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Evidence against an occasion setting account of avoidance learning

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Author note

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Abstract

Earlier studies on human avoidance learning showed that an avoidance response reduces the expectancy that a warning stimulus (WS) will be followed by an unconditioned stimulus (US). This modulation can transfer to WSs with which the avoidance response did not occur in the past. Recent studies suggest that transfer of modulation is selective in that it is stronger for WSs that previously went together with other avoidance responses than for WSs that never went together with an avoidance response. This finding has been interpreted as providing unique support for an occasion setting account of avoidance learning. We put forward alternative explanations of selective transfer of modulation in terms of the rate with which a WS was reinforced in the absence an avoidance response. In support of the alternative explanations, we found that transfer of modulation depended not on whether a WS previously went together with another avoidance response but on the rate with which the WS was reinforced in the past. We conclude that selective transfer of modulation in avoidance learning does not provide (unique) support for the occasion setting account. Our findings are in line with a revised expectancy model of avoidance learning.

Keywords: avoidance learning, expectancies, propositional knowledge, reinforcement history

Evidence against an occasion setting account of avoidance learning

Avoidance responses are instrumental response that prevent exposure to aversive stimulation. A typical avoidance procedure entails the following sequence of events: a warning stimulus (WS) is followed by an aversive unconditioned stimulus (US), unless a particular avoidance response (R) is performed. For example, in the classical study of Solomon and Wynne (1953), a light (WS) was presented and was followed by an electric foot shock (US), unless the animal jumped to the other side of the shuttle-box (R).

Recent studies on avoidance learning with human subjects (e.g., De Houwer, Crombez, & Baeyens, 2005; Declercq & De Houwer, 2008, 2009) supported an occasion setting account of avoidance learning. According to this theory, avoidance responses can function as negative occasion setters (De Houwer et al., 2005). Occasion setting refers to the capacity of a stimulus to disambiguate the relation between a target and a reinforcer. In the case of negative occasion setting, the presence of the occasion setter signals that the target will not be followed by the reinforcer, whereas the absence of the occasion setter signals that the target will be reinforced (for a review on the literature of occasion setting, see Holland, 1992 or Schmajuk & Holland, 1998). According to Holland (1992), a negative occasion setter possesses three functional properties. First of all, conditioned responding towards the target is stronger in the absence of the occasion setter than in the presence of the occasion setter. This property is called *trained modulation*. Second, the presence of a contingency between the occasion setter and the reinforcer does not have an effect on the degree to which the occasion setter influences conditioned responding towards the target. This property is called *resistance to counterconditioning*. The third property of negative occasion setting is *selective transfer*. It refers to the observation that a negative occasion setter will also influence conditioned responding towards other targets, but in a selective manner: It will more strongly influence

conditioned responding towards targets that were previously involved in occasion setting training.

During avoidance training, the WS is followed by the US in the absence of the avoidance response and is not followed by the US in the presence of the avoidance response. The structural similarity with negative occasion setting is clear: The avoidance response signals when the WS will or will not be followed by the US. De Houwer et al. (2005; for a similar study, see Declercq & De Houwer, 2008) provided evidence that an avoidance response and a negative occasion setter are similar at a functional level as well, by establishing that an avoidance response can possess the three properties of negative occasion setting. In their study (see the left side of Table 1, only letters without a double asterix), three different WSs were presented. WSs A and B were always followed by the US (100% reinforced), whereas WS C was followed by the US on only half of the trials on which C was presented (50% reinforced). In a second learning phase, two avoidance responses were available, the first one after WS A and the other after WS B. WSs A and B were followed by the US except when the available avoidance response was emitted. In a next learning phase, additional counterconditioning trials for the first avoidance response were presented. On these trials, performing the avoidance response led to the presentation of the US. In a final rating phase, participants rated their US expectancy in different situations.

The results of De Houwer et al. (2005) and Declercq and De Houwer (2008) indicated that the presence of the avoidance response influenced US expectancies when the WS it was originally trained with was present (trained modulation; e.g., higher expectancy of US when only A is present than when A is present and R1 is emitted; see Table 1), that this influence on US expectancy was resistant to counterconditioning (i.e., trained modulation was equally large for R1 and R2), and that it transferred more to the other WS (A or B) that was also involved in occasion setting training than to the WS that was only partially reinforced (C)

(selective transfer; e.g., R1 modulated expectancies more when B was present than when C was present). Therefore, De Houwer et al. (2005) concluded that avoidance responses can function as negative occasion setters.

Two of the three occasion setting properties can, however, also be explained in terms of the expectancy model of avoidance learning that was proposed by Lovibond (2006). He argued that participants acquire two propositions during avoidance learning: They learn that (a) after a particular WS, a particular US will be presented and (b) after performing a particular response, a particular US will be omitted. According to this model, trained modulation occurs because these propositions imply that the US is less likely to follow the WS when the avoidance response is emitted. Resistance to counterconditioning can be explained by a revised version of the Lovibond model in which it is assumed that the second proposition can be context-specific (Declercq & De Houwer, 2009, p. 127). For instance, participants might form the belief that the avoidance response prevents the US only when a WS is present. Such a belief is consistent with the fact that the avoidance response is followed by the US on counterconditioning trials and the fact that the US is less likely to follow a WS when the avoidance response is emitted. Hence, the extent to which the avoidance response modulates US expectancies in the context of a WS should not be influenced by counterconditioning on trials without a WS.

On the other hand, neither the (revised) model of Lovibond (2006), nor any other model of avoidance learning, can account for the property of selective transfer of modulation between WSs involved in occasion setting training (i.e., WSs whose relation with the US was shown to depend on the presence of an avoidance response). This finding is thus considered to provide unique support for the occasion setting account (De Houwer et al., 2005). It is possible, however, that the selective transfer effect observed by De Houwer and colleagues was in fact unrelated to whether a WS was involved in occasion setting training. In the design

of De Houwer et al. (see Table 1), the training history of C differed from that of A and B not only with regard to the fact that only A and B were involved in occasion setting training but also in that only A and B were continuously reinforced on trials without an avoidance response. That is, unlike stimuli A and B, stimulus C was partially reinforced (50%).

There are at least three ways in which the difference in reinforcement rate could have been responsible for the observed selective transfer effect. First, based on the revised model of Lovibond (2006; Declercq & De Houwer, 2009), one could argue that participants formed the belief that avoidance responses prevent the US only for WSs that were continuously reinforced. Such a belief can give rise to the expectancy that avoidance responses modulate the likelihood of the US in the context of A and B but not in the context of C, which would result in the observed selective transfer effect. Second, because C was partially reinforced whereas A and B were continuously reinforced in the absence of an avoidance response, US expectancy ratings were generally lower for C presented alone than for A or B presented alone. Because of this difference, the maximal absolute effect of the presence of an avoidance response (i.e., when the avoidance response completely abolished US expectancy) must be smaller in the presence of C than in the presence of A or B. De Houwer et al. (2005) and Declercq and De Houwer (2008) therefore used ratio scores that reflected the relative extent to which the avoidance response reduced US expectancy (e.g., the differences between US expectancy when only C is present and when both C and the avoidance response are present, divided by the US expectancy when only C is present; $[C - CR] / C$). Unfortunately, these ratio scores have poor psychometric properties, especially when the denominator approaches zero. For example, when a participant gave a near zero rating when only C was present and a slightly higher rating when both C and the avoidance response were present, this generated a large negative ratio that overwhelmed the smaller positive ratios of other participants. Such statistical biases are more likely to occur for the control stimulus C than for A and B because

the former stimulus is more likely to receive near zero ratings. Third, because C was followed by the US on 50% of the trials, participants might give a US expectancy rating for C at about the midpoint of the rating scale. Participants might also use the midpoint of the rating scale when they are uncertain about whether a US would occur in a situation. This could lead to artifactual selective transfer because transfer of modulation must always be calculated by comparing familiar situations in which a WS is presented on its own (A, B, C test trials) with novel situations in which a WS is present together with an avoidance response it has not yet been paired with (AR2, BR1, CR1, CR2 test trials; see Table 1). Hence, if participants do give ratings at the midpoint of the scale in novel situations, this would lead to the absence of modulation for C (because ratings for C are also situated at the midpoint of the rating scale) and the presence of modulation for A and B (because ratings for A and B are situated at the top of the rating scale).

To summarize, selective transfer of modulation in avoidance learning has until now been regarded as providing unique support for the occasion setting account of avoidance learning. We argue, however, that previously observed selective transfer effects might have been determined not by whether a WS was involved in occasion setting training but by the rate with which the WS was reinforced in the absence of the avoidance response. To test this alternative explanation, we replicated the study of De Houwer et al. (2005) while adding a second control stimulus D that was always reinforced. The design can be found in Table 1. The method of our study was identical to that of De Houwer et al. (2005) except for issues related to the inclusion of control stimulus D. Based on the occasion setting explanation of selective transfer, we should expect an equally small amount of transfer of modulation towards the 50% (C) and the 100% reinforced (D) stimuli because neither was involved in occasion setting training. If, however, transfer of modulation is determined by the rate at which a WS was reinforced, then transfer to D should be as large as transfer to A and B and

larger than transfer to C. The latter pattern of results would show that selective transfer of modulation in avoidance learning is not due to the procedural element that the occasion setting account considers to be crucial (i.e., occasion setting training), which would imply that selective transfer of modulation does not provide support for the occasion setting model.

Method

Participants

Forty first-year bachelor students at Ghent University took part in the experiment in exchange for course credits. They also received a small amount of money (on average €1) dependent on how successful they were in avoiding the USs.

Stimuli and Materials

The experiment was run on a portable computer with a 15-inch screen. Stimuli were presented using Affect 4.0 (Spruyt, Clarysse, Vansteenwegen, Baeyens, & Hermans, 2010). As WSs, we used a triangle (base = 2 cm; height = 2 cm), circle (diameter = 2 cm), square (2 × 2 cm) and a trapezium (base = 2 cm; height = 2 cm). As US, we used a red letter X, presented in Arial, font size 72. The stimuli were presented in a frame that was 20 cm wide and 13 cm high. At the top of this frame, a smaller frame was drawn, that was 9 cm wide and 1.5 cm high. In this frame, a message appeared that informed participants that a certain key was available. At the bottom of the main frame, a smaller frame was drawn, that was 5 cm wide and 1.5 cm high. In this frame, a response confirmation (a blue or green horizontal rectangle of 2 cm by 0.5 cm) was presented when participants gave a valid response. Participants could perform an avoidance response by pressing the D and K keys of the AZERTY keyboard. On the D key, a green label was attached and on the K key, a blue label was attached. The ratings that were presented at the end of the experiment were presented in Arial, font size 20. Participants could choose their rating by moving with the left and right

arrow over a scale from 0 (very unlikely) to 100 (very likely). The chosen rating was confirmed when participants pressed the ENTER button.

Procedure

Participants took part individually and were seated in front of the computer screen. After they signed the informed consent form, instructions appeared on the screen. They were told that they received a credit of €13. They were also told that four different geometrical figures would be presented, some of which would be followed by a red X. Every time this red X appeared on the screen, €0.25 would be subtracted from their credit. Their main task was to prevent the red X from appearing on the screen. They would be able to do so by pressing certain keys, which would be occasionally available. Participants were encouraged to learn as much as possible during the experiment. After participants indicated that they had read the instructions, some practice trials were presented to show how a correct avoidance response should be executed. On these trials, no stimuli were presented and the only available key was the space bar.

After these practice trials, a first learning phase started. In this phase, participants received four trials in which A was followed by the red X (A+ trials), four trials in which B was followed by the red X (B+ trials), four trials in which D was followed by the red X (D+ trials), two trials in which C was followed by the red X (C+ trials), and two trials in which C was not followed by the red X (C- trials). On these trials, the WS was presented 1500 ms after the onset of the frame and remained on the screen for 2000 ms. On the trials in which the US was presented, a red X appeared at the centre of the screen, 3000 ms after the WS disappeared. A message that informed participants that they lost €0.25 accompanied the US. The message and US remained on the screen for 1500 ms. If the US was not presented (C- trials), a message, that informed participants that their credit remained unchanged, appeared on the screen for 1500 ms, 3000 ms after the WS had disappeared. The intertrial interval was

5000 ms. These trials were presented in a random order. In this learning phase, no keys were available. However, if participants pressed one of the keys, this had no influence on the presentation of the US.

In a second learning phase, participants received four trials in which WS A was presented and R1 was available (AR1- trials), four trials in which WS B was presented and R2 was available (BR2- trials), four D+ trials, two C+ trials and two C- trials. The AR1- and BR2- trials were identical to the A+ and B+ trials except on the following point. Immediately after the WS disappeared, a message that informed participants that a particular key was available was presented for 2000 ms. If participants made a correct response, a confirmation bar was presented for 1000 ms and the trial ended as a US-absent trial (see above).

A third learning phase started immediately after the second learning phase. In this phase, four A+, four B+, four C+, four C-, eight D+, four AR1-, and four BR2- trials were presented. Additionally, eight counterconditioning (R1+) trials were presented. On these trials, no WS was presented. Instead, the message “*press the [color of R1] key*” appeared on the screen and remained on the screen until participants pressed the appropriate key. The experiment halted until participants followed the instruction to ensure that all participants pressed the appropriate key. Then, a confirmation bar was presented for 1000 ms and the trial ended as a US-present trial.

After the third learning phase, a rating phase was presented. Participants received the instruction that they now had to indicate how likely they thought it would be that in a certain situation the red X would be presented. They would be able to do so by choosing a value between 0 (very unlikely) and 100 (very likely). They were also told that they would not receive feedback about the correctness of their rating. On each rating trial, the description of the situation appeared at the top of the screen. For situations in which only the WS was presented, the description read as follows: “*If the [name of shape] is presented and you press*

no key, how likely is it that the red X would be presented?" For situations in which the WS is presented and a key is pressed, the description read as follows: *"If the [name of shape] is presented and you press the [color of key] key, how likely is it that the red X would be presented?"* For situations in which no WS was presented and a key was pressed, the description read as follows: *"If no shape is presented and you press the [color of key] key, how likely is it that the red X would follow?"* The description and the rating scale disappeared after participants confirmed their rating. After 500 ms, a new description appeared on the screen. The order of these trials was random for each participant.

Results

As can be seen in Table 2, we observed trained modulation that was resistant to counterconditioning, thus replicating the results of previous studies (Declercq & De Houwer, 2008; De Houwer et al., 2005). In the remainder of the results section, we discuss only selective transfer effects because these are crucial to our main hypotheses. Because we were interested in selective transfer towards stimuli that had a different reinforcement history, we took into account only the data of participants who did differentiate between the 100% (A, B, and D) and 50% reinforced stimulus (C). More specifically, the data of two participants were removed from further analyses because their mean US expectancy after A, B, and D ($[A+B+D]/3$) was lower than their US expectancy after C. Furthermore, to investigate selective transfer of modulation, it is important that R1 and R2 did modulate responding towards the WS it was originally trained with. Therefore, the data of two participants who had a trained modulation index for R1 and R2 (i.e., $[(A-AR1) + (B-BR2)]/2$) equal to or lower than zero, were removed from further analyses.

Mean ratings for the remaining participants can be found in Table 1. Because US expectancy after C was lower ($M = 49.03$, $WS = 11.58$) than after A, B, or D ($M = 94.21$, $WS = 10.45$), $t(35) = -21.17$, $p < .001$, the extent to which the presence of the avoidance

responses could reduce the US expectancies was lower for stimulus C than for stimuli A, B, and D. Therefore, in line with De Houwer et al. (2005), we decided to use the ratios instead of the absolute level of modulation. We calculated a ratio score separately for each combination of a WS (A, B, C, D) and a response (R1, R2). Each ratio corresponded to the difference between the expectancy rating when the WS was presented on its own and when it was presented in combination with an avoidance response, divided by the expectancy rating for when the WS was presented on its own (e.g., $[C - CR1] / C$).

Transfer towards A and B versus transfer towards C

We first analyzed the ratio scores for BR1, CR1, AR2, and CR2 using an ANOVA with stimulus type (A or B versus C) and response type (R1 versus R2) as within-subjects variables. The main effect of stimulus type was significant, $F(1, 34) = 14.06, p = .001$, showing that transfer of modulation was stronger for A and B than for C. This replicates the selective transfer effect that was found by De Houwer et al. (2005) and Declercq and De Houwer (2008). The main effect of response type, $F(1, 34) = 1.88, p = .18$, and the interaction between stimulus type and response type, $F < 1$, were not significant. Hence, there was no indication that counterconditioning had an effect on transfer of modulation. *t*-Tests showed that selective transfer (i.e., larger ratio for A or B than for C) occurred for both the counterconditioned response (R1), $t(34) = 2.40, p < .05$, and the avoidance response that was not counterconditioned (R2), $t(34) = 3.53, p = .001$.

Transfer towards A and B versus transfer towards D

Secondly, we analyzed the ratios for BR1, DR1, AR2, and DR2 using a stimulus type (A or B versus D) and response type (R1 versus R2) within-subjects ANOVA. This time, the main effect of stimulus type was not significant, $F < 1$. Hence, there was no indication of selective transfer when comparing stimuli that differed in their involvement in occasion setting training but that did not differ with regard to rate of reinforcement. Table 2 shows that

the modulating effect of the avoidance response transferred as strongly to D than to A and B, even though only the latter two were involved in occasion setting training. Neither the main effect of response type, nor the interaction between stimulus type and response type was significant, $F_s < 1$, again showing that counterconditioning did not influence transfer of modulation. Selective transfer was absent for both R1, $t < 1$, and R2, $t(34) = -1.53$, $p = .14$.

Transfer towards D versus transfer towards C

To compare transfer towards the control stimulus that was partially reinforced (C) and the control stimulus that was continuously reinforced (D), we analyzed the ratios for CR1, DR1, CR2, and DR2. The ANOVA with stimulus type (D versus C) and response type (R1 versus R2) as within-subjects variables revealed a main effect of stimulus type, $F(1, 34) = 23.71$, $p < .001$. Transfer of modulation was significantly stronger for D than for C. The main effect of response type approached significance, $F(1, 34) = 3.76$, $p = .06$. If anything, transfer of modulation was larger for the counterconditioned response (R1) than for the avoidance response that was not counterconditioned (R2). The interaction between stimulus type and response type was not significant, $F(1, 34) = 1.31$, $p = .26$. Selective transfer occurred both for R1, $t(34) = -3.27$, $p < .005$, and R2, $t(34) = -3.98$, $p < .001$.

Discussion

We further examined the occasion setting account of avoidance learning by comparing transfer towards a continuously (100%) reinforced stimulus and a stimulus that was partially (50%) reinforced. Participants first learned that stimulus A and stimulus B were always followed by a US except when a certain avoidance response was emitted. When they were afterwards asked to rate their expectancy of the US in different situations, they had a stronger expectation of the US when only A or only B was present than when A or B was present and an avoidance response was emitted. Contrary to what would be expected on the basis of an occasion setting account, this modulation of expectancies (a) transferred to the same extent to

stimuli that were involved in occasion setting training (A and B) than to a control stimulus that was not involved in occasion setting training but was reinforced continuously (D) and (b) transferred more strongly to the latter control stimulus D than to a control stimulus C that was also not involved in occasion setting training but was reinforced only partially. This pattern of results suggests that previous demonstrations of selective transfer of the moderating function of an avoidance response (Declercq & De Houwer, 2008; De Houwer et al., 2005) were not due to the occasion setting function of the avoidance response. As such, these selective transfer effects can no longer be regarded as supportive for the occasion setting account of avoidance learning.

Nevertheless, our results do not contradict the idea that avoidance responses can function as negative occasion setters. For instance, some have argued that selective transfer as a function of occasion setting training is not a defining feature of occasion setters (e.g., Rescorla, 1985). Instead, resistance to counterconditioning is sometimes deemed to be the most central property. Given that trained modulation was resistant to counterconditioning in the current and previous studies, it could still be argued that the avoidance responses qualified as negative occasion setters. The arguments and data put forward in this paper do, however, invalidate the idea that selective transfer effects in avoidance learning provide unique support for the occasion setting account. Contrary to what is postulated in the occasion setting account, these effects do not seem to be related to occasion setting training but to the rate with which WSs were reinforced.

The impact of reinforcement rate on selective transfer in avoidance learning is in line with the revised version of the expectancy account of Lovibond (2006; Declercq & De Houwer, 2009). According to this account, participants form context-specific propositions about relation between WSs and the US and about the relation between the avoidance response and the US. The present results can be explained by the revised expectancy model if

it is assumed that the reinforcement history of a stimulus (i.e., continuous or partial) can serve as a context that signals when the avoidance response will be effective. For instance, the moderating function of an avoidance response might transfer more to a continuously reinforced stimulus (D) than to a partially reinforced stimulus (C) because participants believe that the avoidance response is effective only for continuously reinforced stimuli (A or B).

There is another reason why we should prefer the revised expectancy model over the occasion setting model. According to the revised expectancy model, participants learn that in a particular context (a) a particular WS is followed by a particular US and (b) the performance of the avoidance response results in the omission of a particular US. From these propositions, it can be inferred that (a) in the absence of the response, the WS will be followed by the US and (b) in the presence of the response, the WS will not be followed by the US. These are exactly the propositions that underlie avoidance learning according to the occasion setting account. Hence, all predictions that can be derived from the occasion setting account can also be derived from the (revised) expectancy model. The reverse is not true: Knowing that the avoidance response determines whether the WS is followed by the US does not allow one to infer that the avoidance response (under certain conditions) causes the absence of the US. Therefore, in principle, the revised expectancy model can lead to predictions that are not supported by the occasion setting account.

Although the expectancy theory of Lovibond (2006) is in line with the observed results, other explanations of the observed selective transfer effects are possible. As already mentioned in the Introduction, reduced transfer might arise for partially reinforced stimuli as the result of (a) the use of ratio scores or (b) the way in which participants use the rating scale when they are uncertain. Additional analyses of our data do, however, argue against the former possibility. First, when we investigated selective transfer by comparing the absolute difference scores rather than ratio scores, we observed the same results as with the ratio

scores: modulation of R1 and R2 transferred more to D and less to C. As already mentioned, because the baseline ratings for A, B and D were different from the baseline rating for C, the results with absolute values should be interpreted carefully. Second, only two participants gave a zero US expectancy rating when only C was present. All other participants gave ratings for C of 35 and higher. Because the ratio scores have poor psychometric properties primarily when the US expectancy for C approaches zero, we re-ran the analyses after removing the data of the two participants with a zero rating for C. We again observed significantly more transfer towards D than to C. We also re-analyzed the data with participants who had a transfer index for C $[(C-CR1) + (C-CR2)]/2$ that was equal to or higher than zero. This led to the removal of the data of eight participants. The analyses also revealed more transfer towards D than to C. The additional analyses argue against an alternative account of our results in terms of the use of ratio scores.

The present study has some limitations. First, our results were obtained in an experimental setting. In such settings, the use of truly aversive USs is for ethical reasons impossible. Although the results suggest that propositional reasoning can be involved in avoidance learning, it is possible that in real-life situations with truly fear-evoking situations, propositional reasoning is not as optimal and other, non-propositional processes might become involved. Furthermore, avoidance training was limited in length. In the literature on instrumental conditioning, it has been suggested that after extensive training, responding can become more stimulus-bound and independent of (propositions about) the outcome of the responses (e.g., Dickinson, Balleine, Watt, Gonzalez, & Boakes, 1995). Nevertheless, the presented results indicate that at least during the initial phase of acquisition, US expectancies may contribute to the acquisition of an avoidance response in a way that is best explained by the revised expectancy model of Lovibond (2006).

References

- Declercq, M., & De Houwer, J. (2008). Evidence for the interchangeability of an avoidance behavior and a negative occasion setter. *Learning & Behavior*, 36, 290-300.
- Declercq, M. & De Houwer, J. (2009). Evidence for a hierarchical structure underlying avoidance behavior. *Journal of Experimental Psychology: Animal Behavior Processes*, 35, 123-128.
- Declercq, M., De Houwer, J., & Baeyens, F. (2008). Evidence for an expectancy-based theory of avoidance behaviour. *The Quarterly Journal of Experimental Psychology*, 61, 1803-1812.
- De Houwer, J., Crombez, G., & Baeyens, F. (2005). Avoidance behavior can function as a negative occasion setter. *Journal of Experimental Psychology: Animal Behavior Processes*, 31, 101-106.
- Dickinson, A., Balleine, B., Watt, F., Gonzalez, F., & Boakes, R. A. (1995). Motivational control after extended training. *Animal Learning and Behavior*, 23, 197-206.
- Holland, P. C. (1992). Occasion setting in Pavlovian feature positive discriminations. In M. L. Commons, R. J. Herrnstein, & A. R. Wagner (Eds.), *Quantitative analyses of behavior: Discrimination processes* (pp. 183-206). New York: Ballinger.
- Lovibond, P. F. (2006). Fear and avoidance: An integrated expectancy model. In M. G. Craske, D. Hermans, & D. Vansteenwegen (Eds.), *Fear and learning: from basic processes to clinical implications* (pp. 117-132). Washington, DC: American Psychological Association.
- Rescorla, R. A. (1985). Conditioned inhibition and facilitation. In R. R. Miller & N. E. Spear (Eds.), *Information processing in animals: Conditioned inhibition* (pp. 299-326). Hillsdale, NJ: Erlbaum.

- Schmajuk, N. A. & Holland, P. C. (1998). *Occasion setting: Associative learning and cognition in animals*. Washington DC: American Psychological Association.
- Solomon, R. L., & Wynne, L. C. (1953). Traumatic avoidance learning: acquisition in normal dogs. *Psychological Monographs*, 67, 1-19.
- Spruyt, A., Clarysse, J., Vansteenwegen, D., Baeyens, F., & Hermans, D. (2010). Affect 4.0: A Free Software Package for Implementing Psychological and Psychophysiological Experiments. *Experimental Psychology*, 57, 36-45.

Table 1. *Summary of the design and mean US expectancy and standard deviation for each situation.*

<i>Learning Phase 1</i>	<i>Learning Phase 2</i>	<i>Learning Phase 3</i>	<i>Ratings</i>	<i>Mean US expectancy***</i>	<i>Standard Deviation***</i>
A+	AR1-*	A+	A?	90.56	20.73
B+	BR2-*	AR1-*	B?	94.31	15.03
C+	C+	B+	C?	49.03	11.58
C-	C-	BR2-*	D?***	97.78	7.21
D+***	D+***	C+	AR1?	0.97	3.34
		C-	BR1?	52.08	42.15
		D+***	CR1?	37.92	21.89
		R1+	DR1?***	50.83	43.47
			AR2?	53.75	41.91
			BR2?	14.58	31.97
			CR2?	43.89	30.87
			DR2?***	50.83	41.55
			R1?	89.31	26.84

R2?

29.58

32.10

* The US was absent only if participants pressed the appropriate key.

** These trials were not presented in the original design of De Houwer et al. (2005).

*** These data are based only on the data of participants who are included in the analyses of transfer ($N = 36$).

Table 2. Mean US expectancy and standard deviation (SD) for the indices.

	Index	Mean	SD
Trained modulation	A - AR1	84.87**	29.12
	B - BR2	75.53**	39.64
	([A-AR1] + [B-BR2]) / 2	80.20**	29.66
Resistance to counterconditioning	(A-AR1) - (B-BR2)	9.34	36.34
Transfer to stimuli A and/or B	A- AR2	36.81**	40.09
	B - BR1	42.22**	41.50
	([A-AR2] + [B-BR1]) / 2	39.51**	34.93
Transfer to stimuli C or D	C - CR1	11.11*	24.47
	C - CR2	5.14	32.96
	([C-CR1] + [C-CR2]) / 2	8.12	26.04
	D - DR1	46.94**	42.35
	D - DR2	46.94**	41.79
	([D-DR1] + [D-DR2]) / 2	46.94**	40.98
Proportional transfer to stimuli A and/or B	(A - AR2) / A	0.41**	0.45
	(B - BR1) / B	0.46**	0.44
	([(A - AR2)/A] + [(B - BR1)/B]) / 2	0.43**	0.39

Proportional transfer to stimuli C or D	$(C - CR1) / C$	0.25*	0.43
	$(C - CR2) / C$	0.12	0.60
	$[(C - CR1)/C] + [(C - CR2)/C] / 2$	0.19*	0.47
	$(D - DR1) / D$	0.49**	0.43
	$(D - DR2) / D$	0.48**	0.42
	$[(D - DR1)/D] + [(D - DR2)/D] / 2$	0.48**	0.41

* A one-sample *t*-test indicated that this index was significantly different from zero, $p < .05$.

** A one-sample *t*-test indicated that this index was significantly different from zero, $p < .001$.