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Automatization and familiarity in repeated checking

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ABSTRACT

Repeated checking paradoxically increases memory uncertainty. This study investigated the underlying mechanism of this effect. We hypothesized that as a result of repeated checking, familiarity with stimuli increases, and automatization of the checking procedure occurs, which should result in decreased memory confidence. We also hypothesized that defamiliarization of the stimuli background leads to de-automatization of checking procedures, and thereby attenuates the effects of repeated checking on memory.

Eighty-nine healthy participants performed a computerized checking task, in which they had to activate, deactivate, and check threat-irrelevant stimuli. In a pre- and post-test, participants re-checked stimuli, after which they rated confidence in their memory about the last check. They also completed a reaction time task during the pre- and post-test, to assess automatization of the checking task, in which they responded to tones that were randomly presented. To test the effects of defamiliarization, the perceptual characteristics of the stimuli background were modified.

Results showed that repeated checking led to reductions in memory confidence. Furthermore, re-checking led to automatization of checking procedures, but automatization did not mediate the relationship between repeated checking and memory confidence. Defamiliarization did not lead to de-automatization, nor did defamiliarization attenuate the detrimental effects of re-checking on memory confidence.

1. Introduction

Repeated checking is an important feature of obsessive-compulsive disorder (OCD) (Fullana et al., 2009), and occurs in around 80% of afflicted patients (Ball, Baer, & Otto, 1996; Ruscio, Stein, Chiu, & Kessler, 2010). When asking patients with OCD why they repeatedly check their actions, they usually report they do not trust their memory (Reed, 1985). Rachman (2002) suggested that reduced confidence in memory is one of the key features in compulsive checking. Studies have demonstrated that actual memory performance of patients suffering from OCD is the same as healthy controls, but patients report that they desire higher levels of memory vividness in order to trust their memories completely (Constans, Foa, Franklin, & Mathews, 1995). Furthermore, other studies indicated that patients with OCD experience greater intolerance of uncertainty compared to non-clinical controls (Steketee, Frost, & Cohen, 1998; Tolin, Abramowitz, Brigidi, & Foa, 2003). This suggests that OCD patients may place higher demands on their memories in general.

Several authors have used an obsessive-compulsive like checking task, and demonstrated that repeated checking is a counter-productive strategy, which reduces memory uncertainty (Boschen & Vuksanovic, 2007; Dek, van den Hout, Engelhard, & Giele, 2010; Coles, Radomsky, & Horng, 2006; van den Hout & Kindt, 2003a, 2003b, 2004; Radomsky, Gilchrist, & Dussault, 2006). In the original experiment using this task (van den Hout & Kindt, 2003a), participants were administered a computer task in which they had to activate, deactivate, and check different stimuli, and rate their confidence in memory in a pre-test and post-test. In between the pre- and post-test, the relevant checking group performed 20 checks on the same stimuli, while the irrelevant checking group performed 20 checks on different stimuli than those used in the pre- and post-test. Results indicated that while memory accuracy remained unaffected, memory confidence paradoxically declined after repeated relevant checking (van den Hout & Kindt, 2003a, 2003b). This effect has been found with virtual stimuli (Boschen & Vuksanovic, 2007; van den Hout & Kindt, 2003a, 2003b, 2004), real-life stimuli (Coles et al., 2006; Radomsky et al., 2006), and threat-irrelevant stimuli (Dek et al., 2010), and even with a relatively low number of checks (Coles et al., 2006). The effect occurs in healthy controls (Coles et al., 2006; van den Hout & Kindt, 2003a, 2003b, 2004; Radomsky et al.,

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2006), and OCD patients (Boschen & Vuksanovic, 2007). Thus, not only does memory uncertainty serve as a motive for compulsive checking, repeated checking seems to paradoxically increase uncertainty about memory as well. The 'checking -> memory uncertainty' paradigm is not specific to OCD, but seems to be a general phenomenon. Although patients with OCD have lower initial memory confidence ratings before perseverative checking, they show similar reductions in memory confidence as a result of checking compared to controls (Boschen & Vuksanovic, 2007). Patients with OCD do seem to be more sensitive to the negative effects of perseveration on memory confidence when perceived responsibility for a mild shock to another person was added (Boschen & Vuksanovic, 2007).

Explaining their results, van den Hout and Kindt (2003a) suggested that repeated checking increases familiarity with the checked stimulus. Familiarity leads to the prioritizing of higher-level, 'semantic' aspects of the stimulus (Johnston & Hawley, 1994; Roediger, 1990), while, at the same time, its lower-level, 'perceptual' aspects are inhibited. This shift from perceptual to conceptual processing was thought to reduce vividness and detail of the person's recollection of the stimulus, thereby reducing memory confidence. van den Hout and Kindt labeled this as automatization-induced reduction of memory confidence.

In perseverative checking, the same act with the same stimuli is continuously repeated, and as a result familiarity should increase and the act of checking gradually becomes more automatic. Checking becomes more efficient and is executed faster. If perseverative checking leads to automatization, an increasing number of checks will require less cognitive capacity, and, hence, more cognitive capacity becomes available for other processes to co-occur. This hypothesis was tested in the present study.

Since familiarity is supposed to play an important role in automatization (Glass & Holyoak, 1986; Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977; Shiffrin, 1988), it follows that defamiliarization leads to (partial) de-automatization. When a person is required to perform an automatic routine with a novel stimulus (e.g., driving in a rental car in an unfamiliar city), the automatic routine requires more attentional control and conscious decision making (Bargh, 1989). In other words, defamiliarization of the stimulus or environment leads to partial de-automatization of the automatic routine (more explicit consciousness and deliberate attention are required while driving).

Boschen, Wilson, and Farrell (2011) studied the effect of defamiliarization in the context of OCD research. They hypothesized that by experimentally manipulating the distinctiveness and novelty of a stimulus, the shift from perceptual to conceptual processing would be reduced, thereby leading to smaller reductions in memory confidence. They used the van den Hout & Kindt checking task and added a 'perceptual change' condition, in which the color of stimuli was altered after every five checks. They replicated previous results on meta-memory of relevant as opposed to irrelevant checking. More importantly, as expected, modifying the perceptual characteristics of stimuli reduced the decrease in memory confidence levels after repeated relevant checking.

However, an alternative explanation of the findings is that by perceptually modifying the stimuli after every five checks, no shift in processing may have occurred to begin with. Automaticity theories (Shiffrin & Schneider, 1977) emphasize the importance of practice and stimulus consistency for processes to become automated. Thus, it is possible that the five-check perceptual alterations *prevented* automatization (i.e., the shift to conceptual processing) rather than *undoing* automatization.

The current study examined whether repeated checking leads to automatization. If automatization would result from re-checking, one would not only expect faster checking, but also increased cognitive capacity for simultaneous cognitive operations. To test this hypothesis, we used the van den Hout and Kindt (2003a) checking task, and added a reaction time (RT) task. We expected that (1) repeated relevant checking would lead to a decrease in memory confidence, vividness and detail while actual memory accuracy would remain unaffected, and that this well documented effect would also occur if participants carried out a secondary RT task, (2) as a result of automatization the performance on both the checking task and the secondary RT task would be improved after repeated checking (measured as shorter check durations and faster RTs, respectively), and (3) the effect of repeated checking on (meta-)memory uncertainty is mediated by automatization.

In addition, we tested whether defamiliarization by altering perceptual characteristics would lead to (partial) de-automatization of checking, which would result in slower RTs on the RT task for a relevant checking with defamiliarization condition. Furthermore, if defamiliarization would cause de-automatization of checking, we hypothesized that memories of checking would become more detailed and vivid, thereby attenuating the detrimental effects of repeated checking on memory confidence. Using a modified version of the van den Hout and Kindt checking task, there were three conditions: relevant checking without defamiliarization, irrelevant checking, and relevant checking with defamiliarization. Since manipulating contextual information of an item by changing its color has been associated with enhanced distinctiveness and recall of the item itself (Oker & Versace, 2010), we decided to modify the *background* color of stimuli in the defamiliarization condition rather than the color of stimuli. Furthermore, to allow potential automatization, we decided to alter the perceptual characteristics in the defamiliarization condition only at the post-test. We expected that (4) defamiliarization leads to de-automatization on both the checking task and the RT task (measured as longer check durations and slower RTs compared to repeated checking without defamiliarization), and (5) defamiliarization reduces the negative (meta-)memory effects of repeated checking. Since we wanted to investigate possible underlying processes of the general 'checking -> uncertainty' phenomenon, we deliberately decided not to test this in patients, but in a healthy sample.

2. Method

2.1. Participants

Ninety undergraduate students (59 females) participated in this study. They were, on average, 21.9 (SD = 2.9) years old, and were given a small remuneration or course credit for their participation.

2.2. Procedure and computer task

Participants were tested in a dimly lit, sound-attenuated laboratory room. They were seated in front of a computer screen and asked to perform a computer task, during which they had to answer a questionnaire using Visual Analogue Scales (VASs). The computer task took approximately 20 min, and consisted of two partially simultaneously administered tasks.

2.2.1. Computer task, part I: checking task

A modified version of the 3D checking computer task by van den Hout and Kindt (2003a) was used. Following Dek et al. (2010), the present study used abstract stimuli: large green star-circles or small gray circles were presented on a dark gray background. The checking task started with a training phase during which participants were trained to activate and deactivate the stimuli with the computer mouse, thereby intensifying the color of the circles. In the pre-test, participants had to execute one checking trial. They were shown a schematic diagram in which three of six circles were crossed. Participants were asked to activate the large green star-circles or the small gray circles (this was counterbalanced across conditions). Next, they were asked to deactivate them, and finally to check whether they had done this accurately. Participants were then asked to fill out a questionnaire about this checking trial (see: Section 2.3). Check duration of