American Psychological Association

Journal of Experimental Psychology: Animal Learning and Cognition

© 2019 American Psychological Association
2329-8456/19/$12.00

2019, Vol. 45, No. 1, 102–110
http://dx.doi.org/10.1037/xan0000189

Operant Evaluative Conditioning

Andreas B. Eder and Anand Krishna
University of Würzburg

Pieter Van Dessel
Ghent University

Two experiments investigated an evaluative transfer from actions producing pleasant and unpleasant outcomes to novel stimuli that were assigned to those actions in a subsequent stimulus–response task. Results showed that a fictitious social group was liked more when this group was assigned to the action previously associated with pleasant outcomes relative to the other action. This evaluative transfer from operant contingencies was observed although the actions did not generate outcomes during the stimulus–action pairing. It is concluded that operant contingencies can be used for preference construction because they specify the existence of a relation between specific actions and particular valenced events. Implications for mental process theories of preference formation and motivated perception are discussed.

Keywords: preference, evaluative conditioning, operant learning, intersecting regularities

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

Many of our likes and dislikes are not fixed but can be modified through experience and learning of regularities in the environment (Levey & Martin, 1975). Research on so-called evaluative conditioning (EC) has provided much evidence that evaluative responses to a stimulus (the conditioned stimulus, conditional stimulus [CS]) become more (un)favorable after pairing that stimulus with a clearly (un)pleasant stimulus (the unconditioned stimulus [US]; see De Houwer, Thomas, & Baeyens, 2001; Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010). For example, one study paired images of fatty snack foods with images of plausible adverse health consequences, such as cardiovascular disease and obesity. After the repeated pairings, participants evaluated the snacks less favorably and selected them less often in a behavioral choice test relative to healthy foods (Hollands, Prestwich, & Marteau, 2011).

Most EC studies have been run by pairing one stimulus event (presentation of the CS) with another stimulus event (presentation of the US). EC effects in those studies have most often been explained with a mental link or connection between the representation of the CS and the representation of the US after conditioning (e.g., Baeyens, Eelen, Van den Bergh, & Crombez, 1992; Walther, Gawronski, Blank, & Langer, 2009). However, a growing number of studies have also investigated a contribution of response-related processes to EC effects. Gast and Rothermund (2011) argued that if the US triggers an evaluative response, the representation of the CS can become associated with that response during the conditioning phase. This account was supported by an experiment in which participants had to loudly pronounce either the word *likable* or *dislikeable* during presentations of specific neutral faces. Results showed that, after conditioning, faces paired with a likable response were evaluated more positively and faces paired with a dislikeable response were evaluated more negatively in an indirect evaluation task relative to control stimuli that were not paired with an evaluative response. This indicates that the pairing of a stimulus with a valenced response can induce a change in liking, supporting a response-based explanation of EC effects.

Gast and Rothermund (2011) conceptualized an *evaluative response* as an affective expression (e.g., verbal expressions, interoceptions, laughter, or smiling) that is intrinsically related to a valence. However, a recent study has suggested that an evaluative property can also be transferred from a behavioral response to a neutral stimulus when the response becomes extrinsically evaluative by entertaining contingencies with affective stimuli (Blask, Frings, & Walther, 2016). In this study, an evaluative response was first established by asking participants to categorize the affective valence of emotional pictures with presses of left and right response keys on a computer keyboard (i.e., response formation phase). The rationale was that the left and right keypresses would become temporarily associated with the affective valence of the assigned pictures, and would therefore constitute a temporarily positive or negative response (De Houwer, 2003). In a subsequent conditioning phase, participants were asked to categorize neutral stimuli (CSs) using the same responses. Results showed that the CSs assigned to the positive response were liked more relative to the CSs assigned to the negative response. Thus, the evaluative property of the response established during the first phase was transferred to the neutral stimuli during the second phase.

Andreas B. Eder and Anand Krishna, Department of Psychology, University of Würzburg; Pieter Van Dessel, Department of Experimental-Clinical and Health Psychology, Ghent University.

This research was supported by Grant ED 201/3-1 of the German Research Foundation to Andreas B. Eder and a postdoctoral fellowship of the Scientific Research Foundation, Flanders to Pieter Van Dessel. The funding agencies had no role in the study design, collection, analysis, or interpretation of the data; writing the manuscript; or the decision to submit the manuscript for publication.

Correspondence concerning this article should be addressed to Andreas B. Eder, Department of Psychology, University of Würzburg, Röntgenring 10, 97070 Würzburg, Germany. E-mail: andreas.eder@uni-wuerzburg.de

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

A useful framework for the analysis of those results is provided by the intersecting regularities account (Hughes, De Houwer, & Perugini, 2016). According to this framework, there are often specific regularities or relations between elements in the environment, such as a predictive relation between two stimuli (e.g., presentation of a CS consistently followed by presentation of a US), or between an action and its outcome (e.g., instrumental contingencies). Evaluative responses to a specific stimulus can change when this stimulus is part of an environmental regularity that includes an element with evaluative properties (e.g., more positive evaluation of a CS in a predictive relation with a positive US: EC). Importantly, however, evaluative change can also occur when stimuli are part of an environmental regularity that intersects with another regularity (i.e., the first regularity shares a specific element with the second regularity). The shared element could be a stimulus, a behavior, or the outcome of a behavior. Hence, evaluation of a specific stimulus should change when this stimulus is part of a regularity that intersects with a regularity of which one element has specific evaluative properties. From this perspective, neutral CSs assigned to the positive response were liked more in the study of Blask and colleagues (2016) because these CSs had an indirect relation to positive stimuli (US_{pos}) through the intersection with a stimulus–response (S–R) regularity (Regularity 1a: CS $\rightarrow$ R1; Regularity 1b; $US_{pos} \rightarrow$ R1), whereas neutral CSs assigned to the negative response were liked less because they intersected with a S–R relationship involving negative stimuli (Regularity 2a: CS $\rightarrow$ R2; Regularity 2b: $US_{neg} \rightarrow$ R2). Thus, evaluation of the CS changed because it shared a response element with another regularity involving clearly valenced stimuli.

Although the intersecting regularities framework is useful for a functional analysis (i.e., analysis in terms of elements in the environment) of the results of Blask and colleagues (2016), it leaves many questions open. More specifically, it does not specify moderators or boundary conditions of a transfer of valence on the basis of intersecting regularities nor does it indicate why these effects occur (i.e., the mental processes operating on these regularities). In the research of Blask et al., for example, it is plausible that participants learned in the response-formation phase that there was a relation between positive and negative stimuli and left and right keypresses, respectively. Because of having new stimuli assigned to these keypresses in the conditioning phase, participants could have used this relation (either intentionally or unintentionally) for an inference of positivity and negativity of new stimuli assigned to this response via transposition of the relation to the conditioning phase. This inference of valence is likely to depend on specific moderators such as the type of relation between elements that participants register (Van Dessel, Hughes, & De Houwer, 2018). Importantly, the environmental regularities analysis leaves unclear the type of relations that were learned in Blask et al.'s study because, in principle, many relations between stimuli and responses are possible (predictive, correlative, causal, hierarchical, etc.). As a matter of fact, S–R relations can have very different meanings depending on the arrangement of its elements in space and time (De Houwer & Hughes, 2016). Therefore, investigating different types of S–R relations is important to find out what relations allow for an evaluative transfer from responses to stimuli and what processes might underlie these effects.

The Present Research

The present study examined whether evaluative properties can also be transferred from operant contingencies to neutral stimuli (rather than from valenced response categorizations to neutral stimuli as in the study by Blask et al., 2016). In an operant contingency, there exists a regularity between an action and its outcome, and the action is carried out to produce an outcome that has some value for the individual performing that action (Dickinson & Balleine, 1993; Rescorla, 1998). Importantly, an action–outcome contingency not only involves a temporal co-occurrence of the action and the outcome but also a causal relationship between these events: Actions cause the outcome in the sense that the outcome is present after execution of the action and absent after no action. Note that this causal relationship is different from S–R tasks that only specify a sequential order, and not a causal relation, between a stimulus and the production of a particular response. Furthermore, the order of stimulus and action events is reversed in S–R tasks and in instrumental tasks (R–S), which means that it is not possible to simply transpose the learned R-S relation of the instrumental phase of the experiment to another S–R relation in a subsequent (conditioning) phase of the experiment. An evaluative transfer from valenced stimuli involved in an operant contingency (Regularity 1: R1 $\rightarrow$ US) to new stimuli involved in an S–R task that shares the same response (Regularity 2: CS $\rightarrow$ R1) would hence only be possible if the specific order of the stimulus and response elements (and the meaning of this directional information) is not important for an evaluative transfer effect. For instance, participants might learn that R1 and US are related in a specific manner (Regularity 1) and the mere fact that they are related (rather than the specific way in which they are related) might inform change in liking of a stimulus that is related to this response in a different manner (Regularity 2). This was the main hypothesis of the experiments presented in this article.

A previous study from our laboratory showed that actions can become associated with pleasant and unpleasant affect (or the cognitive representation thereof) that is contingent upon the execution of those actions (Eder, Rothermund, De Houwer, & Hommel, 2015). In a first acquisition phase, participants had a free choice between presses of two response keys. The press of one response key consistently produced pleasant images on a computer screen, while the press of the other key consistently produced unpleasant images on the screen. After sufficient training, participants responded to another set of affective stimuli using the same response keys. Responses were faster when the (task irrelevant) affective valence of the new stimuli was congruent with affective valence of the response effect, indicating that the associated affective action effect was anticipated during action selection. This effect was however only observed when the responses continued to produce affective images on the screen. The present experiments extend this research by examining whether affective action consequences that were learned in a first phase of the experiment can be used for an evaluative conditioning of neutral stimuli in a second phase of the experiment.

Two experiments examined whether affective outcomes involved in instrumental response–outcome (R–O) contingencies transfer to evaluations of neutral stimuli (CS) involved in S–R mappings. The study design was a mixture of the study procedures described above. In a first operant conditioning task, participants could freely select between presses of a left and a right key. A press of one key always generated the presentation of pleasant images, while a press of the other key was followed by unpleasant images. In line with the research of Eder and colleagues (2015), we assumed that the keypresses would become associated with the pleasant and unpleasant affects elicited by the generated emotional pictures. Following this phase, participants performed a S–R mapping task similar to the task used by Blask et al. (2016) but this time with categorizations of members of fictitious social groups (Niffites and Luupites). Importantly, the same response keys were used as during the operant conditioning task and members of one group were always categorized with one key, whereas members of the other group were always categorized with the other key. Subsequent to the S–R mapping task, evaluative ratings of group members and a relative, global group rating were collected as dependent measures.

It was hypothesized that the intersecting regularity with a pleasant response outcome ($R1 \rightarrow O_{pos,}$ $CS1 \rightarrow R$) would facilitate positive evaluative responses toward the group linked to the positive outcome key (CS1), whereas the intersection with an unpleasant response outcome ($R2 \rightarrow O_{neg,}$ $CS2 \rightarrow R2_{)}$ would facilitate negative evaluative responses toward the group categorized with the negative outcome key (CS2). Note that this hypothesis requires that the operant contingencies are considered informative of a bidirectional relation between particular keypresses and specific affective events in the absence of directional information ($R \leftrightarrow O$). In contrast, no evaluative transfer effect is expected on the basis of intersecting regularities when participants use the operant contingency as a symbol for a causal relation with a clear direction ($R \rightarrow O$).

For both experiments, the study design, data analysis plan, and the hypotheses were preregistered on the Open Science Framework website prior to data-collection. The preregistered study plans as well as the raw data underlying the findings reported in this article are available at https://osf.io/9fu84/. Any deviation from preregistration is noted in the main text. Three pilot studies with methodological issues and minor programming bugs were additionally conducted that are not included in this article. Their results were in line with the results of the experiments reported below and provided an estimate of a small effect size ($0.28 <$ Cohen's $d < .33$). Sample size was planned prior to the data collections and preregistered together with the study design. The sample size was determined using a sequential Bayes hypothesis testing procedure (Schönbrodt, Wagenmakers, Zehetleitner, & Perugini, 2017). Bayesian tests of an evaluative change in the group and exemplar ratings were performed for the first time after 200 participants were reached (using the JASP 0.8.5.1 software package with default priors; JASP Team, 2018). The critical value of Bayesian tests is the Bayes factor (BF), which indicates the relative likelihood of the observed data under the alternative hypothesis compared to the null hypothesis (BF_{10}). The larger the value of BF_{10}, the stronger the evidence for the alternative hypothesis: for $BF_{10} = 10$, the observed data are 10 times more likely under the alternative hypothesis than under the null hypothesis. The Bayes factor may also be written as BF_{01}, which is the inverse of BF_{10}. Jeffreys (1961) suggests that Bayes factors of higher than 3 in favor of a given hypothesis may be seen as substantial evidence for that hypothesis, whereas higher than 10 may be considered strong, higher than 30 very strong and higher than 100 extreme. Following a sequential Bayesian testing procedure, we increased the sample size by steps of 50 participants until a decisive BF (BF_{10} or BF_{01}) larger than 10 was obtained on a rating measure or until a maximum number of 400 participants was reached. This procedure was used for both experiments. Standard frequentist analyses were performed exclusively after the final sample size was reached.

Experiment 1

Method

Participants. A total of 310 volunteers completed the experiment online via the Prolific Academic website (https://prolific.ac) after providing informed consent. Only English-speaking persons with an age below 50 years were permitted to the study. The experiment was programmed in Inquisit 5.0 and hosted via Inquisit Web (Millisecond Software, Seattle, WA). The study procedure was approved by a local ethics committee The study procedure was approved by the Ethics Committee of the Department of Psychology, University of Würzburg (Reference No. 2013-14).

In line with our preregistered data analysis plan, we excluded data from participants who were outliers in the number of incorrect responses (greater than 20.5% based on a threshold criterion of 1.5 interquartile above the third quartile according to Tukey, 1977) in the S–R transfer task (35 participants) or did not indicate the correct response-outcome contingencies after the operant conditioning phase (14 participants). Analyses were performed on the data of 261 participants (156 women; age $M = 32.1$ years, $SD = 7.8$, range $= 18–49$).

Procedure. Participants worked on the following tasks in this sequence: (1) operant conditioning task, (2) S–R transfer task, and (3) exemplar and relative global group rating task.

Operant conditioning task. In this task, two responses were paired with pleasant and unpleasant response outcomes (presentation of positive or negative pictures). The task procedure was adapted from the study by Eder and colleagues (2015). Participants were instructed to press one of the response keys (*E* and *I*) as quickly as possible following a fixation cross. They could choose freely between the two response keys but they were advised to press the keys in random order and about equally often. A press of one response key always triggered the presentation of a clearly pleasant picture (henceforth called the *pleasant* response key) and a press of the other key always produced a clearly unpleasant picture on the screen (henceforth called the *unpleasant* response key). The assignment of the (un)pleasant pictures to the left and right response keys was counterbalanced across participants. Pictures were 50 pleasant and 50 unpleasant pictures that were selected from the International Affective Picture System (Lang, Bradley, & Cuthbert, 2005) according to their affective norms (for a list with picture identifiers see the preregistration file at OSF or Eder et al., 2015). The resolution of the participant's computer screen was set to 1,024 pixels × 786 pixels and pictures were displayed in full size (1,024 pixels × 786 pixels). Participants were not explicitly informed about the contingencies between the responses and the emotional pictures; rather, task instructions stated that the picture following a key press was irrelevant for the task at hand and should therefore be ignored.

At the start of a trial, a fixation cross appeared for 200 ms at the center of the screen. Then, the program waited up to 2,000 ms for a

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

response. If a response was made, a pleasant or unpleasant picture was presented for 500 ms. In trials with no response, an error message appeared instead of a picture and the trial was repeated. The next trial was initiated after 1.5 s.

Participants worked through four blocks with 50 acquisition trials each. After each trial block, a summary appeared that informed the participant about the ratio of left and right key presses. Following the fourth block, a surprise contingency test was presented that probed the participant's knowledge of the contingencies between keypresses and the emotional content of the pictures following the keypresses. Instructions stated that one of the keys was consistently followed by positive pictures and the participant was asked to press this key. A second question asked participants to press the key that was consistently followed by negative pictures. If an error was made to one of these questions, a fifth and sixth learning block with 50 trials each was presented; thereafter, a final R–O contingency test followed and the participant was scored as being unaware of the R–O contingency if he or she failed this final test.

S–R transfer task. For this task, participants used the pleasant and unpleasant response keys (i.e., *E* and *I*) for categorizations of fictitious social groups. Importantly, keypresses in this phase were not followed by presentations of pleasant and unpleasant pictures. Task instructions stated that participants would see names of members of two social groups called the *Luupites* and the *Niffites*. They could recognize names of Niffites because these names always end with "nif" (e.g., Borrinif, Kenninif) and Luupites' names because these names always end with "lup" (e.g., Loomalup, Ageelup). Instructions were to press one response key when participants saw a Niffites name and the other key when they saw a Luupites name and to respond as quickly and as accurately as possible. The assignment of the pleasant and unpleasant response keys to Niffites and Luupites was counterbalanced across participants. On each trial, a fixation cross was displayed for 200 ms in the center of the screen followed by a Luupite or Niffite name (Helvetica, 20-pt. font). The name was presented until a response was emitted or after 2,000 ms. An error message was shown for an additional 2,000 ms after no or incorrect responses. The next trial started after 500 ms. There were five blocks of eight trials in which each of the four Niffites and Luupites names was presented once in random order. These names were randomly selected from sets of eight Niffites and eight Luupites names (for a list see the preregistration file at OSF). There were no breaks between the trial blocks.

Exemplar ratings. Instructions for this task were to rate the liking of group members of Niffites and Luupites on an eight-level rating scale ranging from -4 (*strongly dislike*) to $+4$ (*strongly like*). Participants rated the eight Niffites and Luupites members whose names were presented during the S–R transfer task, and the eight additional names of Niffites and Luupites that were not shown before. We included new names for exploratory reasons to examine whether the execution of a response to a specific exemplar is necessary for an evaluative change. The group member names appeared in random order on a higher position on the screen with the ratings scale were presented below. A value was selected with the number keys (*1* through *8*) of the keyboard and confirmed with the enter key or by clicking with the computer mouse on the respective buttons of the rating scale.

To promote (and measure) attentiveness during the rating task, four catch trials were randomly intermixed that asked participants to indicate the group membership of the name that was presented in the foregoing trial. Response options were Niffites versus Luupites (forced-choice answer).

Group rating. Instructions for this task were to indicate their preference for the social groups. The rating procedure was similar to the exemplar task but this time the anchors *strongly prefer Niffites* and *strongly prefer Luupites* were presented at the start or end point of the rating scale. The placement of the Niffites/Luupites anchors at the start or end points was determined by chance.

Postexperimental questions. At the end of the session, participants were asked for their recognition of group members ("When you were rating the individual Niffites/Luupites, how did you perceive the individual names?", with four response options: "All of the individual names were new to me"; "Some of the individual names were new to me, some I had seen in the categorization task"; "I had seen all the individual names in the categorization task"; "I'm not sure/don't know"). In addition, they were asked whether they used a specific answer strategy for the exemplar ratings ("On what did you base your ratings of the individual Niffites/Luupites?", with three response options: "On my feelings and thoughts towards the group of Niffites/Luupites and towards the specific name"; "On what I believed the researchers expected/wanted me to indicate"; "Other") and for the relative group rating ("On what did you base your preference rating for the group of Niffites/Luupites?", with three response options: "On my spontaneous feelings and thoughts towards the groups"; "On my average individual ratings of members of each group"; "On what I believed the researchers expected/wanted me to indicate"; "Other"). When the participant selected the response "Other," an open text field appeared for additional elaboration of the answer.

Results

The significance criterion was set to $p < .05$ for all analyses. Greenhouse-Geisser corrected p values are reported with the original degrees of freedom. Standardized effect sizes (Cohen's d, partial eta-square) are reported when appropriate. In line with the task instructions, participants pressed both response keys about equally often during the instrumental training phase (ratio of the pleasant response key: $M = 51.5\%$, $SD = 7.8$, range $= 18–97\%$). Correct performance in the S–R transfer phase was very high ($M = 94.8\%$, $SD = 4.6\%$).

It was hypothesized that the social group that was paired with the pleasant response key in the S–R transfer phase receives higher liking ratings relative to the group that was paired with the unpleasant response key in this phase. The results were in line with this prediction. The relative group ratings were recoded so that higher values indicate a preference for the social group paired with the pleasant response key. A t test against zero produced a significant result ($M = 0.38$, $SD = 2.06$), $t(260) = 2.98$, $p < .01$, $d = .18$, $BF_{10} = 10.32$.

Before analyses of the exemplar ratings, ratings of 23 participants (8.8%) who produced two or more incorrect answers in the catch trials were removed.[1] The mean exemplar ratings were

[1] Our preregistered plan was to remove exemplar ratings of participants who made one or more errors in the catch trials. However, this would have resulted in a substantial data loss (28.4%); therefore, a less strict criterion (2+ errors) was used for the present analysis.

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

entered in a mixed analysis of variance (ANOVA) with social group (Niffites, Luupites) and familiarity (old, new names) as within-subjects factors and response key assignment (Niffites, pleasant key; Luupites, pleasant key) as a between-subjects factor. The main effect of social group was not significant, $F(1, 236) = 3.69$, $p = .056$, $\eta^2 = .015$. More importantly, the interaction between social group and response key assignment was significant, $F(1, 236) = 8.52$, $p < .01$, $\eta^2 = .035$. As shown in Figure 1, Niffites and Luupites were liked more when they were assigned to the pleasant response key during the S–R transfer phase than when they were assigned to the unpleasant response key during this phase. This effect was not influenced by the familiarity with the group member ($F < 1$). Follow-up tests with separate ANOVAs for old and new items revealed a significant interaction effect for old group members, $F(1, 236) = 8.42$, $p < .01$, $\eta^2 = .034$, and for new group members, $F(1, 236) = 7.18$, $p < .01$, $\eta^2 = .030$. In short, an operant EC effect was observed in evaluations of group members that were categorized during the S–R transfer phase; in evaluations of new group exemplars that were not seen before; and in evaluations on a categorical group level (Niffites, Luupites). The operant EC effect was also supported by a corresponding one-tailed Bayesian *t* test of the ratings of group members assigned to the pleasant and unpleasant keys ($BF_{10} = 6.19$).

Additional exploratory analyses examined whether perceived demand characteristics as indicated in the postexperimental questions are related to the EC effect. When asking about a response strategy for the relative group rating, a majority of 182 (69.7%) participants selected spontaneous feelings and thoughts; 43 (16.5%) selected summaries of individual judgments and 12 (4.6%) indicated experimenter's demand as reason for their judgments (the remaining 9.2% selected "Other"). After removal of the 12 participants who indicated experimenter's demand, the operant EC effect in the relative group rating was still significant, $t(248) = 3.01$, $p < .01$, $d = .19$. An analogous exploratory analysis was performed with the exemplar ratings. For these ratings, 187 (78.6%) participants selected feelings and thoughts toward the groups; 17 (7.1%) participants demand characteristics and 34 (14.3%) other reasons. After removal of the 17 participants, the interaction between social group and response key assignment (i.e., the operant EC effect) remained significant, $F(1, 219) = 8.73$, $p < .01$, $\eta^2 = .038$.

Discussion

Results showed more liking of a social group that was assigned to a response that previously produced a pleasant outcome relative to a group assigned to a response that previously produced an unpleasant outcome. This operant evaluative conditioning effect is in line with the intersecting regularities account (Hughes et al., 2016) that predicts an evaluative change when an element (here: a response) is present in two separate regularities (here, a S–R contingency and a response-outcome contingency) and one element in these regularities has certain evaluative properties (here: a valued action outcome). Furthermore, the current experiment provides important new information. First, in contrast to Blask et al. (2016), the relation between the elements in the intersecting regularities was different: affective stimuli were presented as antecedents to responses in Blask et al., whereas they were used as response outcome in our study. Intriguingly, we still observed an intersecting regularities effect, indicating that the presence of a

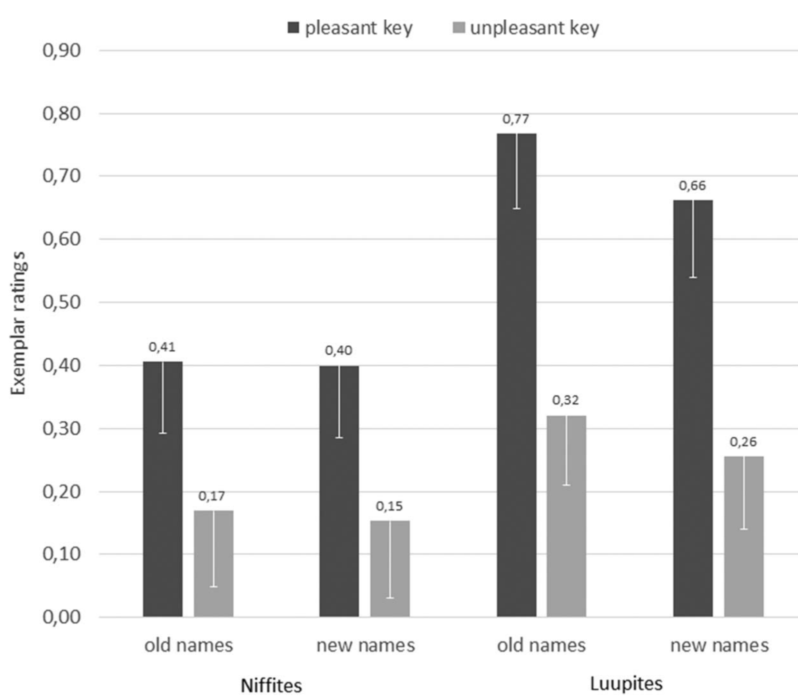

Figure 1. Exemplar ratings in Experiment 1 as a function of social group, item familiarity, and assignment of pleasant and unpleasant response keys in the stimulus–response transfer phase. Error bars show the standard error.

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

relation (rather than the specific type of relation) is important for the observation of these effects. Second, we found that the evaluative transfer generalized to new group members that were not directly paired with the evaluative response, suggesting an indirect transfer to new exemplars on a categorical level. In short, operant contingencies can produce changes in liking by their reference to pleasant and unpleasant action outcomes.

Experiment 2

Although Experiment 1 provided clear evidence for an evaluative transfer from operant contingencies, the role of the performed action for this transfer is less clear. Blask and colleagues (2016, Experiment 2) investigated whether the observed evaluative transfer from an evaluative action was due to a transfer from the left or right hand producing a particular keypress (i.e., the effector) or from the pressed response keys. To disentangle these response components, participants in one condition had to operate the response keys with anatomically crossed hands. Results in this condition showed that the effector, and not the response key, was crucial for the evaluative transfer. The authors concluded from this result that motor features of the response were responsible for the evaluative transfer effect.

However, other studies found strong evidence for interactions with evaluative responses on a cognitive level. For instance, Eder and colleagues observed that a prepared evaluative keypress affects the execution of an affectively congruent, but anatomically different, lever movement (Eder, Müsseler, & Hommel, 2012). They proposed a hypothetical evaluative response code that represents the affective value of the action or action goal, and that can be linked to other stimulus and action events (Eder & Klauer, 2009). Another study disentangled low-level motor features and more abstract, semantic features of a response and found evidence for interactions at both levels of representation (Giesen & Rothermund, 2016). This research suggests that the mental representation of an evaluative response includes both, a representation of low-level motor features and a representation of more abstract, conceptual features of the response (see also Hommel, 2004).

Experiment 2 was therefore conducted to investigate whether motor features of the action are necessary for an evaluative transfer on the basis of operant evaluative conditioning, or whether an evaluative transfer can be obtained on the basis of more abstract features of a response. For this investigation, we introduced two distinct, but conceptually overlapping action sets for the operant conditioning and the S–R transfer phases. For operant conditioning, participants were now asked to move the computer mouse (or more precisely, the mouse cursor) either to the left or to the right. Each mouse movement generated a pleasant or unpleasant image on the screen depending on the action–outcome contingency (counterbalanced). Instructions for the S–R transfer task were to categorize members of Niffites and Luupites with presses of the left and right arrow keys on the computer keyboard. It was hypothesized that spatial response codes for left–right mouse movements overlap with spatial response codes of left–right button presses (for evidence see Wallace, 1971). Response relations to positive and negative affects established during operant conditioning might transfer to neutral stimulus ratings via these shared (spatial) response codes. If a conceptual overlap between response sets is sufficient for an evaluative transfer from operant contingencies, one would expect more favorable ratings of the group that was assigned to a spatially congruent response conditioned to pleasant affects, and more unfavorable ratings of the group that was assigned to a spatially congruent response conditioned to unpleasant affects.

Method

Participants. Participants were again recruited online via the Prolific Academic website using the same inclusion criteria and the experiment was run with Inquisit Web software. Sample size was determined using a sequential Bayesian testing procedure ($n = 295$, complete data sets). No participant had participated in Experiment 1. In-line with our preregistered data analysis plan and with the exclusion criteria for Study 1, we excluded data from participants who were outliers in the number of incorrect responses (greater than 20.5% based on a threshold value of 1.5 interquartile above the third quartile according to Tukey, 1977) in the S–R transfer task (24 participants) or did not indicate the correct response-outcome contingency following the operant conditioning phase (three participants). The final sample comprised 268 participants (171 women; age $M = 31.4$ years, $SD = 7.6$, range = 18–49).

Apparatus, stimuli, and procedure. Procedure, stimuli, and design were identical with Study 1 with the exception that distinct response sets were now used for operant training and S–R mapping. Volunteers were asked about their computer hardware at the start of the experiment and only hardware setups with a computer mouse ($n = 161$) or a trackpad ($n = 106$) were permitted to the study (1 missing value). For operant conditioning, a trial was initiated with a mouse click on a cross presented at the center of the computer screen. Task instructions were to move the computer mouse (or the finger on a trackpad) either to the left or to the right following the mouse click. One movement produced pleasant images and the other movement generated unpleasant images on the screen (counterbalanced assignment). Each trial, participants could freely decide in which direction they wanted to move; however, it was also emphasized that both directions should be selected approximately equally often.

Instructions for the S–R transfer task were to categorize Niffites and Luupites with presses of the left and right arrow keys (counterbalanced assignment). To accommodate for differences in the layout of computer keyboards, the arrows keys between the standard section and the numeric pad and the arrow keys of the numeric pad could be used for this task.

Results

The same data analytic procedures were used as for Experiment 1. In line with the instructions for the operant learning task, participants pressed both response keys about equally often (ratio of the pleasant response key $M = 51.5\%$, $SD = 8.1$, range = 11–99%). Correct performance in the S–R transfer task was high ($M = 95.0\%$, $SD = 4.4\%$).

Relative group ratings were again rescored so that positive values index a preference for the group that was assigned to the pleasant response key. A t test of these values against zero yielded evidence for an operant EC effect ($M = 0.33$, $SD = 2.10$), $t(267) = 2.56$, $p < .01$, $d = .16$, $BF_{10} = 3.31$. Before analyses of

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

the exemplar ratings, data of 15 participants (5.6%) who produced two and more incorrect answers in the catch trials were removed. A mixed ANOVA with social group (Niffites, Luupites) and familiarity (old, new names) as within-factors and response key assignment (Niffites, pleasant key; Luupites, pleasant key) as between-subjects factor showed a significant main effect of social group, $F(1, 251) = 20.57$, $p < .001$, $\eta^2 = .076$, indicating a general preference for Luupite names. More importantly, the interaction between social group and response key assignment was significant, $F(1, 251) = 12.36$, $p < .01$, $\eta^2 = .047$. As is shown in Figure 2, Niffites and Luupites received higher liking ratings when they were assigned to the pleasant response key than when they were assigned to the unpleasant response key during the S–R transfer phase, and this effect was not moderated by the familiarity with the group member ($F < 1$). Follow-up tests with separate ANOVAs for ratings of old and new items confirmed a significant interaction effect for previously seen group members, $F(1, 251) = 12.49$, $p < .001$, $\eta^2 = .047$, and novel group members, $F(1, 251) = 9.82$, $p < .01$, $\eta^2 = .038$. In line with the frequentist analyses, an operant EC effect was also supported by a one-tailed Bayesian t test of the evaluative ratings of group members assigned to the pleasant and unpleasant keys ($BF_{10} = 67.95$).

In the postexperimental questions, 193 participants (72%) reported that they based their group rating on spontaneous thoughts and feelings; 52 participants (19.4%) indicated that they used an average of individual ratings, and only six participants (2.2%) justified the group rating with experimenter's demand. After their exclusion, the effect in the group rating remained significant, $t(261) = 2.62$, $p < .01$, $d = .16$. For the exemplar ratings, 212 participants (83.8%) indicated that they used their thoughts and feelings toward the group; 8 participants (3.2%) selected experimenter's demand, and the remaining participants (13%) indicated other reasons. Importantly, the observed interaction effect between social group and response key assignment was not affected by the exclusion of the eight participants who indicated experimenter's demand, $F(1, 243) = 9.76$, $p < .01$, $\eta^2 = .039$.

Discussion. Experiment 2 used physically distinct but conceptually overlapping movements for the operant learning and the S–R transfer tasks. Results again showed an operant EC effect: The group that was assigned to a spatial action congruent with a positively conditioned movement was liked more than the group assigned to a spatial action congruent with the negatively conditioned movement. This result confirms that an overlap in low-level motor features is not necessary for an evaluative transfer from operant contingencies; rather, a conceptual overlap between the responses on the evaluative dimension appears to be sufficient to produce an evaluative transfer from operant contingencies. In combination with the study of Blask and colleagues (2016), these results suggest that evaluative properties can be transferred from both low-level motor features and higher level conceptual features of a response.

General Discussion

Two experiments examined a transfer of positive and negative affect from operant contingencies to novel stimuli (fictitious social groups) involved in S–R mappings. Social groups assigned to actions that generated a pleasant outcome in a previous conditioning phase were liked more than stimuli assigned to actions that generated an unpleasant outcome in the previous phase. Importantly, responses did not generate affective outcomes during the

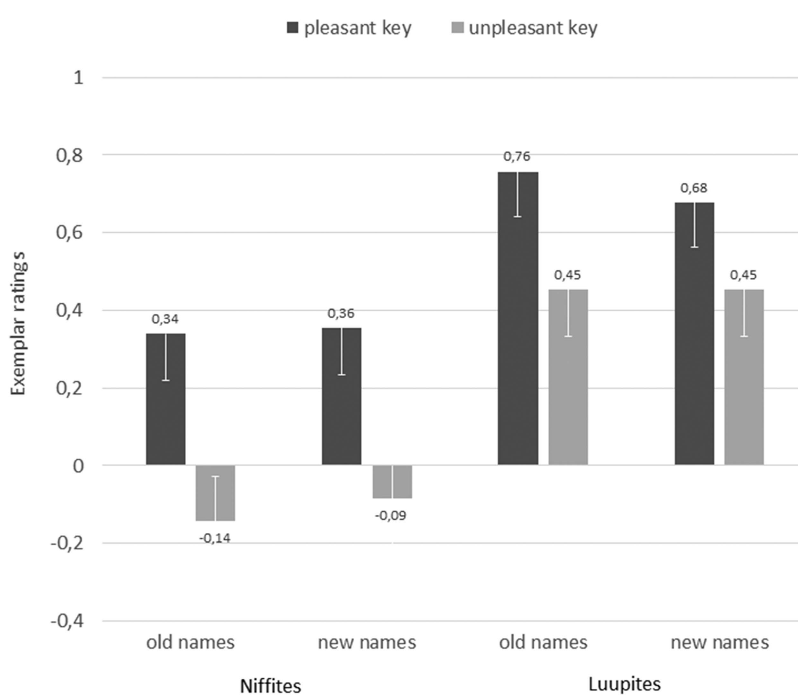

Figure 2. Exemplar ratings in Experiment 2 as a function of social group, item familiarity, and assignment of pleasant and unpleasant response keys in the stimulus–response transfer phase. Error bars show the standard error.

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

S–R transfer task (corresponding formally to an extinction phase), which rules out an explanation of the transfer effect based on stimulus-stimulus learning. The only element that was shared by both tasks was the action set, suggesting that the evaluative meaning was transported by this element in the operant contingencies to the neutral stimuli in the S–R task. This conclusion is in line with an intersecting regularities framework that expects an evaluative change when one regularity (here, the S–R mapping) intersects with a shared element (here, the action set) of another regularity that involves an evaluative element (here, the operant contingencies with affective outcomes). Importantly, our research extends the intersecting regularities account by showing that intersecting regularities allow for changes in liking even when different types of regularities are involved. Specifically, intersections of response-stimulus with S–R relations allow for a transfer of valence, suggesting that information about the presence of a relation between actions and evaluative stimuli, and not about the specific instrumental causality relation, is central to evaluative transfer. Mental process explanations of evaluative learning in general, and operant EC effects in particular, must take this into account.

Although the intersecting regularities framework is useful for a functional analysis of operant EC effects, it does not provide an explanation at a mental level. One very simple mental process account of operant EC effects is demand compliance. Demand characteristics of the experimental procedure might have led participants to infer that the experimenter wanted them to prefer the group assigned to the pleasant response key and they complied with this demand. Although this explanation cannot be completely ruled out, we view it as not very plausible. First, task instructions for the operant conditioning phase explicitly highlighted that the images produced by keypresses were irrelevant for the task at hand and should be ignored. Hence, a "good" participant would not have used the operant contingencies in order to please the experimenter. Second, only a few participants indicated demand compliance in the postexperimental questionnaire, and their removal had no effect on the results. Therefore, demand characteristics of the experimental procedures, if they existed at all, were presumably not a big issue in the present research.

A more plausible explanation might involve (automated) inferences based on a set of propositions (Mitchell, De Houwer, & Lovibond, 2009; Van Dessel et al., 2018). For instance, participants could have formed a set of propositions as follows: "When I pressed the left key, I saw pleasant images appear on the screen. Now I press the left key when I see Niffites. Hence, Niffites might be more pleasant than Luupites." Although this type of inference is logically incorrect, it may still have exerted an effect on evaluative group ratings in the absence of more reliable and diagnostic information about the groups (Schwarz, 1996).

An alternative mental process account might involve the automatic formation of mental associations, and more specifically, episode formation in associative memory. On the basis of a recent study, it has been argued that associations generated by CS–US pairings are symmetric and bidirectional, because EC effects had similar magnitudes with forward (CS–US) and backward (US–CS) presentation orders of the stimuli during conditioning (Kim, Sweldens, & Hütter, 2016). One can hypothesize an analogous bidirectionality for R–S pairings. Furthermore, many studies have provided evidence that features of stimuli, responses, and their outcomes can become integrated into a cognitive structure that Hommel (2004) called an *event file* (for reviews see Henson, Eckstein, Waszak, Frings, & Horner, 2014; Nattkemper, Ziessler, & Frensch, 2010; Zmigrod & Hommel, 2013). Features of stimuli and responses, including affective properties, are represented in a common coding domain (Eder & Klauer, 2009), which allows for cross-links between stimuli (e.g., CS–US representations) and between stimuli and responses (e.g., CS–R representations). Retrieving one element of the event file (e.g., a response) can lead to the automatic retrieval of the other elements (e.g., the associated outcome), including its evaluative properties (Coll & Grandjean, 2016; Eder et al., 2012; Giesen & Rothermund, 2016). It should be noted, however, that research on episodic binding obtained no evidence for transitive relations between features in an event file, at least when the event file was formed on single encounters (Hommel, 1998). Therefore, it is unclear whether hypothetical event files can account for the present results. Clearly, more research is needed on the underlying processes of operant EC effects.

The demonstration of an evaluative transfer from operant contingencies has implications to several fields of psychological research. One implication of the present research is that social attitudes toward a group can be changed on the basis of the behavior that is displayed toward members of that group. Traditional theories in social psychology typically view negative behaviors toward social groups as resulting from negative attitudes about that group (Fishbein & Ajzen, 2011; Hewstone, Rubin, & Willis, 2002). The present research reverses this link: Engaging in a behavior that has produced an unpleasant outcome in the past can lead to the formation of a negative attitude toward a group, even when the unpleasant experience was not caused by that group (see also studies on a retraining of approach-avoidance tendencies; e.g., Van Dessel, Eder, & Hughes, 2018).

Another important implication is that valued action outcomes anticipated during goal pursuit have a capacity to change evaluations of stimuli relevant for action pursuit. Many theories assume that goal pursuit has an impact on the evaluation of the environment in which the action is situated (Dunning & Balcetis, 2013; Eder & Hommel, 2013; Ferguson, 2007). In line with the present research, the anticipation of a positive action outcome (e.g., a reward), or approach goal, might improve liking of the environment that is associated with the approach action, while the anticipation of a negative action outcome (e.g., the prevention of a punishment), or avoidance goal, might make those evaluations more negative. Intersections with operant contingencies hence provide an explanatory model for how goal-directed action might relate to evaluations of the environment and vice versa.

References

Baeyens, F., Eelen, P., Van den Bergh, O., & Crombez, G. (1992). The content of learning in human evaluative conditioning: Acquired valence is sensitive to US-revaluation. *Learning and Motivation, 23,* 200–224. http://dx.doi.org/10.1016/0023-9690(92)90018-H

Blask, K., Frings, C., & Walther, E. (2016). Doing is for feeling. *Journal of Experimental Psychology: General, 145,* 1263–1268. http://dx.doi.org/10.1037/xge0000211

Coll, S. Y., & Grandjean, D. (2016). Visuomotor integration of relevant and irrelevant angry and fearful facial expressions. *Acta Psychologica, 170,* 226–238. http://dx.doi.org/10.1016/j.actpsy.2016.09.001

De Houwer, J. (2003). The extrinsic affective Simon task. *Experimental Psychology, 50,* 77–85. http://dx.doi.org/10.1026//1618-3169.50.2.77

De Houwer, J., & Hughes, S. (2016). Evaluative conditioning as a symbolic phenomenon: On the relation between evaluative conditioning, evaluative conditioning via instructions, and persuasion. *Social Cognition, 34,* 480–494. http://dx.doi.org/10.1521/soco.2016.34.5.480

De Houwer, J., Thomas, S., & Baeyens, F. (2001). Associative learning of likes and dislikes: A review of 25 years of research on human evaluative conditioning. *Psychological Bulletin, 127,* 853–869. http://dx.doi.org/10.1037/0033-2909.127.6.853

Dickinson, A., & Balleine, B. (1993). Actions and responses: The dual psychology of behaviour. In N. Eilan, R. A. McCarthy, & B. Brewer (Eds.), *Spatial representation: Problems in philosophy and psychology* (pp. 277–293). Malden, MA: Blackwell Publishing.

Dunning, D., & Balcetis, E. (2013). Wishful seeing: How preferences shape visual perception. *Current Directions in Psychological Science, 22,* 33–37. http://dx.doi.org/10.1177/0963721412463693

Eder, A. B., & Hommel, B. (2013). Anticipatory control of approach and avoidance: An ideomotor approach. *Emotion Review, 5,* 275–279. http://dx.doi.org/10.1177/1754073913477505

Eder, A. B., & Klauer, K. C. (2009). A common-coding account of the bidirectional evaluation-behavior link. *Journal of Experimental Psychology: General, 138,* 218–235. http://dx.doi.org/10.1037/a0015220

Eder, A. B., Müsseler, J., & Hommel, B. (2012). The structure of affective action representations: Temporal binding of affective response codes. *Psychological Research, 76,* 111–118. http://dx.doi.org/10.1007/s00426-011-0327-6

Eder, A. B., Rothermund, K., De Houwer, J., & Hommel, B. (2015). Directive and incentive functions of affective action consequences: An ideomotor approach. *Psychological Research, 79,* 630–649. http://dx.doi.org/10.1007/s00426-014-0590-4

Ferguson, M. J. (2007). On the automatic evaluation of end-states. *Journal of Personality and Social Psychology, 92,* 596–611. http://dx.doi.org/10.1037/0022-3514.92.4.596

Fishbein, M., & Ajzen, I. (2011). *Predicting and changing behavior: The reasoned action approach*. New York, NY: Psychology Press. http://dx.doi.org/10.4324/9780203838020

Gast, A., & Rothermund, K. (2011). I like it because I said that I like it: Evaluative conditioning effects can be based on stimulus–response learning. *Journal of Experimental Psychology: Animal Behavior Processes, 37,* 466–476. http://dx.doi.org/10.1037/a0023077

Giesen, C., & Rothermund, K. (2016). Multi-level response coding in stimulus–response bindings: Irrelevant distractors retrieve both semantic and motor response codes. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 42,* 1643–1656. http://dx.doi.org/10.1037/xlm0000264

Henson, R. N., Eckstein, D., Waszak, F., Frings, C., & Horner, A. J. (2014). Stimulus–response bindings in priming. *Trends in Cognitive Sciences, 18,* 376–384. http://dx.doi.org/10.1016/j.tics.2014.03.004

Hewstone, M., Rubin, M., & Willis, H. (2002). Intergroup bias. *Annual Review of Psychology, 53,* 575–604. http://dx.doi.org/10.1146/annurev.psych.53.100901.135109

Hofmann, W., De Houwer, J., Perugini, M., Baeyens, F., & Crombez, G. (2010). Evaluative conditioning in humans: A meta-analysis. *Psychological Bulletin, 136,* 390–421. http://dx.doi.org/10.1037/a0018916

Hollands, G. J., Prestwich, A., & Marteau, T. M. (2011). Using aversive images to enhance healthy food choices and implicit attitudes: An experimental test of evaluative conditioning. *Health Psychology, 30,* 195–203. http://dx.doi.org/10.1037/a0022261

Hommel, B. (1998). Event files: Evidence for automatic integration of stimulus–response episodes. *Visual Cognition, 5*(1–2), 183–216. http://dx.doi.org/10.1080/713756773

Hommel, B. (2004). Event files: Feature binding in and across perception and action. *Trends in Cognitive Sciences, 8,* 494–500. http://dx.doi.org/10.1016/j.tics.2004.08.007

Hughes, S., De Houwer, J., & Perugini, M. (2016). Expanding the boundaries of evaluative learning research: How intersecting regularities shape our likes and dislikes. *Journal of Experimental Psychology: General, 145,* 731–754. http://dx.doi.org/10.1037/xge0000100

JASP Team. (2018). *JASP* (Version 0.8.5). Retrieved from https://jasp-stats.org

Jeffreys, H. (1961). *Theory of probability*. New York, NY: Oxford University Press.

Kim, J. C., Sweldens, S., & Hütter, M. (2016). The symmetric nature of evaluative memory associations: Equal effectiveness of forward versus backward evaluative conditioning. *Social Psychological and Personality Science, 7,* 61–68. http://dx.doi.org/10.1177/1948550615599237

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2005). *International Affective Picture System (IAPS): Affective ratings of pictures and instruction manual* (Tech. Rep. No. A-6). Gainesville: University of Florida.

Levey, A. B., & Martin, I. (1975). Classical conditioning of human 'evaluative' responses. *Behaviour Research and Therapy, 13,* 221–226. http://dx.doi.org/10.1016/0005-7967(75)90026-1

Mitchell, C. J., De Houwer, J., & Lovibond, P. F. (2009). The propositional nature of human associative learning. *Behavioral and Brain Sciences, 32,* 183–198. http://dx.doi.org/10.1017/S0140525X09000855

Nattkemper, D., Ziessler, M., & Frensch, P. A. (2010). Binding in voluntary action control. *Neuroscience and Biobehavioral Reviews, 34,* 1092–1101. http://dx.doi.org/10.1016/j.neubiorev.2009.12.013

Rescorla, R. A. (1998). Instrumental learning: Nature and persistence. In M. Sabourin, F. Craik, & M. Robert (Eds.), *Advances in psychological science, Vol. 2: Biological and cognitive aspects* (pp. 239–257). Hove, England: Psychology Press.

Schönbrodt, F. D., Wagenmakers, E.-J., Zehetleitner, M., & Perugini, M. (2017). Sequential hypothesis testing with Bayes factors: Efficiently testing mean differences. *Psychological Methods, 22,* 322–339. http://dx.doi.org/10.1037/met0000061

Schwarz, N. (1996). *Cognition and communication: Judgmental biases, research methods, and the logic of conversation*. Mahwah, NJ: Lawrence Erlbaum.

Tukey, J. W. (1977). *Exploratory data analysis*. Reading, MA: Addison Wesley.

Van Dessel, P., Eder, A. B., & Hughes, S. (2018). Mechanisms underlying effects of approach-avoidance training on stimulus evaluation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 44,* 1224–1241. http://dx.doi.org/10.1037/xlm0000514

Van Dessel, P., Hughes, S., & De Houwer, J. (2018). How do actions influence attitudes? An inferential account of the impact of action performance on stimulus evaluation. *Personality and Social Psychology Review*. Advance online publication. http://dx.doi.org/10.1177/1088868318795730

Wallace, R. J. (1971). S–R compatibility and the idea of a response code. *Journal of Experimental Psychology, 88,* 354–360. http://dx.doi.org/10.1037/h0030892

Walther, E., Gawronski, B., Blank, H., & Langer, T. (2009). Changing likes and dislikes through the back door: The US-revaluation effect. *Cognition and Emotion, 23,* 889–917. http://dx.doi.org/10.1080/02699930802212423

Zmigrod, S., & Hommel, B. (2013). Feature integration across multimodal perception and action: A review. *Multisensory Research, 26,* 143–157. http://dx.doi.org/10.1163/22134808-00002390

Received April 3, 2018
Revision received September 26, 2018
Accepted September 28, 2018 ■

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.