between stimuli and actions exist, none of the participants received any contingency information.

Method

Participants. A total of 64 native Dutch-speaking undergraduates participated in Experiment 2 (51 women). The data from two participants were discarded because their error rate in the evaluative priming task was more than 2.5 standard deviations above the population mean (population mean = 4.44 %, *SD* = 3.01%).

Procedure. Experiment 2 was identical to Experiment 1 except for the following changes. First, none of the participants received instructions specifying the stimulus-action contingencies. Second, subsequent to performing the AA training task, half of the participants first performed the evaluative priming task and then completed the explicit ratings. The other participants completed the explicit rating task before the evaluative priming task. Third, participants could choose between four response options for answering the contingency awareness questions (i.e., ‘approach’, ‘avoid’, ‘I don’t know’, or ‘both actions the same number of times’).

Results

Contingency awareness. In line with Experiment 1, participants selected the correct action (*M* = 49%, *SD* = 27%) more often than the incorrect action (*M* = 19%, *SD* = 17%), $t(61) = 6.58$, $p < .001$. On average, participants indicated they did not know the correct action for 9% of the faces (*SD* = 14%) and indicated they had performed both actions an equal number of times for 22% of the faces (*SD* = 27%).

Evaluative priming task. We first performed an lmer analysis on RTs in the evaluative priming task. We defined a base model that included Target Type, Prime Face Type, and Task Order as fixed factors and *target word* and *subject* as random effects. In line with Experiment 1, we observed a main effect of Target Type, $\chi^2(1) = 4.72$, $p = .030$, indicating that participants were faster to respond to a positive target, as well as the crucial interaction effect of Prime Face Type x Target Type, $\chi^2(1) = 5.75$, $p = .017$. Participants were faster on trials with positive target and approached face (*M* = 531, *SD* = 115) than on trials with positive target and avoided face (*M* = 538, *SD* = 125), $\chi^2(1) = 4.72$, $p = .030$, 95% CI = [-12.97, -0.67], whereas no significant differences were found for trials with negative targets (approached face: *M* = 563, *SD* = 129, avoided face: *M* = 560, *SD* =129), $\chi^2(1) = 1.77$, $p = .18$, 95% CI = [-2.17, 11.33]. We observed no other effects, $\chi^2s < 1.29$, *p*s > .25.

In our second model, we included the Contingency Awareness factor (contingency aware, contingency reversed, contingency indiscriminate). Faces for which participants had indicated that both actions were performed an equal number of times and faces for which they had indicated that they did not know which action the face had been paired with, were collapsed in these analyses to reduce the number of empty cells for ‘contingency indiscriminate’ faces. The main effect of Target Type remained significant, $\chi^2(1) = 5.00$, $p = .025$, whereas the interaction effect of Target Type and Prime Face Type, $\chi^2(1) = 3.07$, $p = .080$, was only marginally significant. We observed an interaction effect of Target Type and Contingency Awareness, $\chi^2(2) = 6.24$, $p = .044$, indicating that the main effect of Target Type was larger for contingency reversed and contingency doubt faces than for contingency aware faces. Most importantly, we also found a marginally significant three-way interaction effect Target Type x Prime Face Type x Contingency Awareness, $\chi^2(2) = 5.17$, $p = .075$ (Table 3). Similar to Experiment 1, separate analyses revealed a significant Target x Prime interaction effect for contingency aware faces, $\chi^2(1) = 9.74$, $p =.002$, indicating faster RTs on positive target trials with approached primes (*M* = 529, *SD* = 116) than with avoided primes (*M* = 539, *SD* = 131), $\chi^2(1) = 6.41$, $p = .011$, 95% CI = [-22.10, -2.82], and slower RTs on negative target trials with approached primes (*M* = 551, *SD* = 119) than with avoided primes (*M* = 561, *SD* = 121), $\chi^2(1) = 2.64$, $p = .10$, 95% CI = [-1.66, 17.77]. We did not observe a significant interaction effect for contingency indiscriminate faces, $\chi 2(1) = 0.20$, $p = .65$, or contingency reversed faces, $\chi^2(1) = 0.55$, $p = .46$. We observed no other main or interaction effects, $\chi^2 s < 0.50$, *p*s > .47.

Explicit rating scores.. The base model for analyzing participants' explicit rating scores (internal consistency: mean Cronbach's Alpha = .84, *SD* = 0.04) included *Face* and *Participant* as random factors and Face Type (approached, avoided) and Task Order (evaluative priming task first, explicit rating task first) as fixed factors. This revealed only a main effect of Face Type, $\chi^2(1) = 7.41$, $p = .007$. Participants liked approached faces (*M* = 3.87, *SD* = 1.31) better than they liked avoided faces (*M* = 3.61, *SD* = 1.27), 95% CI = [0.08, 0.46]. No other effects were observed, χ^2s < 0.96, *ps* > .32.

When we added the Contingency Awareness factor to the model, the main effect of Face Type was not significant, $\chi^2(1) = 1.46$, $p = .23$. Importantly, we again observed a significant interaction effect of Face Type and Contingency Awareness, $\chi^2(2) = 23.13$, $p < .001$ (Table 4). A significant effect of Face Type was observed for contingency aware faces, $\chi^2(1) = 25.00$, $p < .001$, showing that approached faces were preferred (*M* = 4.28, *SD* = 1.29) over avoided faces (*M* = 3.44, *SD* = 1.31), 95% CI = [0.47, 1.07], but not for faces that participants did not indicate a specific action for, $\chi^2(1) = 1.66$, $p = .20$. In line with Experiment 1, a (non-significant) trend for a contrast effect was found for faces participants had indicated the incorrect action for, $\chi^2(1) = 2.64$, $p = .10$. We also observed a main effect of Contingency Awareness, $\chi^2(2) = 6.13$, $p = .047$, indicating that contingency aware faces were liked more than contingency reversed or contingency indiscriminate faces. No other effects were observed, χ^2s < 2.61, *ps* > .27.

Discussion

Experiment 2 corroborated that training to approach or avoid novel faces causes changes in implicit and explicit evaluations of these faces, and that these effects are strongly related to participants' awareness of the stimulus-action contingencies. Even though participants never received any information that the AA training procedure involved specific stimulus-action contingencies, they detected these contingencies at an above chance level. More importantly, AA training effects were observed only for contingency aware stimuli. This data pattern was observed even though participants had the opportunity to indicate that they did not know the contingencies, which renders it less likely that these effects are the result of biases in our contingency awareness measure.

In line with Experiment 1, we found no evidence that AA training effects can arise in the absence of awareness. To further corroborate this, we performed an lmer analysis on the data from both Experiment 1 and Experiment 2. The overall analysis showed the Prime Face Type x Target Type x Contingency Awareness interaction effect for evaluative priming task RTs, $\chi^2(2) = 8.25$, $p = .016$, and the Face Type x Contingency Awareness interaction effect for explicit rating scores, $\chi^2(2) = 38.53$, $p < .001$. To examine these interactions, we calculated indices of the AA effects for contingency aware, contingency reversed and contingency indiscriminate faces. For each type of face an index of the AA effect on implicit evaluation was calculated by subtracting participants' mean response latency for congruent trials (i.e., trials with positive target and approached prime or trials with negative target and avoided prime) from their mean response latency for incongruent trials (i.e., trials with positive target and avoided prime or trials with negative target and approached prime) and an index of AA effects on explicit evaluation was calculated by subtracting participants' mean explicit rating score for avoided faces from their mean explicit rating score for approached faces. In order to test whether these indices differed significantly from zero, we performed one-sample t-tests supplemented with Bayesian analyses. Bayesian analyses were performed according to the procedures outlined by Rouder, Speckman, Sun, Morey, and Iverson (2009). They provide a Bayes Factor that gives an indication of how strongly the data support either the null hypothesis (BF_0; reflecting the absence of a significant effect) or the alternative hypothesis (BF_1; reflecting the presence of a significant effect). BFs smaller than 1, between 1 and 3, between 3 and 10, and larger than 10, respectively designate 'no evidence', 'anecdotal evidence', 'substantial evidence', and 'strong evidence' for either the null or the alternative hypothesis (Jeffreys, 1961). We observed a significant AA effect for contingency aware faces on implicit, $t(103) = 3.97$, $p < .001$, $d = 0.39$, $BF_1 = 164$, and explicit evaluations, $t(103) = 6.52$, $p < .001$, $d = 0.64$, $BF_1 = 3861013$, and a contrast AA effect for contingency reversed faces on explicit, $t(47) = -3.08$, $p = .003$, $d = -0.44$, $BF_1 = 11$, but not implicit evaluations, $t(48) = 0.06$, $p = .95$, $d = 0.01$, $BF_0 = 5$. Importantly, we observed no significant AA effect for contingency indiscriminate faces on implicit, $t(48) = 1.07$, $p = .29$, $d = 0.15$, $BF_0 = 3$, nor explicit evaluations, $t(48) = -0.72$, $p = .48$, $d = -0.10$, $BF_0 = 4$, even though we had sufficient statistical power (power > .80) to detect small to medium effect sizes ($d > 0.35$).[5]

[5] We report power estimates for the t-test analyses and not the lmer analyses because for mixed model analyses the required analytical tools for calculating the sampling distributions in situations where the null hypothesis is false are currently lacking. Because lmer analyses included the data of a larger number of participants who had expressed doubt about at least one of the stimulus-action contingencies (N = 82) and because these analyses control for by-

General Discussion

In two experiments, we observed more positive evaluations of novel faces that were approached compared to faces that were avoided. We consistently found that contingency awareness, assessed by participants' memory for stimulus-action relations, moderated AA training effects on implicit and explicit evaluations. Both participants who received information specifying the stimulus-action contingencies and participants who did not receive contingency information preferred approached faces over avoided faces only if they were able to correctly identify what action they had performed most often in response to the specific face. Providing participants with contingency information via instructions, however, did not significantly influence AA training effects.

The role of contingency awareness in AA training effects

Our data provide the first evidence that contingency awareness moderates effects of AA training. Even though an imperfect measure was used to estimate contingency awareness (i.e., participants' memory for the stimulus-action contingencies), AA training effects were larger when participants reported awareness of the contingencies. This strongly resembles findings in the EC literature that contingency awareness is a potent moderator of EC (see Hofmann et al., 2010; Sweldens et al., 2014). We also found no evidence for unaware effects of AA training. When participants did not identify the stimulus-action contingencies correctly or expressed doubt about the contingencies we did not find a preference for approached faces over avoided faces even though our statistical tests had sufficient power to detect a small to medium sized effect. Bayesian analyses indicated that our data provided substantial evidence that AA training effects do not arise for contingency indiscriminate faces. Nevertheless, caution is warranted when

subject and by-item variation, these analyses had more power to detect a significant effect of small effect size. These analyses also did not reveal a significant AA effect for contingency indiscriminate faces, $\chi 2s < 1.26$, $ps > .26$.

drawing conclusions about the role of contingency awareness in AA training on the basis of our results. Importantly, our evidence is essentially correlational in nature. The liking of a stimulus was influenced by AA training only if participants could report the action that they performed in the presence of that stimulus during training. However, an experimental manipulation of contingency awareness did not influence AA training effects in the expected direction. Correlations do not reveal the direction of causality. Thus, although it is possible that AA training was related to contingency awareness because contingency awareness mediates the impact of training on liking, it is also possible that learning mediates the impact of training on contingency awareness. We will now consider two ways in which AA training could have mediated the changes in contingency awareness.

First, it is possible that the relation between contingency awareness and AA training effects in our study arose because our contingency awareness measure was influenced by the effects of AA training on liking. In EC research, there is a lot of discussion about the usefulness of contingency awareness measures and correlational approaches in general to address questions about contingency awareness (Gawronski & Walther, 2012; Dedonder, Corneille, Bertinchamps, & Yzerbyt, 2014). Most importantly, contingency awareness measures may be contaminated by reconstructive memory processes. That is, participants may complete these measures on the basis of other information, such as their liking of the stimulus (Hütter et al., 2012). Although we cannot completely exclude this alternative explanation, we did try to minimize guessing in Experiment 2 by giving participants the opportunity to indicate that they do not know the contingency. Importantly, we observed a strong relation between AA training effects and contingency awareness also in Experiment 2.

Second, even if the contingency awareness measure did capture contingency awareness rather than changes in liking, it is possible that contingency awareness itself was produced by the same processes that lead to changes in liking. For instance, one could assume that AA training leads to the formation of associations that in their turn produce both changes in liking and contingency awareness (see Lovibond & Shanks, 2002). In such a scenario, any factor that leads to variations in the strength of associations would lead to corresponding changes in both liking and contingency awareness, thus resulting in a correlation between AA training effects and contingency awareness. For instance, participants might have differed in the extent to which they attended the identity of the faces. Participants were asked to respond to the color of the frame surrounding face pictures. Hence, the task did not require that they processed face identity. Assuming that the formation of associations requires attention to the elements that are paired (e.g., Mackintosh, 1975; Wagner, 1981), participants who did pay attention to face identity might have formed stronger face-action associations in memory than participants who did not attend face identity. If association strength determines both changes in liking and contingency awareness, then inter-individual differences in attention to face identity might have resulted in a correlation between AA training effects and contingency awareness. Note, however, that this explanation is at odds with the observation that contingency instructions, which draw attention to the identity of the stimuli, did not cause stronger AA training effects in Experiment 1. Also, Vandenbosch and De Houwer (2011) included a manipulation designed to draw attention to the identity of the faces in four AA training studies, but did not observe an overall effect of training, suggesting that AA training effects critically depend on other boundary conditions.

Although alternative explanations are possible, the fact remains that our results are compatible with the view that AA training effects are mediated by contingency awareness.

Contingency awareness might not only be *sufficient* for AA effects (as indicated by the fact that AA instructions alone can produce changes in liking; Van Dessel et al., 2015), it might also be necessary (as indicated by the fact that, in the current study, we observed changes in evaluations only when participants were able to consciously report the relation between face and action). Nevertheless, the idea that contingency awareness is necessary for AA training effects seems to contradict earlier studies in which AA training effects were observed when AA actions were performed in response to subliminally presented stimuli (Kawakami et al., 2007; Jones et al., 2011). However, in a recent attempt to replicate and extend these findings we failed to find any evidence for subliminal AA training effects (Van Dessel, De Houwer, Roets, & Gast, in press). Moreover, Bayesian analyses indicated that the original studies provided only anecdotal evidence for subliminal AA training effects while our results consistently provided substantial evidence for the absence of subliminal AA training effects. However, given the paucity of studies on this matter, more research is warranted to establish if and under what circumstances AA training causes changes in evaluation in the absence of conscious knowledge of stimulus-action contingencies

Importantly, we did not observe an overall effect of our experimental manipulation of contingency awareness on stimulus evaluations which seems difficult to reconcile with the interpretation of our results as evidence that contingency awareness causes AA training effects. As we previously contended, however, the absence of an effect of contingency instructions may have resulted from (a) a lack of power to detect such an effect in the between-subjects analysis, or (b) the fact that a larger proportion of participants revealed a reversed AA training effect in the contingency instruction group than in the no contingency instructions group. Another explanation might be that contingency instructions have effects other than making participants aware of the contingencies, effects that actually reduce the impact of AA training. For instance, some participants (e.g., participants with high levels of psychological reactance) may follow the goal to control against influences of these contingencies on evaluations. It seems possible that reactant responses might be more common after such instructed compared to merely observed contingencies.

Implications for mental process theories of AA training

The observation that contingency awareness moderates AA training effects seems to contradict the idea that AA training effects depend exclusively on implicit learning processes and does not fit well with current associative accounts of AA training effects. According to these accounts, the gradual formation of associations during action performance influences stimulus liking (e.g., Woud et al., 2013; Phills, Kawakami, Tabi, Nadolny, & Inzlicht, 2011). Because association formation is often considered an automatic process, there is no reason to assume that AA training effects should depend on participants' awareness of the contingencies (Kawakami et al., 2007). To accommodate our results, these traditional accounts of AA training would need to make a number of additional assumptions. First, in addition to automatic association formation, it seems necessary to postulate that another process, which critically depends on contingency awareness, also contributes to AA training effects. Demand compliance may serve as a likely candidate. However, the observation that contingency awareness moderated changes also in implicit evaluations, suggests that participants acquired a genuine preference for the approached stimuli which required contingency awareness (but see De Houwer, Beckers, & Moors, 2007). Second, it seems necessary to assume that the specific AA training procedure we used did not activate the implicit learning process sufficiently (and therefore impeded the detection of AA training effects for stimuli participants did not know the correct action for). For instance, AA training may cause changes in evaluations for contingency indiscriminate stimuli only when the training involves a sufficiently large number of training trials (e.g., because associative learning is a slow and gradual process; Rydell & McConnell, 2006). Support for this was found by Woud et al. (2011) who observed that AA training effects were stronger the more often faces were trained. However, because the addition of training trials may increase the likelihood that participants become aware of the stimulus-action contingencies, these findings could also reflect that AA training effects critically depend on contingency awareness. Also note that in our studies, we used a number of training trials that was comparable to that used in previous studies.

Alternatively, the strong impact that contingency awareness seems to have on AA training effects may be more easily explained by an alternative, propositional account of AA training effects. In line with propositional models of EC (De Houwer, 2009; Hofmann et al., 2010; Mitchell, De Houwer, & Lovibond, 2009), AA training may influence the liking of a stimulus only after participants acquired conscious propositional knowledge about the relation between action and stimulus. Participants may elaborate on this information and infer that the approached stimulus is positive (because they typically approach good things). Once this proposition is formed, this may influence both explicit and implicit stimulus evaluation (see De Houwer, 2014). From this perspective, AA training effects are driven by the acquisition of propositional information rather than by a ‘training’ mechanism that changes evaluations by gradually installing action tendencies to approach or avoid. It is important to note, however, that the current study used only neutral, unfamiliar faces as stimuli. In contrast to these novel stimuli, tendencies to approach or avoid specific well-known stimuli may have been acquired over a long learning history (e.g., spider phobics may have ample experience in avoiding spiders). To change evaluations of well-known stimuli, it may therefore be necessary to repeatedly perform AA actions in response to the stimulus such that the acquired tendencies are gradually re-trained (see Eberl et al., 2014). In line with this idea, we previously found that AA instruction effects were restricted to novel stimuli (Van Dessel et al., 2015). We hope that future research will explore whether contingency awareness is a critical factor also for studies that use AA training as a means of changing stimulus evaluation (e.g., in the treatment of alcohol addiction, Wiers et al., 2011; or social anxiety, Taylor & Amir, 2012).

Concluding remarks

This study indicates that AA training is an important procedure for the acquisition of evaluations of novel stimuli and provides the first evidence that contingency awareness is an important moderator of AA training effects. This conclusion contradicts the prevailing view concerning the automaticity of AA training effects and challenges theories that attribute AA training effects to the automatic acquisition of associations. These results add to recent work showing that various evaluative learning effects which were traditionally assumed to rely on automatic processes, strongly depend on awareness (e.g., EC: Hofmann et al., 2010; the mere exposure effect: de Zilva, Vu, Newell, & Pearson, 2013; mimetic desires: Bry, Treinen, Corneille, & Yzerbyt, 2011). They provide support for recent theoretical accounts that question the involvement of an automatic association-formation mechanism in evaluative learning (e.g., De Houwer, 2009, Mitchell et al., 2009). It should be clear, however, that the issue of (evaluative) learning in the absence of awareness is still far from settled. In order for progress to be made, it is important to continue to carefully validate and replicate findings that do seem to provide evidence for unaware learning (e.g., Rydell, McConnell, Mackie, & Strain, 2006; Hu, Antony, Creery, Vargas, Bodenhausen, & Pallar, 2015). Once reliable evidence has been observed across multiple labs, efforts can start to identify the moderators that determine if and when awareness moderates learning.

However, it is important to repeat that our results provide only correlational evidence for a relation between contingency awareness and AA training. As such, it would be premature to make any conclusive statements about the causal role of contingency awareness in AA training effects. We hope, however, that our findings pave the way for additional AA training studies on the role of contingency awareness in AA training effects. Moreover, our findings point at the possibility that AA training effects are non-automatic in ways other than the need for contingency awareness. For instance, it would be interesting to examine the extent to which AA training effects can be controlled or depend on the availability of attentional resources. Future research on the automaticity features of AA training will provide important new information about the moderators of AA training effects and the mental processes that mediate those effects.

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Table 1.

Mean RTs and AA effects (in ms) in the evaluative priming task in Experiment 1 as a function of Target Type, Prime Face Type and Contingency Awareness.

	Positive Target		Negative Target		AA effect	
	Approached Face	Avoided Face	Approached Face	Avoided Face		
Contingency aware	546 (134)	554 (133)	586 (161)	569 (144)	13	$p < .001$
Contingency reversed	581 (160)	587 (150)	588 (138)	606 (166)	-6	$p = .19$
Contingency indiscriminate	568 (145)	576 (144)	619 (164)	609 (149)	9	$p = .16$

Note. Standard deviations are in parentheses. The AA effect was calculated by subtracting the mean latency of congruent trials (i.e., trials with positive target and approached prime or trials with negative target and avoided prime) from the mean latency of incongruent trials (i.e., trials with positive target and avoided prime or trials with negative target and approached prime).

Table 2.

Mean explicit rating scores and AA effects in Experiment 1 as a function of Face type and Contingency Awareness.

	Approached Face	Avoided Face	AA effect	
Contingency aware	4.26 (1.31)	3.47 (1.33)	0.79	$p < .001$
Contingency reversed	3.35 (1.19)	4.16 (1.04)	- 0.81	$p = .057$
Contingency indiscriminate	3.89 (0.98)	4.03 (1.06)	- 0.14	$p = .54$

Note. Standard deviations are in parentheses. The AA effect was calculated by subtracting explicit rating scores for avoided faces from explicit rating scores for approached faces.

Table 3.

Mean RTs and AA effects (in ms) in the evaluative priming task in Experiment 2 as a function of Target Type, Prime Face Type and Contingency Awareness.

	Positive Target		Negative Target		AA effect	
	Approached Face	Avoided Face	Approached Face	Avoided Face		
Contingency aware	529 (116)	539 (131)	561 (121)	551 (119)	10	*p* = .002
Contingency reversed	534 (116)	529 (113)	563 (126)	550 (113)	4	*p* = .46
Contingency indiscriminate	532 (113)	541 (122)	565 (142)	581 (149)	-4	*p* = .65

Note. Standard deviations are in parentheses. The AA effect was calculated by subtracting the mean latency of congruent trials from the mean latency of incongruent trials.

Table 4.

Mean explicit rating scores and AA effects in Experiment 2 as a function of Face type and Contingency Awareness.

	Approached Face	Avoided Face	AA effect	
Contingency aware	4.28 (1.29)	3.44 (1.31)	0.84	$p < .001$
Contingency reversed	3.54 (1.31)	3.93 (1.33)	- 0.39	$p = .10$
Contingency indiscriminate	3.45 (1.16)	3.70 (1.15)	- 0.25	$p = .20$

Note. Standard deviations are in parentheses. The AA effect was calculated by subtracting explicit rating scores for avoided face from explicit rating scores for approached face.