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Strength of memory encoding affects physiological responses in the Guilty Actions Test

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ABSTRACT

The Guilty Actions Test (GAT) is a valid and scientifically sound technique of forensic psychophysiology that allows for the detection of concealed memories. However, its application has been challenged because the results might be affected by the culprit's forgetting of crime details as well as the leakage of information to innocents. In the current study, these aspects were examined by varying the amount of time between a mock crime and the subsequent GAT, as well as by contrasting culprits with informed innocents. It turned out that culprits specifically forgot peripheral crime details during a period of 2 weeks whereas informed innocents showed similar forgetting for all details. As a consequence, GAT validity based on electrodermal, respiratory and heart rate measures remained temporally stable for culprits whereas the amount of false positive errors for informed innocents decreased as a function of time. These results indicate that the process of memory encoding and consolidation has significant effects on the physiological response pattern in the GAT.

1. Introduction

The Guilty Knowledge or Concealed Information Test (GKT, CIT) is a method of forensic psychophysiology that allows for the detection of concealed crime related knowledge (Lykken, 1959, 1974). It is based on a series of questions presented in a multiple choice format that ask for specific details of the crime under investigation (e.g., the weapon that was used for an armed robbery). It is assumed that guilty examinees recognize the correct relevant item among the irrelevant alternatives and show a larger physiological response to it. This response typically consists of a skin conductance increase, respiratory suppression and heart rate deceleration (Gamer et al., 2006). Innocents who are not able to differentiate between these item types within each GKT question are assumed to show a non-systematic response pattern. A number of laboratory studies found high validity coefficients for the GKT in differentiating between guilty and innocent examinees (for reviews, see Ben-Shakhar and Elaad, 2003; MacLaren, 2001).

However, as a method for the detection of crime related information in forensic cases, the GKT has been frequently criticized because of its strong reliance on recognition memory (e.g., Honts, 2004). Specifically, culprits might forget crime related details before undergoing a GKT examination which would reduce the sensitivity of the test. Indeed, it was suggested that the relatively low sensitivity of the GKT found in field studies (50% in Elaad, 1990; and 76% in Elaad et al., 1992, when excluding inconclusive cases) is related to the forgetting of crime related information or the use of countermeasures. However, several other methodological shortcomings, in particular the small number of GKT questions in both studies, can also account for these results (cf. Ben-Shakhar and Elaad, 2003, p. 146; Lykken, 1998, p. 291f). A second point of criticism is related to the fact that crime details may also become available to innocents for example by mass media. Given that these items are encoded deeply enough to be remembered in a subsequent GKT examination, this leakage of information would increase the risk of false positive results and reduce the test's specificity.

Both above-mentioned points are related to the fact that encoding processes were rarely studied systematically in previous research on the GKT. In laboratory studies relying on the mock crime paradigm, it was typically guaranteed that participants took notice of all relevant details and it was assured that they remembered them in the subsequent GKT examination (e.g., Bradley et al., 1996). In some studies, physiological responses to forgotten items were removed from the analyses (e.g., Elaad and Ben-Shakhar, 2008; Elaad, 2009). With respect to the leakage of

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information to innocents, previous studies showed that knowledge of critical details is sufficient to generate differential physiological responses to relevant and irrelevant GKT items (e.g., Furedy and Ben-Shakhar, 1991). Therefore, Bradley and colleagues proposed to slightly change the question wording of the GKT from passive knowledge (e.g. "What kind of jewelry *was stolen* last night?") to active misconduct ("What kind of jewelry *did you steal* last night?"). Several mock crime studies indeed found a higher specificity rate for informed innocents when this Guilty Actions Test (GAT) was used as compared to the standard GKT procedure (Bradley and Rettinger, 1992; Bradley and Warfield, 1984; Bradley et al., 1996). However, false positive rates for informed innocents were still found to be unacceptably high in GAT examinations (Ben-Shakhar et al., 1999; Gamer et al., 2008a).

In virtually all mock crime studies on the GKT or the GAT, participants were tested immediately after committing the simulated offence or being informed about it otherwise (e.g., by witnessing it). Thus, it is largely unknown how memory for crime related details changes across time in guilty participants and informed innocents and how such forgetting influences detection efficiency. The few studies that used a delayed GKT examination either did not report results for the detection efficiency as a function of time (Elaad, 1997) or they used only one highly salient detail (the stolen item) that could be successfully detected even after 1 year (Hira, 2003). Taken together, the GKT was primarily examined in relatively unrealistic laboratory settings until now that might not be representative for field conditions (Honts, 2004).

An exception to this is a study by Carmel et al. (2003) that systematically varied whether participants were informed about all relevant details in advance (standard mock crime procedure) or whether they were only roughly informed about the simulated theft without giving away all relevant details in the instruction (realistic mock crime procedure). Furthermore, half of the participants were tested immediately after the mock crime whereas the other half was tested 1 week later. The main outcome of this study was that participants in the realistic setting had less memory for crime related details and showed a weaker physiological differentiation between relevant and irrelevant GKT items than participants in the standard mock crime setting (cf. O'Toole et al., 1994). The time of test was not found to have a significant influence on GKT detection efficiency in general. When dividing the GKT items into central and peripheral details in a post hoc analysis, it turned out that recall rate was higher for the central details. Furthermore, when confining the analysis of the detection efficiency to this subset of items, no significant effects of mock crime procedure or time of test could be revealed. It has to be mentioned, however, that even in the realistic mock crime setting, half of the central details were also mentioned in the instruction and not only encoded during the mock crime itself (Carmel et al., 2003, p. 263). This confound limits inferences related to absent group differences for central details and it is not fully clear whether these items can indeed be fully encoded during the mock crime itself without the need to be additionally memorized in the instruction phase.

In the current study, guilty and informed innocent participants were examined in a realistic mock crime setting. All relevant details that were used for the GAT examination were not mentioned in the instruction. They were only perceived and encoded either during mock crime execution itself (guilty subjects) or by reading a fake newspaper article about the offence (informed innocents). Half of the participants were tested immediately and the other half was tested approximately 2 weeks later. An additional group of uninformed innocents was examined to calculate validity coefficients of the test. We expected that in the group of guilty subjects, central crime details should be more resistant to forgetting than peripheral ones. As these differential memory effects are likely to be related to the more elaborative encoding of actively handled central items (so-called enactment effect, Cohen, 1989) which increases depth of processing (Craik and Lockhart, 1972; for an overview see Baddeley, 1997, p. 120ff), they should not be found for informed innocents and this group should show a similar forgetting for both item types. These memory effects should also be reflected in the physiological responses of both groups in the GAT examination.

2. Methods

2.1. Participants

One hundred subjects (62 women, 38 men) with a mean age of 24.2 years (SD = 5.5 years) participated voluntarily in the study. Most of them were students of different fields (89%). Informed consent was obtained from each participant prior to the experiment, which was carried out in accordance with the Declaration of Helsinki.

2.2. Instruments

The Computerized Polygraph System (CPS, Stoelting Company, cf. Kircher and Raskin, 2002) was used to measure skin conductance, thoracic and abdominal respiration. Skin conductance was measured by a constant voltage system (0.5 V) using a bipolar recording with two Hellige Ag/AgCl electrodes (surface area = 1 cm^2) filled with 0.05 M NaCl electrolyte placed on the thenar and hypothenar surfaces of the participant's left hand. Respiration was recorded by two piezo-electric Pneumotrace II transducers attached around the chest and the abdomen with Velcro straps.

Additionally, an electrocardiogram (ECG) was measured using two Hellige Ag/AgCl electrodes filled with electrode paste and attached to the manubrium sterni and the left lower rib cage. The reference electrode was placed at the right lower rib cage. ECG-data were registered by the Varioport-device (Vitaport system, Becker Meditec) with a sampling rate of 512 Hz.

The physiological measurement was conducted in an air-conditioned, sound-attenuated chamber with participants seated in a semi-reclining chair. All recording and programming equipment was located outside the chamber, but the participants could be observed via a video system. A conventional personal computer was used to control the stimulus presentation and the timing of the measurement equipment.

2.3. Design

Basically, a 2 × 2 × 2 design with the between-subjects factors guilt (guilty vs. informed innocent) and delay between mock crime and GAT examination (immediately vs. approximately 2 weeks delayed) with 20 participants in each group was used. The type of GAT item was varied within subjects (central vs. peripheral). To estimate the validity of the test, an additional control group of 20 uninformed innocents was examined. Participants were pseudorandomly assigned to the experimental conditions by means of a predefined list.

2.4. Procedure

In the mock crime scenario, guilty participants were instructed to steal a briefcase from an open access departmental library. After finding the briefcase with an eye-catching *WWF sticker* in a *bookshelf*, they were told to leave the library and search for a computer room. In this room, they had to open the briefcase by identifying the correct last digit (7) of a three digit combination lock. The briefcase contained a *blue* CD and a *calculator*. A slip of paper in the jewel case of the CD revealed the user name and the password (the German word *Tannenbaum*) that should be used to log on one of the computers. Once the computer booted up, the participant could see a *landscape with sand dunes* as background picture on the screen. On the CD, there was only one document (*a test report*) that should be briefly scanned and memorized. Finally, guilty participants were asked to steal the CD while returning the briefcase to the place in the library where it was initially found. The eight critical details that were used as relevant items in the subsequent GAT examination are printed in *italics*. Importantly, none of these critical items was explicitly mentioned in the instructions. Thus, all items were solely perceived and encoded during committing the mock crime.

Items that must have been perceived in order to successfully accomplish the mock crime were designated as central details (the place where the briefcase was found, the last digit of the combination lock, the computer password, and the content of the CD) whereas the other items were more peripheral and might or might not have been perceived and encoded by the participant during the course of the mock theft (the sticker on the briefcase, the other item in the briefcase that was irrelevant for the theft, the color of the stolen CD, and the background picture of the computer).

Informed innocents were instructed to search for a pin board on another floor of the building. On this pin board, they had to find a fake newspaper article and were