Evidence for an expectancy-based theory of avoidance behaviour

Mieke Declercq *, Jan De Houwer, Frank Baeyens

* Ghent University, Ghent, Belgium  

First Published on: 11 March 2008

To cite this Article Declercq, Mieke, De Houwer, Jan and Baeyens, Frank (2008) 'Evidence for an expectancy-based theory of avoidance behaviour', The Quarterly Journal of Experimental Psychology, 61:12, 1803 — 1812

To link to this Article DOI: 10.1080/17470210701851214

URL: http://dx.doi.org/10.1080/17470210701851214

PLEASE SCROLL DOWN FOR ARTICLE
Evidence for an expectancy-based theory of avoidance behaviour

Mieke Declercq and Jan De Houwer
Ghent University, Ghent, Belgium

Frank Baeyens
University of Leuven, Leuven, Belgium

In most studies on avoidance learning, participants receive an aversive unconditioned stimulus after a warning signal is presented, unless the participant performs a particular response. Lovibond (2006) recently proposed a cognitive theory of avoidance learning, according to which avoidance behaviour is a function of both Pavlovian and instrumental conditioning. In line with this theory, we found that avoidance behaviour was based on an integration of acquired knowledge about, on the one hand, the relation between stimuli and, on the other hand, the relation between behaviour and stimuli.

Keywords: Avoidance; Expectancies; Propositional knowledge; Human; Instrumental learning.

Avoidance behaviour lies at the core of many forms of psychopathology. For example, people with an obsessive compulsive disorder called nosophobia perform certain actions to avoid being infected with a virus. But avoidance behaviour is a common phenomenon also in daily life. For instance, most people will not approach a dangerous stray dog to avoid being bitten or they give right of way to prevent a collision with another car. Although it is thus important to gain insight in the mechanisms that underlie avoidance behaviour, relatively little systematic research on this topic has been performed with humans. Animal studies on avoidance behaviour, on the other hand, were quite common until the 1970s. In most of these studies, a warning signal (A; also called the discriminative stimulus or Sd) precedes an aversive stimulus (unconditioned stimulus or US), but animals can avoid the aversive stimulus by performing a particular response (R). For example, in a shuttle box, a light is turned on (A) and is followed by an electrotactile stimulus (US), unless the animal jumps across a hurdle (R) into the other part of the shuttle box (Solomon & Wynne, 1953).

On the basis of the results from animal experiments, theoretical approaches have been put forward to explain the acquisition and maintenance of an avoidance response. One of the first and most influential theories was the two-factor theory of Mowrer (1947). In this theory, both a Pavlovian and an instrumental component are
supposed to underlie avoidance behaviour. First, the Pavlovian component entails that the recurrent pairing of the warning signal and the aversive stimulus results in a conditioned fear to the warning signal. Second, Mowrer (1947) assumed that an instrumental learning process is involved in which the avoidance response is learned. At the beginning, an escape response is emitted during the presence of the US and is reinforced by the end of the US presentation. When the escape response becomes an avoidance response and is emitted before the presentation of the US, it is reinforced by the reduction in fear as a result of the termination of the warning signal. Although the two-factor theory was dominant for years, it has not escaped criticism. A first argument relates to the assumption that termination of the warning signal serves as a reinforcer for the avoidance response. Contrary to this assumption, several experiments showed that an avoidance response can be learned without the presentation of a warning signal (Bolles, Stokes, & Younger, 1966; Sidman, 1962). A second criticism concerns the prediction that there should be a positive correlation between conditioned fear of the warning signal and the strength of the avoidance response. Several experiments give evidence for a dissociation between these factors rather than an association (Rachmann, 1977; Starr & Mineka, 1977). Although some researchers have argued against these criticisms (e.g., McAllister & McAllister, 1991), others have abandoned Mowrer’s theory and have developed alternative theories (e.g., De Houwer, Crombez, & Baeyens, 2005a; Gray, 1987; Seligman & Johnston, 1973).

Very recently, a new theory was proposed by Lovibond (2006; see also Lovibond, Saunders, Weidemann, & Mitchell, in press). In his theory, Lovibond also makes the distinction between a Pavlovian and instrumental learning process, but unlike the two-factor theory (Mowrer, 1947), Lovibond (2006) has a clear cognitive view on both components. The Pavlovian component implies that the recurrent pairing of the warning signal with the US results in a conditioned fear response to the warning signal. According to the cognitive view of Lovibond, this fear occurs because participants have consciously learned that an aversive US will be presented after the presentation of a warning signal (also see Mitchell & Lovibond, 2002). Instrumental learning of the behavioural response is assumed to be based on the acquisition of knowledge about the relationship between the avoidance response and the omission of the US. That is, participants are assumed to acquire conscious propositional knowledge that an avoidance response can prevent the occurrence of an expected US. They choose to emit the avoidance response after a warning signal because they combine their knowledge about the relation between the warning signal and the US and about the relation between the avoidance behaviour and the US. Based on this knowledge, they expect that the US is less likely to occur when they do emit the avoidance response after the warning signal than when they do not emit the avoidance response after the warning signal. This expectancy is assumed to underlie the avoidance behaviour.

In this paper, we report two experiments that were designed to test the theory of Lovibond (2006) empirically. Both experiments have basically the same design (see Table 1). In a first learning phase, participants are confronted with three different warning signals (Bolles, Stokes, & Younger, 1966; Sidman, 1962). A second criticism relates to the assumption that termination of the warning signal serves as a reinforcer for the avoidance response. Contrary to this assumption, several experiments showed that an avoidance response can be learned without the presentation of a warning signal (Bolles, Stokes, & Younger, 1966; Sidman, 1962).
R1 leads to the absence of US1 and that R2 leads to the absence of US2. In a test phase, participants were given a trial with only warning signal A and a trial with only warning signal B. On each test trial, they were asked to avoid the occurrence of USs by performing either R1 or R2. According to the model of Lovibond, participants should select the response that leads to the absence of the US that was paired with the warning signal. If participants have acquired propositional knowledge of the relations between, on the one hand, the warning signals and the USs and, on the other hand, the avoidance responses and the absence of the USs, they can use this knowledge to infer that R1 is the appropriate avoidance response after warning signal A (because A is followed by US1, and R1 prevents the presentation of US1) and that R2 is the appropriate avoidance response after warning signal B (because B is followed by US2, and R2 prevents the presentation of US2).

We examine not only whether participants do select the appropriate avoidance response, but also whether their behaviour is in line with their expectancies, as is postulated by the expectancy model. In order to do so, we also asked participants to rate their expectancy of the USs in various situations.

**EXPERIMENT 1**

**Method**

**Participants**

A total of 28 first- and second-year bachelor’s degree students (9 men and 19 women) at the University of Leuven participated in exchange for course credits.

**Stimuli and materials**

The experiment was run on a Pentium 3 computer with a 17-inch screen and was controlled by Affect (Version 4.0) software (Hermans, Clarysse, Baeyens, & Spruyt, 2005). The warning signals were a white circle (2 cm diameter), a white square (2 cm × 2 cm) and a white triangle (2 cm × 2 cm). Two different USs were used: US1 was a transcutaneous electrocutaneous stimulus, delivered by a constant current (CC) stimulator. The stimulus was delivered by two Ag/AgCl electrodes (1.1 cm diameter) that were attached to the left wrist and were filled with K-Y Jelly. The intensity of the electrocutaneous stimulus was determined at the beginning of the experiment for each participant separately. US2 was the presentation of white noise of 90 dB for 50 ms delivered by a

---

**Table 1. Summary of the design and results of the rating phase in Experiments 1 and 2**

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Test</th>
<th>Rating</th>
<th>US1</th>
<th>US2</th>
<th>US1</th>
<th>US2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-US1</td>
<td>C-R1-US1absentUS2</td>
<td>A-R1orR2?</td>
<td>A?</td>
<td>87</td>
<td>11</td>
<td>93</td>
<td>0</td>
</tr>
<tr>
<td>B-US2</td>
<td>C-R2-US1US2absent</td>
<td>B-R1orR2?</td>
<td>B?</td>
<td>26</td>
<td>92</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>C-US1US2</td>
<td>A-US1</td>
<td>C?</td>
<td>91</td>
<td>94</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B-US2</td>
<td>AR1?</td>
<td>26</td>
<td>18</td>
<td>4</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C-US1US2</td>
<td>CR1?</td>
<td>27</td>
<td>64</td>
<td>3</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CR2?</td>
<td>35</td>
<td>72</td>
<td>8</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AR2?</td>
<td>65</td>
<td>18</td>
<td>89</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>BR2?</td>
<td>24</td>
<td>33</td>
<td>18</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CR2?</td>
<td>61</td>
<td>38</td>
<td>96</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1?</td>
<td>25</td>
<td>57</td>
<td>6</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R2?</td>
<td>44</td>
<td>57</td>
<td>73</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

headphone. We chose these USs as they appear in different modalities and are therefore distinguishable from each other.

The visual stimuli were presented in the centre of a main frame that was 20 cm × 13 cm and that appeared at the centre of the screen. At the top of this main frame, a smaller frame was drawn that was 9 cm × 1.5 cm, in which a message could appear if a certain key was available. At the bottom of the main frame, a third frame was drawn, which was 5 cm × 1.5 cm. In this third frame, a blue or green horizontal bar of 2 cm × 0.5 cm was presented after the participant had given a valid response. The avoidance response could be given by pressing a green or blue key, which were, respectively, the keys D and K on the keyboard. Ratings could be given by moving with the arrow buttons over a scale and then pressing enter. All messages and instructions appeared in Dutch.

**Procedure**

All participants took part individually in a dimly lit room. After signing an informed consent form, participants were placed at a distance of approximately 60 cm from the computer screen. They were then connected to the CC stimulator, and the headphone was placed on their ears. In line with ethical guidelines, participants were informed that they would receive electrocutaneous stimuli and a noise and that they could terminate the experiment at any time without further consequences. Participants were then asked to select an electrocutaneous stimulus that they perceived as unpleasant but bearable.

Participants received written instructions in Dutch in which they were told that their main task was to prevent their receiving the electrocutaneous stimulus or the noise. They were able to do so by pressing the green or blue key when these keys were available. The availability of the keys would be signalled by a message that appeared on the screen. They were also informed that it was important that they tried to learn as much as possible during the experiment. After the participants had read the instructions, the experimenter demonstrated how the responses should be given. In these demonstration trials, no USs and warning signals were presented, and the only available key was the enter button.

After the instructions, the first learning phase started. During this learning phase, participants received four trials in which warning signal A was presented and was followed by US1 (A-US1 trials), four trials in which warning signal B was presented and was followed by US2 (B-US2 trials), and four trials in which warning signal C was presented and was followed by both US1 and US2 (C-US1US2 trials). The assignment of the square and triangle to the warning signals A and B was counterbalanced. Warning signal C was always a circle. On all trials, the warning signal appeared at the centre of the screen, 1,500 ms after the onset of the frame, and disappeared after 2,000 ms. A period of 3,000 ms after the warning signal had disappeared, a single or both USs were presented, depending on which warning signal was presented. US1 was presented for 2 ms, and US2 was presented for 50 ms. The intertrial interval was 5,000 ms.

In the second learning phase, which started immediately after the first one, two A-US1, two B-US2, and two C-US1US2 trials were presented. Additionally, four trials were given in which C was presented, and the R1 key was available (CR1 trials), and four trials were given in which C was presented, and the R2 key was available (CR2 trials). Whether the green (D) or the blue key (K) functioned as R1 or R2 was determined randomly for each participant. The CR1 and CR2 trials were the same as the C-US1US2 trials except on the following points: Immediately after the warning signal disappeared, the message “The blue key is available” or the message “The green key is available” appeared in the top frame of the screen and remained there for 2,000 ms. If the available key was pressed during the presentation of the message, a registration bar was presented for 1,000 ms in the corresponding colour of the pressed key. If participants pressed R1 after its availability, US2 appeared, and US1 was not presented (i.e., pressing R1 avoided the presence of US1). If participants pressed R2 after its availability, US1 appeared, and US2 was not
presented (i.e., pressing R2 avoided the presence of US2). If participants pressed neither R1 nor R2, the CR1 or CR2 trial ended like a C-US1US2 trial.

After this second learning phase, a test phase was presented. Participants were informed that from now on both keys would be available, but that only one key could be pressed. They were told that their task was to prevent that an electrocutaneous stimulus or the noise would be presented. They were also informed that they would not receive feedback about the successfulness of their choice (i.e., no electrocutaneous stimulus or noise would be presented, even if they choose the wrong key). This was done to preclude that responses on the test trials would have an influence on the US expectancy ratings that were collected only after the test phase. In the test phase, two AR1R2 trials and two BR1R2 were presented. On these trials the warning signal appeared 1,500 ms after the onset of the frame and remained for 2,000 ms. Immediately after the warning signal disappeared, the message “The green and blue key are available” appeared on the screen and remained there until the participant pressed a key. After the participant pressed a key, a registration bar in the corresponding colour of the key was presented for 1,000 ms. After 1,500 ms the message “No feedback” appeared in the centre of the screen and remained there for 1,500 ms. The intertrial interval was 5,000 ms. The four trials of this test phase were presented in random order.

After the test phase, instructions appeared on the screen that informed participants about the upcoming rating phase. Participants were instructed to indicate how likely they considered it that an electrocutaneous stimulus or the white noise would be presented in a certain situation. They could do so by moving a red dot over a scale from 0 (very unlikely) to 100 (very likely) using the left and right arrow buttons. The selected rating could be confirmed by pressing the enter key. Participants were informed that there were 11 situations and that each situation would be presented twice: once for indicating how likely it was that an electrocutaneous stimulus would be presented and once for indicating how likely it was that the white noise would be presented. On each rating trial, a description of the situation appeared in the centre of the screen. For situations in which a warning signal and a response were described, the description read as follows: “If you see a [name of shape] and you press the [colour of key] key, how likely is it that an electrocutaneous stimulus/noise will be presented?” For the situation in which no key was available, the description was as follows: “If you see the [name of shape] and you do not press a key, how likely is it that an electrocutaneous stimulus/noise will be presented?” For situations in which only the response was present, the description was as follows: “If no figure is presented and you press the [colour of key] key, how likely is it that an electrocutaneous stimulus/noise will be presented?” The description and scale disappeared after participants pressed on the enter button. The next rating trial started 500 ms later. The order of the rating trials was random.

Results and discussion

A total of 2 participants opted to end the session after they were told that electrocutaneous and white noise stimuli would be presented. The other 26 participants completed the experiment. The mean individually selected intensity of the electrocutaneous stimulus was 1.39 mA (range 0.30–2.70 mA).

To examine whether participants choose the correct avoidance response, we looked at the data of the first test trial (11 participants received warning signal A on this first test trial, and the others received warning signal B). The probability that participants by chance select the correct avoidance response on the first trial is 50%. A total of 15 out of 26 participants

---

1We performed the analyses on the data from the first test trial because the choices on the different test trials are in all likelihood not independent. Because of this, it is not clear what the chance level is for selecting the correct response on multiple trials. However, we should note that all participants who choose the correct response on this first test trial also selected the correct avoidance responses.
(58%) performed the correct avoidance response on this trial. The binomial test indicated that this was not significantly different from chance level, \( p = .56 \). However, this result should be interpreted carefully. The predictions of the expectancy theory of Lovibond (2006) hinge on the assumption that participants have accurate propositional knowledge about the relation between, on the one hand, the warning signals and the USs and, on the other hand, the avoidance responses and the USs. Because response selection is assumed to be based on expectancies, participants can select the correct response only if they correctly learn which warning signal precedes which US and which avoidance response avoids which US.

To verify whether participants had the correct propositional knowledge, we examined the US expectancy ratings that were given during the rating phase. Participants can be assumed to have the appropriate propositional knowledge if (a) US1 expectancy is larger than US2 expectancy when only A is present, (b) the reverse is true when only B is present, (c) US1 is expected to a lesser extent than US2 when C is present, and R1 is emitted, and (d) US2 is expected to a lesser extent than US1 when C is present, and R2 is emitted. If we included only the 11 participants who met all these criteria, 9 of them (82%) performed the correct response on the first test trial. Although this proportion tends to be in line with our expectations, the binomial test showed that it was only marginally different from chance level, \( p = .06 \). We also compared the proportion of participants who had the critical knowledge and performed the correct avoidance response on the first test trial (82%) with the proportion of participants who did not have the critical knowledge and performed the correct avoidance response on the first test trial (40%). The test, which compared two observed proportions, indicated that these proportions were significantly different, \( p < .05 \). Finally, the proportion of participants who performed the correct avoidance response without having the critical knowledge (40%) was not significantly different from chance, \( p = .61 \).

Although evidence for the theory of Lovibond (2006) should be visible in the actual behaviour of the participants, we also investigated the ratings that participants had given in the rating phase. This allows us to verify whether participants can form and combine the expectancies that are assumed to underlie actual avoidance behaviour. We performed two 2 × 2 analyses of variance (ANOVA) with factors response (R1 and R2) and warning signal (A and B). The dependent variables of the first ANOVA were the expectancy of US1 and the dependent variable of the second ANOVA was the expectancy of US2. The results of the first ANOVA indicated a main effect of response, \( F(1, 25) = 5.50, p < .05 \), a main effect of warning signal, \( F(1, 25) = 6.11, p < .05 \), and a significant interaction between these factors, \( F(1, 25) = 6.97, p < .05 \). Planned comparisons indicated that participants expected US1 less after AR1 than after AR2, \( F(1, 25) = 8.88, p < .05 \). The results of the second ANOVA indicated only a main effect of warning signal, \( F(1, 25) = 9.95, p < .005 \), and a significant interaction between response and warning signal, \( F(1, 25) = 6.26, p < .05 \). Planned comparisons indicated that participants expected US2 less after BR2 than after BR1, \( F(1, 25) = 5.04, p < .05 \).

Although the results of the test phase at first sight gave no evidence for the theory of Lovibond (2006), subsequent analyses showed that if participants had the critical knowledge, they tended to select the correct avoidance response above chance on the first test trial. The results also indicated that participants more often chose the correct avoidance response on the first test trials when they had the critical knowledge than did participants who did not have the critical knowledge. However, because the additional analyses were on the next three test trials. This observation suggests that the first choice was not based on chance but rather increases confidence that the choice on this first test trial was well reasoned.
based on the data of a small number of participants, we decided to run a second experiment. To increase the number of participants who acquired the correct expectancies, we decided to test their expectancies during the experiment. Participants could progress to the next phase of the experiment only after they acquired accurate knowledge about the relevant contingencies.

**EXPERIMENT 2**

**Method**

**Participants**
A total of 28 first- and second-year bachelor’s degree students (5 men and 23 women) at the University of Leuven took part in the experiment. None of them had participated in the previous experiment.

**Stimuli, materials, and procedure**
The same stimuli and materials as those in Experiment 1 were used. The procedure was highly similar to that of Experiment 1. However, in this experiment, a learning to criteria paradigm was used. After each learning phase, a rating phase was presented to the participants. The described situations were all the situations that were presented in the preceding learning phase. Participants were informed that the rating phase was designed to test how much they had learned during the experiment. The experimenter started the next learning phase after the participants had given the correct answer for all the situations of the previous learning phase. As a correct answer, we considered all US expectancies that deviated fewer than 15 points from the objective contingency (e.g., if contingency was perfect, we considered as correct ratings that deviated fewer than 15 points from the maximum, i.e., ratings between 85 and 100). After the test phase (in which participants selected one of the two possible avoidance responses in the presence of A or B), all possible situations were presented to the participants (see Experiment 1).

**Results and discussion**
One participant chose to end the experiment after she was told that electrocutaneous stimuli and white noise would be used in the experiment. The other 27 participants all completed the experiment. The mean individually selected intensity of the electrocutaneous stimuli was 1.48 mA (range 0.30–3.90 mA).

We first of all investigated the data for the first test trial. For 15 participants, warning signal A was presented in the first test trial whereas the other participants received warning signal B on the first test trial. A total of 22 out of 27 participants (81%) performed the correct avoidance responses on the four test trials. The chance level to perform the correct avoidance response on the first test trial was 50%. A binomial test indicated that 22 out of 27 was significantly different from chance level, \( p < .005 \). We also performed these analyses only with the participants who had the critical knowledge. A total of 20 out of 23 participants who had the critical knowledge performed the correct avoidance response on the first test trials (87%). A binomial test indicated that this was significantly different from chance level, \( p < .001 \).

To test whether participants can combine the expectancies that are assumed to underlie actual avoidance behaviour, we again investigated the ratings given in the last rating phase of the experiment. We performed two 2 × 2 ANOVAs with factors response (R1 and R2) and warning signal (A and B). The dependent variable of the first repeated measures was the expectancy of US1; the dependent variable of the second ANOVA was the expectancy of US2. The results of the first repeated measures indicated a main effect of response, \( F(1, 26) = 84.66, p < .001 \), and a main effect of warning signal, \( F(1, 26) = 57.00, \)

---

\(^2\) This number does not include the 2 participants who selected the correct avoidance response on the first trial, but not on the following trials.
The interaction between response and warning signal was also significant, $F(1, 26) = 36.16, p < .001$. Planned comparisons indicated that US1 was expected to a lesser extent after AR1 than after AR2, $F(1, 26) = 93.73, p < .001$. The results of the second repeated measures, with US2 expectancy as the dependent variable, indicated a main effect of response, $F(1, 26) = 120.97, p < .001$, a main effect of warning signal, $F(1, 26) = 134.20, p < .001$, and a significant interaction between response and warning signal, $F(1, 26) = 71.47, p < .001$. Planned comparisons indicated that US2 was expected less after BR2 than after BR1, $F(1, 26) = 206.56, p < .001$.

In this second experiment, we found clear evidence for the theory of Lovibond (2006). The actual behaviour of the participants on the first test trials indicates that participants selected the correct avoidance response above chance level. The ratings were also clearly in line with the expectancy-based theory of Lovibond (2006).

GENERAL DISCUSSION

In two studies, we tested the theory of avoidance behaviour that was recently developed by Lovibond (2006). The theory of Lovibond is novel in that Lovibond focuses on the role of conscious propositional knowledge and expectancies, suggesting that people construct propositional knowledge about relations and use this knowledge to decide which actions to perform.

In our first experiment, avoidance behaviour did not seem to be in line with the predictions of the expectancy theory of Lovibond. However, if we looked more closely at the ratings given by the participants, we saw that only a small part of the participants had learned the critical information necessary to select the correct avoidance response. If we focused only on this small part of participants who did have the required knowledge, we did find support for the theory of Lovibond. In a second experiment, we used a learning to criteria paradigm to increase the likelihood that participants did acquire the relevant knowledge. This resulted in a larger sample of participants who had all the relevant propositional knowledge. Importantly, the large majority of these participants used this knowledge in the predicted manner to select the correct avoidance response. The model was also supported by the fact that only participants who had the critical knowledge selected the avoidance response above chance.

Importantly, the results of the reported experiments cannot be explained by other theories of avoidance behaviour. According to the two-factor theory of Mowrer (1947), an avoidance response is in fact an escape response towards a conditioned fear-evoking stimulus. Assuming that warning signals A and B do evoke fear and would therefore elicit an avoidance response, there is no reason why A would elicit a different avoidance response from that elicited by B. The avoidance responses differed only with regard to the US that they eliminated on the C trials. This should have no effect on the selection of the avoidance response on the A and B trials.

Another theory of avoidance behaviour that experiences difficulties in explaining our results is the theory of Seligman and Johnston (1973). Our results demonstrate that the decision of participants to perform a particular avoidance response is dependent both on information about the type of US that is paired with warning signals A and B and on information about the type of USs that do and do not occur when R1 and R2 are emitted. In their theory, Seligman and Johnston (1973) focused only on knowledge about the relation between responses and USs. Their theory postulates that an individual expects a US when no response is made in a given interval and expects no US when a response is made within that interval. A second principle poses that individuals not only acquire expectancies but also preferences, where no US is preferred to a US. Our results, however, indicated that participants had expectancies not only about the absence of a certain US after a response, but also about the presentation of a particular US dependent on which warning signal was presented. This indicates that knowledge about the relation between the warning signals and the USs also has an impact on performance. Yet, the relationship
between warning signal and US is not incorporated in the theory of Seligman and Johnston (1973), which is therefore not able to explain our results. For a similar reason, the safety signal theory of Gray (1987) also cannot account for the obtained results. In line with the two-factor theory, Gray acknowledges that both a Pavlovian and an instrumental learning process are necessary. An important difference is that Gray adopts a cognitive view on Pavlovian conditioning according to which the warning signal becomes a predictor of the US rather than a conditioned elicitor of fear. When the US is expected but absent after the avoidance behaviour, cues that reliably occur after the behaviour (e.g., kinaesthetic feedback) become associated with the positive event of an expected but absent US and thus acquire reinforcing properties. The avoidance behaviour is then reinforced by these cues. Although this theory implies that participants acquire propositional knowledge about the relation between the warning signal and the US, selection of the avoidance response is assumed to depend only on prior reinforcement rather than knowledge about the relation between the response and the US. The fact that our participants selected R1 more after A than after B and R2 more after B than after A implies that they knew not only that A was associated with US1 and B with US2. They also must have known that R1 avoided US1, and R2 avoided US2, and they used this knowledge to select the appropriate avoidance response.

Our results can also not be explained by the cognitive theory of De Houwer et al. (2005a). According to this theory, an avoidance behaviour functions as a negative occasion setter. One of the unique properties of an occasion setter is selective transfer (for an overview of the literature concerning occasion setting and its properties, see Holland, 1992). According to the theory, participants might learn that the avoidance responses R1 and R2 modulate the C–US1 and C–US2 relation, respectively. Because A–US1 and B–US2 were not previously involved in occasion setting, the model should predict that the modulating powers from R1 and R2 would not transfer to these relations and that participants would choose R1 or R2 in the test phase according to chance level. Even if the modulatory powers of R1 and R2 would transfer to A and B, they should do so to the same extent. The results clearly disconfirm this prediction.

Although our results cannot be explained by all cognitive theories of avoidance learning, they do provide clear evidence for the important role of cognitive processes in avoidance learning (see Declercq & De Houwer, 2008, for other recent evidence). This evolution is in line with the movement away from behaviouristic stimulus–response theories and towards even more cognitive theories of learning that has characterized research on Pavlovian and instrumental conditioning in the past decades (e.g., Balleine & Dickinson, 1998; Colwill & Rescorla, 1990; De Houwer, Vandorpe, & Beckers, 2005b; Lovibond, 2003).

Finally, we would like to point out that our studies also have clinical implications. Avoidance behaviour is involved in many forms of psychopathology. Our experiments show that expectancies play an important role in the acquisition and maintenance of avoidance behaviour. According to Lovibond (2006), the most important clinical implication is that associative learning is encoded in a propositional form that makes it available for self-report. The theory of Lovibond implies that therapy can make use not only of behavioural techniques like exposure and response prevention but also of cognitive techniques. However, we want to note that the reported experiments were conducted in a laboratory setting with human subjects. In such kind of settings, it is for ethical reasons impossible to use truly aversive stimuli. Although De Houwer et al. (2005a) found no difference in their results when they used a neutral US (i.e., a letter that participants were instructed to avoid) versus a mildly aversive US (i.e., a mild electrocutaneous stimulus), it is possible that with more fear-evoking stimuli, propositional processing is not as optimal as that in the reported studies, and other, nonpropositional processes become involved in avoidance learning. Although this argument might well be valid, it will not be easy to examine it further, not only...
because of the ethical considerations mentioned above but also because it is still unclear what criteria can be used to determine that nonpositional processes are operating (e.g., Hahn & Chater, 1998). Nevertheless, it is good to keep in mind that our results were obtained in a specific context with a specific set of stimuli.

Original manuscript received 15 March 2007
Accepted revision received 21 November 2007
First published online 11 March 2008

REFERENCES


