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Retroactive memory interference: A potential countermeasure technique against psychophysiological knowledge detection methods

Nurit Gronau[a,*], Lotem Elber[b], Shai Satran[b], Assaf Breska[b], Gershon Ben-Shakhar[b]

[a] Department of Psychology & Cognitive Science Studies, The Open University of Israel, Raanana, Israel
[b] Department of Psychology, The Hebrew University of Jerusalem, Israel

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ABSTRACT

The concealed information test is designed to detect concealed knowledge through differential physiological responses elicited by the concealed items. This study was designed to examine the role of retroactive interference (RI) as a potential countermeasure that may weaken memory traces of the concealed items and attenuate the physiological responses elicited by them. A total of 120 participants committed a mock crime and were randomly assigned to either an interference condition, where they learned and retrieved an alternative mock crime, or a control condition. Further, each group was randomly assigned to one of three "time-delay" conditions. The results revealed that both memory for the mock crime details and the skin conductance responses (SCRs) to these details were attenuated under the memory-interference condition. Time of testing affected recall, but had no effect on the SCRs. In addition, the memory-interference manipulation had no effect on the respiration measure. Theoretical and practical implications of these results are discussed.

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Research interest in psychophysiological detection of deception has significantly increased since the September 11 terror attack in the USA. In particular, the concealed information test (CIT), designed to detect memory traces that can connect suspects to a certain crime, has been extensively studied (Ben-Shakhar, 2012; Rosenfeld, Ben-Shakhar, & Ganis, 2012; Verschuere, Ben-Shakhar, & Meijer, 2011). The CIT is not a deception test, but rather aims to detect whether an examinee possesses certain crime-related information (see Verschuere et al., 2011). It can be used as an aid to law enforcement agencies because possessing crime-related information may imply involvement in the crime, while lack of such knowledge may exonerate a suspect. In the CIT, examinees are presented with a series of multiple-choice questions, each having one relevant (correct) alternative, e.g., a feature of the crime under investigation, and several neutral, control (incorrect) alternatives, chosen so that an innocent suspect would not be able to discriminate them from the relevant alternative. However, for guilty suspects who are familiar with the crime details and are able to discriminate them from the neutral items, these crime-related items are of great significance and are consequently expected to elicit enhanced physiological reactions (Lykken, 1974; Verschuere & Ben-Shakhar, 2011).

The validity of the CIT has been examined extensively under experimental laboratory conditions since the 1950s (e.g., Gustafson & Orne, 1963, 1965; Lykken, 1959, 1960; Kugelmass & Lieblich, 1966). More recently it has been subjected to several meta-analytic studies (Ben-Shakhar & Elaad, 2003; MacLaren, 2001; Meijer, Klein-Selle, Elber, & Ben-Shakhar, 2014) that revealed impressive effect size estimates. For example, Meijer et al. (2014) covered 100 laboratory studies, which used two CIT paradigms (for detection of self-referring personal information, as well as mock crime information) and utilized three ANS measures (skin conductance response—SCR, respiration line length—RLL, and heart rate—HR) as well as the P300 component of the event-related potential. The reported overall averages of Cohen's *d* effect size (Cohen, 1988), reflecting the differentiation between guilty and innocent examinees, were 1.55, 1.11, 0.89, and 1.89 for these four measures, respectively. It should be noted that although the four measures differed significantly in their effect size, even the HR that was the least effective measure yielded a large effect size.

* Corresponding author. Tel.: +972 97781468.
E-mail address: nuritgro@openu.ac.il (N. Gronau).

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However, as mentioned above, these impressive validity estimates were based on laboratory experiments and it is yet unclear whether their results would generalize to realistic applications of the CIT (see Carmel, Dayan, Naveh, Raveh, & Ben-Shakhar, 2003). For example, the bulk of CIT research used the mock crime paradigm, where subjects assigned to the "guilty" condition are instructed to steal something (e.g., an envelope containing money and jewelry). Typically, the experiments are designed to optimize memory of the critical items. Thus, for instance, the CIT is conducted immediately after completion of the mock crime, and often memory of the critical items is verified before the administration of the CIT. Clearly, in reality, the situation is very different and culprits do not necessarily pay attention to all of the crime scene details. Furthermore, the test is usually delayed and may be administered weeks or months after the event. Thus, memory of the critical items, which is clearly crucial for a successful CIT, may be compromised in realistic setups but not in laboratory studies. Indeed, several studies that have examined the role of memory for critical items on the CIT's outcomes (Carmel et al., 2003; Gamer, Kosiol, & Vossel, 2010; Nahari & Ben-Shakhar, 2011) revealed that when the CIT is administered 1 or 2 weeks after the mock crime, certain critical items are not recalled and do not elicit differential responses. However, consistent with memory research (e.g., Kensinger, Garoff-Eaton, & Schacter, 2007; Loftus, 1979; Safer, Christianson, Autry, & Osterlund, 1998), memory loss occurs mostly with 'peripheral' items (features that are not directly related to the execution of the crime, such as a picture on the wall of the crime scene). 'Central' features, such as type of weapon used or the stolen item, are typically recalled and are capable of eliciting large responses even when the test is delayed (e.g., Hu & Rosenfeld, 2012).

Various additional factors may differentiate the artificial laboratory conditions from those characterizing realistic lie-detection situations. One of these factors, which is the focus of the present study, is the possibility that guilty suspects try to avoid detection by using countermeasures to distort their physiological responses. The effects of countermeasures on the outcomes of the CIT have been studied with both ANS measures (e.g., Ben-Shakhar & Dolev, 1966; Honts, Devitt, Winbush, & Kircher, 1996) and ERPs (Mertens & Allen, 2008; Rosenfeld, Soskins, Bosh, & Ryan, 2004). Most of these studies demonstrated large effects, showing a dramatic increase in false-negative outcomes when examinees performed countermeasures (for a review see Ben-Shakhar, 2011). One exception to this finding is a new CIT protocol, called the *Complex Trial Protocol*, which was proposed by Rosenfeld et al. (2008) and has been repeatedly demonstrated by Rosenfeld and his colleagues to be relatively resistant to countermeasures in CIT based on the P300 component (Meixner & Rosenfeld, 2010; Rosenfeld & Labkovsky, 2010; Winograd & Rosenfeld, 2011).

The bulk of countermeasures studies relied either on physical countermeasures (e.g., subjects can bite their tongue to inflict pain when the control items are presented) or on mental means (e.g., recalling exciting and emotional memories during presentation of control items). Both types of countermeasures involve specific actions taken during the CIT in an attempt to increase responses to the neutral items and reduce CIT effectiveness. In this study, we examined a completely different type of potential mental countermeasure that involves an attempt to learn, *prior* to the CIT, self-generated false information in order to interfere with memory of the *crime-related* details. As mentioned earlier, the CIT is based on increased physiological responses to items that match existing memory traces (e.g., of the committed crime), and therefore its success depends on the strength of these memory traces. Several studies have shown a positive correlation between explicit memory performance for crime-related information and CIT detection efficiency (Ben-Shakhar, Gronau, & Elaad, 1999; Carmel et al., 2003; Iacono, Boisvenu, & Fleming, 1984; Verschuere, Crombez, Koster, Van Bockstaele, & De Clercq, 2007; Waid, Orne, Cook, & Orne, 1978; Waid, Orne, & Orne, 1981). Accordingly, any technique that interferes with memory of the critical items may reduce the sensitivity of the CIT in differentiating between critical and neutral (control) items.

In the present study we examined, for the first time, the effects of a memory-interference technique, in which a culprit deliberately memorizes post-event information in order to weaken and perhaps eliminate original memory traces of a committed crime. Ample evidence has documented the detrimental effects of post-event interfering information on memory for an event or a crime scene. Classic studies investigating retroactive interference (RI) have shown that learning new material after an encoding phase hinders memory for the initially encoded items (e.g., Barnes & Underwood, 1959; Postman & Underwood, 1973; Underwood, 1948a,b). Interference is particularly robust when the experimental design involves competition among old and new items sharing the same retrieval cue (see, e.g., Anderson & Neely, 1996). Several key studies have investigated retroactive interference effects in the context of eye-witness memory and/or memory distortion induced by late exposure to misinformation. Loftus and colleagues, for instance, have repeatedly shown that exposing participants to post-event information, either through leading interrogative questions, false information, or false imagination, contaminates participants' memory for a witnessed event (e.g., Loftus, 1979, 1996; Loftus & Hoffman, 1989; Nourkova, Bernstein, & Loftus, 2004; Thomas & Loftus, 2002; see Frenda, Nichols, & Loftus, 2011, for a recent review of the misinformation effect).

While the bulk of studies examining the constructive nature of memory have stressed the unreliability of memory and its vulnerability to external interference manipulations (see, e.g., Allen & Mertens, 2009, for false memory findings in the context of the CIT), the present study aims to investigate whether post-event interference may in fact serve as a deliberate, self-initiated mental technique for distorting and/or weakening memory traces for a crime. Participants in the current research committed a mock crime (i.e., a theft) and then were instructed to learn a hypothetical alternative crime scenario. In order to optimize memory interference as a countermeasure technique, the hypothetical crime scenario was constructed of items from the same categories of the actual mock crime. Subsequently, the participants performed a CIT and were tested for knowledge of the original crime details. We hypothesized that the competing information of the alternative crime scenario (e.g., a specific amount of money or a type of jewelry stolen) would weaken memory traces for the details of the original mock crime performed by the subjects. Accordingly, detection efficiency of the crime-relevant information in the CIT would be reduced, compared to detection efficiency among members of a control group who were not exposed to the alternative crime scenario.

Furthermore, we aimed to test the interaction between the retroactive interference manipulation and the natural decay of memory traces occurring with the passage of time. We therefore added a temporal factor potentially affecting memory performance, by manipulating the time delay between the initial mock crime, the RI manipulation, and the CIT. This time-delay manipulation resulted in three different "time delay" conditions: (a) Participants committed a mock crime, immediately learned an alternative crime scenario (or performed a neutral-control task) and then immediately took the CIT; (b) participants committed a mock crime, immediately learned an alternative crime scenario (or performed a neutral-control task), but took the CIT a week later; (c) participants committed a mock crime and were invited to the laboratory a week later, during which time they learned an alternative crime scenario (or performed a neutral-control task) and then immediately took the CIT. Note that subsequent to the CIT, participants

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