Operant conditioning of autobiographical memory retrieval

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Functional avoidance is considered as one of the key mechanisms underlying overgeneral autobiographical memory (OGM). According to this view OGM is regarded as a learned cognitive avoidance strategy, based on principles of operant conditioning; i.e., individuals learn to avoid the emotionally painful consequences associated with the retrieval of specific negative memories. The aim of the present study was to test one of the basic assumptions of the functional avoidance account, namely that autobiographical memory retrieval can be brought under operant control. Here 41 students were instructed to retrieve personal memories in response to 60 emotional cue words. Depending on the condition, they were punished with an aversive sound for the retrieval of specific or nonspecific memories in an operant conditioning procedure. Analyzes showed that the course of memory specificity significantly differed between conditions. After the procedure participants punished for nonspecific memories retrieved significantly more specific memories compared to participants punished for specific memories. However, whereas memory specificity significantly increased in participants punished for specific memories, it did not significantly decrease in participants punished for nonspecific memories. Thus, while our findings indicate that autobiographical memory retrieval can be brought under operant control, they do not support a functional avoidance view on OGM.

Keywords: Autobiographical memory specificity; Overgeneral memory; Avoidance; Affect regulation; Operant conditioning.

Over the past 25 years an extensive research tradition has developed on the role of autobiographical memory in emotional disorders. Within this tradition a large body of studies has focused on the specificity of autobiographical memory (for a review, see Williams et al., 2007). The latter is typically assessed using the Autobiographical Memory Test (AMT; Williams & Broadbent, 1986) in which respondents are presented with a series of emotional or neutral cue words and asked to recall a specific memory in response to each of them. Specific memories refer to events that occurred at a particular time and place and lasted less than a day (e.g., “my best friend’s wedding two weeks ago”). Overgeneral (categoric) memories on the other hand, summarise similar events (e.g., “attending weddings”). Numerous studies have indicated that depressed
individuals retrieve significantly fewer specific and more categoric memories on the AMT, compared to controls (for a review, see Williams et al., 2007). This reduced autobiographical memory specificity has been termed overgeneral (autobiographical) memory (OGM).1

Research has shown that OGM plays an important role in the development and maintenance of depression. First, it is related to a poorer prognosis in depression (e.g., Hermans, Vandromme, et al., 2008; Raes, Hermans, Williams, Beyers, et al., 2006) and the development of depressive symptoms after stressful life events in nonclinical groups (e.g., van Minnen, Wessel, Verhaak, & Smeenk, 2005). Second, OGM is significantly associated with other vulnerability factors for depression, such as rumination (e.g., Watkins & Teasdale, 2001) and impaired social problem solving (e.g., Goddard, Dritschel, & Burton, 1996).

Further research has shown that OGM is not only related to depression but also to a history of trauma (for a review, see Williams et al., 2007). First, in clinical groups and nonclinical groups, traumatised individuals have shown to be significantly less specific compared to non-trauma-exposed controls (e.g., Henderson, Hargreaves, Gregory, & Williams, 2002; Kuyken & Brewin, 1995). Second, significant correlations have been observed between autobiographical memory specificity on the one hand and qualitative and quantitative features of trauma on the other hand (e.g., Hermans et al., 2004). Third, studies have shown that patients suffering from trauma-related disorders (post-traumatic stress disorder and acute stress disorder) retrieve significantly fewer specific memories compared to traumatised patients without these disorders (e.g., Harvey, Bryant, & Dang, 1998; Schönfeld & Ehlers, 2006). Importantly, recent studies have indicated that the relationship between OGM and trauma is independent of depression (e.g., Aglan, Williams, Pickles, & Hill, 2010; Hauer, Wessel, Geraerts, Merckelbach, & Dalgleish, 2008).

Based on the observed link between trauma and OGM, functional avoidance has been put forward as one of three inter-related mechanisms underlying OGM, together with Capture and Rumination, and reduced Executive Control (the CaRFAX model; Williams et al., 2007). Consistent with this model, our previous work has shown that OGM serves an affect-regulating function (Hermans, de Decker, et al., 2008; Raes, Hermans, de Decker, Eelen, & Williams, 2003). The Functional Avoidance theory assumes that voluntary retrieval from episodic memory is a hierarchically organised search strategy that starts with more abstract, generalised semantic information, and then recursively recruits greater episodic information as the search continues (Conway & Pleydell-Pearce, 2000). Persons who have been confronted with trauma or extremely negative events learn that the retrieval of specific memories about these adversities reactivates the associated intense negative emotions. In order to avoid anticipated reactivation of affect they learn to abort hierarchical memory retrieval at the stage of overgeneral memories. For example, a woman who has been the victim of childhood sexual abuse by her 10-years-older brother might re-experience feelings of intense anxiety, disgust, and sadness (negative emotions) when she retrieves specific details of these adverse events (e.g., the feeling of her brother’s hands on her body or the smell of his cologne). The retrieval of such specific details would be more likely when she retrieves specific instances of the abuse (e.g., the first day of the summer holidays when she was 6 and alone in the house with her brother). To avoid these negative emotions she might learn to retrieve less-detailed images of the abuse and to think back to it in a more abstract, verbal way. This would result in the retrieval of overgeneral memories about the childhood sexual abuse (e.g., “I was abused by my brother”).

Importantly, the model also assumes that, in the short term, such an avoidance strategy can be beneficial and, if it is limited to certain negative memories, it may be part of a set of healthy coping strategies. In some people, however, this overgeneral retrieval style might generalise to other specific episodic memories over time and become a habit. Within the autobiographical memory base, specific memories are assumed to form a highly elaborated associative network (Conway & Pleydell-Pearce, 2000), in which one specific memory can activate another one. For example, a memory about a nice summer holiday she spent in France with her family might remind the abused woman of the instance of abuse she experienced

1 In line with previous studies (Williams et al., 2007) we use the term OGM to indicate both lower levels of specific retrieval and higher levels of categoric retrieval. Given that the term reduced memory specificity is semantically more closely linked to only one AMT-index, namely the number/proportion of specific memories, we do not use this term in case the described conclusion is only valid for number/proportion of overgeneral (categoric) memories.
earlier that summer. As such, a relatively neutral or even positive memory can trigger traumatic memories and thus negative affect (Williams et al., 2007). Therefore the only successful strategy to block these traumatic memories might be to block all specific retrieval. If OGM is no longer restricted to certain memories but applied inflexibly to the entire autobiographical memory base, it may render one vulnerable for emotional disorders (Hermans, de Decker, et al., 2008).

Evidence for functional avoidance as a process underlying OGM has already been provided by a number of studies, which can be divided into three main groups. A first group consists of the above-discussed studies showing that OGM is related to a history of trauma, independent of its relationship with depression (e.g., Aglan et al., 2010; Hauer et al., 2008). A second group of studies have demonstrated that OGM is positively associated with avoidant coping. Significant positive correlations have been reported between OGM and the avoidance subscale of a widely used measure of trauma-related avoidance, the Impact of Event Scale (IES; Horowitz, Wilner, & Alvarez, 1979; see also Brewin, Watson, McCarthy, Hyman, & Dayson, 1998; Hauer, Wessel, Engelhard, Peeters, & Dalgleish, 2009; Hauer et al., 2008; Hauer, Wessel, & Merckelbach, 2006; Kuyken & Brewin, 1995; Raes, Hermans, Williams, Beyers, et al., 2006; Stokes, Dritschel, & Bekerian, 2004; Wessel, Merckelbach, & Dekkers, 2002). Additionally, in a group of students, Hermans and colleagues (Hermans, Defranc, Raes, Williams, & Eelen, 2005) observed that lower specificity of memory was associated with social behavioural avoidance, experiential avoidance, and thought suppression, and a further study (Debeer, Raes, Williams, & Hermans, 2011) showed that this association particularly occurs when participants are made aware of possible negative emotional effects of retrieving personal memories.

Studies showing short-term affect-regulatory benefits of reduced memory specificity have provided a third line of support for the functional avoidance account. In two experiments, Raes and colleagues (Raes et al., 2003; Raes, Hermans, Williams, & Eelen, 2006, Study 1; but see Philippot, Schaefer, & Herbette, 2003) demonstrated that, after failure on an experimental task, students scoring low on the AMT experienced less affective distress, reported fewer intrusions, and rated these intrusions as less unpleasant, when compared to students scoring high on the AMT. In a prospective study in first-year students, Hermans and colleagues (Hermans, de Decker, et al., 2008) found that less-specific autobiographical memory predicted less-sustained emotional distress over a 9-week period following students’ failure at their first university exams.

As can be concluded from the above-reviewed studies, evidence for the functional avoidance account of OGM has hitherto been restricted to studies showing associations between low autobiographical memory specificity and (a) trauma/PTSD, (b) (trauma-related) avoidance, and (c) diminished short-term affective impact of negative events. No studies have yet focused on the learning process thought to underlie the reduction of memory specificity, which is at the very core of the functional avoidance account. In this view OGM is considered a learned passive avoidance strategy, based on principles of operant conditioning. The retrieval of specific memories about extremely negative events (behaviour; e.g., instances of childhood sexual abuse) leads to the reactivation of the associated negative emotions (punishment; e.g., intense anxiety, disgust, sadness). As a consequence people learn to passively avoid this punishing consequence by truncating memory retrieval at the stage of overgeneral memories. The present study is the first to investigate this very basic assumption of the functional avoidance view on OGM, namely that autobiographical memory retrieval can be brought under operant control. As such, it aims to fill an important gap in the existing literature.

Participants underwent a conditioning procedure in which they were punished for the retrieval of specific memories (specific-punishment condition; SP condition) or nonspecific memories (nonspecific-punishment condition; NSP condition). We hypothesised (a) that the course of memory specificity during the operant conditioning procedure would significantly differ between conditions, (b) that participants from the SP condition would be significantly less specific after the operant conditioning procedure, compared to participants from the NSP condition, and (c) that memory specificity would gradually decrease in the SP condition and gradually increase in the NSP condition.

Hypotheses (a) and (b) focus on the relative difference in memory specificity between the conditions. A confirmation of these hypotheses would support the assumption that autobiographical memory retrieval can be brought under operant control. As already stated, testing this assumption, which is at the basis of the functional...
avoidance account, is the central aim of the present study. As such, hypotheses (a) and (b) are our main hypotheses. Hypothesis (c), on the other hand, focuses on the absolute effect of punishment in each condition. This last hypothesis could be considered the strongest test of the functional avoidance account, as it explicitly tests whether punishment of the retrieval of specific memories leads to a decrease in memory specificity. In the functional avoidance account the latter process is assumed to underlie the development of OGM.

**METHOD**

**Participants**

A total of 47 students participated in the study. One participant did not start the operant conditioning procedure because he met one of the exclusion criteria. These included pregnancy, cardiovascular or pulmonary dysfunction, neurological complaints, other serious medical conditions, clinical depression, anxiety disorder or any other psychiatric disorder, medical request to avoid stressful situations, or auditory impairment. Before the start of the experiment participants had to confirm in writing that they did not meet any of these exclusion criteria (see procedure). In addition four participants discontinued participation during the study because they did not follow the instructions. Consequently the final sample consisted of 41 students (38 women) with a mean age of 19.68 years ($SD = 2.89$; range = 17–34). The majority of them were first-year students ($n = 36$; 35 women) at the Department of Applied Psychology of Lessius University College, who participated as partial fulfilment of course requirements. The other participants were friends of the student-assistant of the experimenter (two secondary school students, one second-year bachelor student, and two third-year bachelor students). Participants were randomly allocated to the SP ($n = 21$) or the NSP condition ($n = 20$). The two conditions did not significantly differ regarding age, $t < 1$, or sex ratio, $p = .606$ (Fisher’s exact test).

**Materials**

*Emotional cue words.* In a first step we composed a list of 133 low- to medium-imageable emotional nouns and adjectives. Imageability refers to the ease with which a word arouses an image (e.g., tree is a high-imageable word and truth is a low-imageable word). We selected the words from two existing lists of words of which imageability ratings had been collected (de Decker, 2001; van Loon-Vervoorn, 1985). The selected words had scores between 2 and 5 on a 7-point Likert-type scale of imageability. In a second step we selected 30 words with a clear positive valence (e.g., safe, joy, brave) and 30 words with a clear negative valence (e.g., disappointment, lonely, sad) from the long list of 133 words, while omitting words with overlapping meaning.

During the experiment the 60 cue words were presented one by one on the computer screen (white letters on a black background). On the left of the screen a vertical red progress bar, divided into 30 equal parts, indicated the response window. In line with recent studies using the AMT (e.g., Aglan et al., 2010; Kleim & Ehlers, 2008) we opted for a time limit of 30 seconds, which urged participants to respond quickly with the first memory that came to mind (see below). The response bar indicated the maximal response latency. In other words, participants did not need to complete their memory within 30 seconds.

**Visual Analogue Scales—mood** (McNally, Litz, Prassas, Shin, & Weathers, 1994). Participants’ current levels of happiness, sadness, anxiety, anger, emotional arousal, positive mood, and negative mood were assessed by means of seven 100 mm visual analogue scales, ranging from 0 (not at all X) to 100 (very X).

**Aversive stimulus.** The punisher in the operant conditioning procedure was a 2-second loud human scream with an instantaneous rise time (103 dB, scream10.wav retrieved at http://www.partnersinrhyme.com/soundfx/human.shtml and modified using the audio software Audacity 1.2.6). This stimulus was presented binaurally through headphones (Philips SHP 2000).

**Post-experimental interview (see Appendix).** In addition to a number of questions assessing participants’ remarks (Question 1), prior knowledge of the experiment (Question 2), and recollection of the contingency instructions (see training phase; Questions 5 and 6), the semi-structured post-experimental interview (see Appendix) contained questions assessing their contingency awareness (CAness), i.e., awareness of the contingency between the retrieval of
specific (SP condition)/nonspecific memories (NSP condition) and the aversive sound. There were seven CAness questions: six open-ended questions (Questions 3, 4, 7, 8, 9, and 10) and one forced-choice multiple-choice question (Question 11). The six open-ended questions (Questions 3, 4, 7, 8, 9, and 10) were designed to gradually prompt participants’ awareness of the contingency. In the forced-choice multiple-choice question the participant was presented with 10 possible aspects of the experiment with which the aversive sound could have been correlated, and was asked to choose one. The correct option was “whether you described a specific memory/event or a nonspecific memory/event”.

Procedure

Introduction and pre-assessment. The experiment was presented as a study about the “emotional meaning of memories”. In the introduction participants were informed that their basic task would be to retrieve memories in response to cue words and that a loud and aversive sound would be administered repeatedly. After providing written informed consent and confirming in writing that they did not meet any of the exclusion criteria, they filled out the VAS-mood (VAS-mood pre).

Instructions2. Participants were instructed to describe aloud the first memory that came to mind in response to each cue word that would appear on the computer screen. They were told (a) that this memory could refer to an important or a trivial event, (b) that the event could have happened long time ago or just recently, and (c) that they could retrieve a specific memory (which was defined as a memory referring to a specific event) or a nonspecific memory. The experimenter illustrated each type of memory (important, trivial, long time ago, recent, specific) with one example (example of specific memory: “the last day of our holidays in Sweden this summer”) and gave two examples of nonspecific memories: one of a categoric memory (referring to category of events, example used: “going on a holiday”) and one of an extended memory (referring to a period that lasted longer than 1 day, example used: “our holiday in Sweden this summer”). In addition participants were asked not to repeat the same memory, to describe the memory in one or two sentences, and to start their description within the response window depicted by the progress bar on the computer screen. After having given these instructions the experimenter demonstrated the course of a trial on the computer screen (i.e., presentation of the cue word together with the progress bar, see above). Finally participants were informed that cues would be presented in blocks of 10 and that if they did not respond to a certain cue, it would be repeated at the end of the block to which it belonged.

Practice phase. To familiarise themselves with the procedure participants were given five practice trials (glad, bad luck, beautiful, hard, good). The experimenter provided feedback regarding the suitability of their responses for the experiment (e.g., appropriate length of the response, response latency within time limit, response should be a memory not a semantic association).

Training phase. The computer randomly divided the 60 emotional cue words into six blocks of 10 cues, with the restriction that each block should contain 5 positive and 5 negative cues. After the practice phase participants were informed that during the actual training phase, the aversive sound would follow certain memories. They were told that there would be a connection between the type of memory retrieved and the occurrence or non-occurrence of the sound. It was explained to the participant that “type of memory” referred to the form of the memories, not to their content. The experimenter, however, did not explicitly instruct them to avoid the sound.

During the whole training phase the participant was sitting in front of the desktop computer. The experimenter was sitting behind the participant and immediately coded his/her verbal responses to the cue words by pressing a key on the keyboard. Each memory was coded as S(ppecific) or N(onspecific); failure to recall a memory within the response window was coded as an O(mission). Depending on the condition, the human scream was programmed to play contingent upon every specific (SP condition) or nonspecific memory (NSP condition). When the experimenter pressed S or N, the cue word immediately disappeared from the screen. The progress bar, on the other hand, was shown until the end of the 30-second response window, independent of the speed of the participant’s response. Cue words to which no response was given were automatically repeated at the end of the block. The reason for this was to

2Full instructions can be obtained from the authors.
motivate participants to keep retrieving memories and to prevent them from avoiding the punishing sound by not responding to the cues. After each block participants were asked to rate the (un)pleasantness of the sound on a scale from 10 (very unpleasant) to +10 (very pleasant). After Blocks 1, 3, and 5 they were reminded of the main instructions of the experiment: (1) “Please describe the first memory that comes to mind in response to the cue word, within the time limit” and (2) “The sound will follow certain type of memories”. Participants could take a short break after each block.

The randomisation of the cues, their presentation, the registration of the experimenter’s coding, and the administration of the sound were controlled by an Affect 4.0 program (Spruyt, Clarysse, Vansteenwegen, Baeyens, & Hermans, 2010). If participants consented, their responses were audio taped.

Post-assessment and debriefing. Immediately after the operant conditioning procedure, participants again completed the VAS-mood (VAS-mood post), followed by the post-experimental interview. At the end of the experiment the participants were fully debriefed, and they promised in writing not to inform their fellow students about the content or purpose of the study. The study was approved by the Ethical Committee of the Faculty of Psychology and Educational Sciences, University of Leuven.

Data analysis

Memories that were given in response to a repeated cue word were not taken into account in the analyses. We calculated the proportion of specific memories per block by dividing the number of specific memories by 10 minus the number of omissions. This index was used as the dependent variable in a series of mixed model ANOVAs, with block as a within-participants and condition (and contingency awareness) as a between-participants independent variable(s). Reported p-values and degrees of freedom of within-participants effects were Greenhouse-Geisser (G-G) corrected when Mauchly’s test of sphericity was significant. Two-sided statistical significance tests were used for all analyses. The alpha was set at 0.05.

RESULTS

Ratings for mood and (un)pleasantness of the sound

If the conditions had differential effects on participants’ mood or perception of the sound, any observed effects of condition could be attributed to an effect of mood induction or to differences in the perceived aversiveness of the punisher, respectively. With regard to the first possible confound, separate 2 (condition: SP condition vs NSP condition) × 2 (time: pre vs post) mixed model ANOVAs, one for each of the emotions that was included in the VAS-mood, revealed no significant Condition × Time interactions, all ps >.239. Thus the change in mood from pre to post operant conditioning procedure did not significantly differ between conditions.

With regard to the second possible confound, a 2 (condition) × 6 (block) mixed model ANOVA with rating of the sound as the dependent variable, showed no significant Condition × Block interaction, $F(2.55, 71.43) = 1.00, p = .388$ (G-G corrected), but a significant main effect of block, $F(2.55, 71.43) = 6.42, p < .01$ (G-G corrected). These results indicated that the conditions did not significantly differ with regard to the course of participants’ rating of the sound. However, participants gradually rated the sound as less unpleasant over the course of the experiment.

Contingency awareness

The majority of the participants did not show any sign of CAness in the post-experimental interview (contingency unaware (CU) group; n = 28, 17 in SP condition, 11 in NSP condition). A total of 13 participants were labelled contingency aware (CA) (CA group; 4 in SP condition, 9 in NSP condition). All these participants already showed signs of CAness in the open-ended CAness questions.

We applied a rather broad definition of CAness. Participants were considered CA if they described at least one common feature of (a particular subtype of) specific or nonspecific memories as characteristic of the punished or unpunished memories, depending on the condition. Features of specific memories that were considered correct were: (more) specific, more concrete, more elaborated, containing more
details, containing more unique elements, containing descriptions of places and dates, with specified day/moment, well described, accurately retrieved, and requiring more thinking (specified as “going deeper into the memories”). Features of nonspecific memories that were considered correct were: nonspecific, (more) general, non-concrete, more vague, more superficial, describing longer time periods, and containing descriptions/qualities of persons. Even (a) participants who only showed slight signs of CAness (e.g., in a late stage of the interview, after extensive prompting), (b) participants who showed signs of CAness in the open-ended questions but did not pick the correct option in the forced-choice question, and (c) participants who said they had become CA during the interview (and not during the experiment) were considered CA.

To test whether CAness functioned as a moderator for the operant conditioning effect, we conducted a 2 (CAness: CA group vs CU group) × 2 (condition: SP vs NSP) × 6 (block) mixed-model ANOVA with proportion of specific memories as the dependent variable. No evidence was found for a moderating effect of CAness: The triple interaction between block, condition, and CAness was not significant, $F(3.95, 146.14) = 1.59, p = .182$ (G-G corrected). Moreover, neither the main effect of CAness, $F(1, 37) < .01, p = .933$, nor the two-way interactions with contingency awareness were significant. CAness × Condition: $F(1, 37) = 1.90, p = .176$, CAness × Block: $F(3.95, 146.14) = 0.51, p = .727$ (G-G corrected). Importantly, however, the Block × Condition, which is indicative of an effect of our operant conditioning procedure, was significant, $F(3.95, 146.14) = 3.33, p < .05, \eta_p^2 = .083$ (G-G corrected).

Figure 1 shows the course of memory specificity in the SP and the NSP condition. Because we failed to find evidence for an effect of CAness on memory specificity (see above), we decided to exclude this variable from the final model. The resultant 2 (condition) × 6 (block) mixed model ANOVA revealed no significant main effects of block, $F(3.89, 151.74) = 1.48, p = .211$ (G-G corrected), or condition, $F(1, 39) = 3.08, p = .087, \eta_p^2 = .073$. Most importantly, the Condition × Block interaction was significant, $F(3.89, 151.74) = 3.66, p < .01, \eta_p^2 = .086$ (G-G corrected), which again confirmed our hypothesis that the course of memory specificity would be impacted by the operant conditioning procedure.

We further investigated the significant interaction in two ways. First, we tested whether proportion of specific memories significantly differed between conditions in each block. The results of the independent $t$ tests are reported in Table 1. No significant differences were observed in Blocks 1, 2, and 3. In Blocks 4, 5, and 6, on the other hand, the mean proportion of specific memories was significantly lower in the SP condition compared to the NSP condition, $d = 0.89$ (Block 4), $d = 0.69$ (Block 5), and $d = 0.66$ (Block 6). The latter confirmed our second hypothesis, which stated that participants from the SP condition would be significantly less specific after the operant conditioning procedure, compared to participants from the NSP condition.

Second, we tested the effect of block within each condition. We conducted two repeated-measures

![Figure 1](image_url). Mean proportion of specific memories in each block in the specific-punishment ($n = 21$) and nonspecific-punishment ($n = 20$) condition. Error bars represent standard errors.
ANOVAs with block as the within-participants variable, one in each condition. In the NSP condition the main effect of block was significant, $F(5, 95) = 3.61, p < .01, \eta^2_p = .160$. There was a significant increase in memory specificity over blocks in this condition: significant linear trend, $F(1, 19) = 12.14, p < .01, \eta^2_p = .390$. In the SP condition, on the other hand, the main effect of block was not significant, $F(5, 100) = 1.47, p = .208$. Similarly, paired $t$-tests indicated that the difference in proportion of specific memories between Block 1 and 6 was significant in the NSP condition, $t(19) = -2.85, p < .05, d = 0.64$, but not in the SP condition, $t(20) = 1.53, p = .143$. Our third hypothesis was thus only partly confirmed: Whereas memory specificity significantly increased over blocks in the NSP condition, we failed to find evidence for a decrease in memory specificity in the SP condition.

### DISCUSSION

In the CaRFA model (Williams et al., 2007) functional avoidance is incorporated as one of the mechanisms underlying OGM. In this view OGM is considered as a learned cognitive avoidance strategy, based on principles of operant conditioning: Individuals learn to avoid the emotionally punishing consequence of retrieving specific memories about very negative events by aborting the hierarchical autobiographical memory retrieval process at the stage of overgeneral memories (Hermans, de Decker, et al., 2008; Raes et al., 2003; Williams et al., 2007). The aim of the present study was to test one of the basic assumptions of the functional avoidance hypothesis, namely that autobiographical memory retrieval can be brought under operant control. We developed a new operant conditioning paradigm in which participants were asked to retrieve autobiographical memories in response to 60 cue words (six blocks of 10 cues). Depending on the condition, participants were punished with an aversive sound following the retrieval of specific (SP condition) or following the retrieval of non-specific memories (NSP condition).

Results confirmed our first hypothesis: Our analyses showed that the course of memory specificity significantly differed between conditions. In addition we failed to find evidence that the significant operant conditioning effect was mediated by CAness. Our second hypothesis was also supported. Conditions did not significantly differ in memory specificity in the first part of the experiment (Blocks 1, 2, and 3). In the second part of the experiment (Blocks 4, 5, and 6), on the other hand, participants punished for nonspecific memories retrieved significantly more specific memories, compared to participants punished for specific memories. Our third hypothesis was only partly confirmed: Whereas participants’ memory specificity gradually increased in the NSP condition, it did not significantly change in the SP condition.

We assessed participants’ mood before and after the operant conditioning procedure and their evaluation of the (un)pleasantness of the sound after each block. Analyses indicated that the conditions did not have a differential effect on mood or on the evaluation of the sound. The observed significant operant conditioning effect

### TABLE 1

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Independent $t$-tests comparing the mean proportion of specific memories in the specific-punishment ($n = 21$) and the nonspecific-punishment condition ($n = 20$) per block. In Block 3 Levene’s test indicated unequal variances across conditions ($F = 4.23, p < .05$). Therefore a $t$-test assuming unequal variances $(df = 34)$, was used to test the significance of the difference in mean proportion of specific memories between conditions in Block 3.
may thus not be attributed to simple effects of negative mood induction or to differences in the perceived aversiveness of the punisher. With regard to the ratings of the sound, it is important to note that participants in both conditions gradually rated the sound as less unpleasant over the course of the experiment. This general effect might have multiple causes; for example, habituation, less exposure to the sound in participants who showed an effect of the operant conditioning, or increasing predictability of the occurrence of the sound in CA participants.

As already stated, we failed to find evidence for CAness as a significant moderator of our operant conditioning effect. It must be noted, however, that the study might have lacked power to reliably test the triple interaction between CAness, condition, and block. Moreover, the CA group was small and heterogeneous. For example, whereas some participants indicated that they had used their awareness of the contingency to try to avoid the sound during the experiment, others said that they had become CA only during the interview. To allow a more thorough investigation of the role of CAness in the operant conditioning of autobiographical memory specificity, it would be interesting to experimentally manipulate CAness in a future study.

Two considerations should be made with regard to the issue of CAness. First, researchers in the field of (operant) conditioning have made an important distinction between CAness and demand awareness (e.g., Allen & Janiszewski, 1989; Page, 1972). While the first only implies awareness of the contingency between a certain behaviour and its consequences, the latter implies awareness of the performance hypothesis of the experimenter. A participant who is CA may develop demand awareness, but, importantly, according to Page (1972), demand awareness does not necessarily follow CAness. In the light of this distinction between CAness and demand awareness, it is interesting to note that the vast majority of CA participants were not able to verbalise the hypothesis of the experiment, when explicitly asked to do so in the interview. This might indicate that a considerable number of CA participants may not have been demand aware.

Second, the functional avoidance view on OGM does not assume that all stages in the development of OGM happen outside conscious awareness. People might actually learn that reducing memory specificity is helpful to avoid negative memories and their associated emotions in a conscious way, but later apply this learned retrieval strategy in an unconscious way. This view opens interesting possibilities for future studies in which the learning process that is assumed to underlie OGM, according to the functional avoidance hypothesis, might be investigated in a more ecologically valid way. In a future paradigm the participant could be made fully aware of the contingency, after a first, short learning phase, in which he/she experiences that the sound follows certain memories. This full activation of CAness could then be followed by a second learning phase in which the participant can apply his/her CAness to avoid the sound. The critical test in such a paradigm would consist of an implicit measure of memory specificity (e.g., Sentence Completion for Events from the Past Test; Raes, Hermans, Williams, & Eelen, 2007), administered after the operant conditioning procedure. Based on the assumption that people might acquire the contingency consciously but apply it unconsciously, we would predict that memory specificity on the implicit test would be significantly lower in the SP condition than in the NSP condition.

As mentioned earlier, contrary to our hypothesis, memory specificity did not significantly decrease in the SP condition. In the NSP condition, on the other hand, we observed a significant increase in memory specificity, as predicted. There are at least two possible explanations for this pattern of results. First, it might have been due to the unequal distribution of the number of CA participants: in the NSP condition 45% of participants (9 out of 20) were CA, compared to only 19% (4 out of 21) in the SP condition. In other words, the absence of an effect in the SP condition might have been due to a lack of CAness. It should be noted, however, (a) that the difference between conditions in the contingency aware/unaware ratio was only marginally significant, $\chi^2(1) = 3.19, p = .074$ and (b) that we do not have evidence at this moment that CAness moderates the operant conditioning effect (see above).

A second possible explanation lies in the search process that is supposed to underlie the retrieval of memories in this experiment. As in the AMT, memory retrieval in the experiment is based on a hierarchical, voluntary, directed, top-down retrieval strategy (Conway & Pleydell-Pearce, 2000). This process moves from conceptual, abstract information, corresponding to more general (non-specific) memories, to more event-specific material, high in sensory perceptual detail, corresponding
to specific memories. The memory system is accustomed to using general descriptions, the early responses in the retrieval process, to cue further memory searches (Conway & Pleydell-Pearce, 2000). Each general description thus opens a lot of options for the next stage of directed search. In this regard it is possible that general descriptions are more conditionable in this experiment, compared to specific memories, because the aversive stimulus can prompt multiple options for further searching very quickly. By contrast, specific memories might be less amendable to punishment because they represent one “end” of voluntary search strategies. The response window that was used in the present experiment might thus be too short to allow participants to restart the search process and stop it at the level of overgeneral memories. Further research needs to examine whether, with different response windows, the pattern of findings might change.

The present study has some limitations. First, the present experimental design did not contain a control condition. As a consequence we cannot determine which of the conditions significantly differs from a possible “natural” change in memory specificity due to, for example, fatigue or practice effects, induced by the retrieval of such a large number of personal memories. In other words, although memory specificity did not decrease significantly in the SP condition, it might still be the case that this more or less stable pattern significantly differs from a “natural” increase in memory specificity, while the significant increase in the NSP condition does not. Interesting control conditions to include in future experiments would be a no-punishment condition and/or an “explicitly unpaired” condition in which punishment is explicitly non-contingent on the specificity of participants’ memories (i.e., the number of punished specific memories is equal to the number of punished nonspecific memories). Second, given that the study was conducted in a rather homogeneous, largely female, student sample, the generalisability of the present findings to other nonclinical samples requires further investigation.

The present study’s finding that people’s autobiographical memory specificity can be increased through a learning process (cf. significant effect of block in NSP condition), further supports the feasibility of recently developed training programmes to increase memory specificity in (formerly) depressed individuals (Raes, Williams, & Hermans, 2009; Watkins & Moberly, 2009). Obviously it seems inadvisable to use punishment-based procedures in clinical practice. Future studies should therefore also investigate the effect of reinforcement on memory specificity.

According to the functional avoidance view, OGM can be the result of an operant learning process: The retrieval of specific memories about intensely negative events is “punished” by the reactivation of the associated negative emotions and people learn to avoid this punishing consequence by retrieving memories in a less-specific format. Although multiple lines of research have provided evidence for the functional avoidance hypothesis of OGM, the basic assumption that autobiographical memory retrieval can be brought under operant control, has hitherto not been investigated. The present experiment is the first to fill this important gap in the literature.

Our results showed that autobiographical memory retrieval can be shaped by an operant learning process. That is, they indicated that memory specificity can increase as a function of the negative consequences of general retrieval. However, importantly, there was no evidence that memory specificity significantly decreased following the punishment of specific memories. We thus found no support for the core assumption of the functional avoidance account that OGM can develop as an avoidance strategy for the punishing emotional consequences of retrieving specific memories. Unfortunately, as discussed above, the absence of a control condition hampers an unambiguous interpretation of the present results. Future experiments containing a control condition are needed to further investigate the absolute effects of punishment of specific versus general memories. Nevertheless, the present findings provide an interesting first step in a to-be-extended research line. In this perspective our newly developed operant conditioning procedure seems a promising paradigm to further investigate the operant conditionability of autobiographical memory.

REFERENCES


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APPENDIX: POST-EXPERIMENTAL INTERVIEW

1. Before I start the other questions, do you have any remarks regarding the experiment?

2. Did you hear about this experiment before, for example, via fellow-students? Or did you hear about this research domain before? And if so, what did you already hear?

3. What do you think we want to investigate in this experiment? (What is our hypothesis?)

4. Did you notice anything special with regard to the unpleasant sound you heard now and then?

5. Do you remember the instruction I gave you about the unpleasant sound? (participant has to specify, experimenter prompts if participant does not answer that the occurrence of the sound was related to the type of memory he/she retrieved)

6. (only if the participant did not mention the connection between the occurrence of the sound and the type of memory retrieved in response to question 5) Do you remember which instruction I gave you about the connection between the unpleasant sound and another aspect of the experiment?

7. Did you have the feeling/the impression that you had any control of the administration of the sound? Or did you try to avoid the administration of the sound in a certain way? And if so, in what way?

8. Do you think that the sound was somehow related to certain aspects of the experiment? And if so, with what aspects?

9. Do you think the sound was somehow related to the answers you gave? In other words, did you notice a common feature of the memories that were followed by the sound? Maybe something about the content of the memories, or the way of formulating them? If so, what?

10. Do you think that the sound was somehow related to the type of memory you retrieved? If so, in what way?

11. I will now present you a few aspects of your memories that could have been connected with the administration of the sound. I will ask you to choose one of these options. Was the administration of the sound connected with:

   ○ how fast you responded?
   ○ the time period from which your memory dated?
   ○ the valence (positive or negative) of the word for which you had to retrieve a memory?
- the valence (positive or negative) of the memory you retrieved?
- whether the word, in the memory you retrieved, referred to yourself or to others?
- whether you described a specific memory/event or a nonspecific memory/event?
- a returning theme or a returning content throughout your memories?
- whether it was an important or a more trivial ('banal') memory?
- your use of words or sentence structure when describing the memory?
- something else, namely...?