Leakage of Relevant Information to Innocent Examinees in the GKT:

An attempt to Reduce False-Positive Outcomes by Introducing Target Stimuli

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ABSTRACT

This study focused on the Guilty Knowledge Test (GKT) - a psychophysiological detection method based on a series of multiple-choice questions, each having one relevant and several neutral (control) alternatives. The study examined a new method, designed to reduce false-positive outcomes, due to leakage of relevant items to innocent suspects, by introducing target items (i.e. items known to all examinees, but unrelated to the crime), to which subjects have to respond (e.g., by pressing a key), while answering the GKT questions. Informed innocents showed relatively larger electrodermal responses to the critical items than uninformed participants, but not as large as the responses made by guilty participants. No differences between informed and uninformed innocents were obtained with a respiration measure. The use of the target items tended to reduce the differences between informed and uninformed innocents. The results further demonstrated that electrodermal responding to the relevant items was correlated with memory of these items.

Key Words: Guilty Knowledge Test (GKT), Elctrodermal Measures, Respiration Line Length (RLL), Psychophysiological Detection

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The Guilty Knowledge Test (GKT) is a method of psychophysiological detection that has been extensively researched and discussed in the literature (e.g., Ben-Shakhar, 1991; Furedy & Heslegrave, 1991; Lykken, 1974, 1981). It utilizes a series of multiple-choice questions, each having one relevant alternative (e.g., a feature of the crime under investigation) and several neutral (control) alternatives, chosen so that an innocent suspect would not be able to discriminate them from the relevant alternative (Lykken, 1981). Typically, if the subject's physiological responses to the relevant alternative are consistently larger than the responses to all other alternatives, knowledge about the event (e.g., crime) is inferred.

This method protects innocent suspects because, as long as information about the event has not been leaked out, the relevant and control questions should be equivalent from their perspective. Under these conditions, the probability that an innocent suspect would show consistently larger responsivity to the relevant alternative than to the neutral ones depends only on the number of questions and on the number of alternative answers per question, and this probability can be controlled such that maximal protection for the innocent is provided. Indeed, a relatively large number of studies, which were conducted to assess the accuracy of the GKT, reveal that the rate of false-positive errors (innocent suspects classified as guilty) is around 5% (for a review of these studies, see, Ben-Shakhar & Furedy, 1990; Elaad, 1998).

However, a successful implementation of the GKT depends on the validity of the assumptions underlying it, and in particular on the assumption that the relevant information is not known to innocent suspects. This seems crucial because it has been assumed that knowledge of the "guilty information" is sufficient for creating psychophysiological differentiation between the relevant and the neutral items (e.g., Lykken, 1974). The concern about possible leakage of relevant information to innocent suspects is one of the reasons for the infrequent usage of the GKT as an aid in criminal investigations (e, g., Honts & Perry, 1992). In some cases, leakage of relevant information may not constitute a severe problem, because innocent suspects failing a GKT could explain how they became aware of the critical items (e.g., cite a newspaper which mentioned this information while describing the crime). But suspects can be exposed to some critical items during the interrogation without being aware of the circumstances in which this occurred, and without being able to prove that the information has been leaked. The research on the effects of misleading information on eyewitnesses (e.g., Zaragoza & Mitchell, 1996) demonstrates the vulnerability of human memory, and indicates that people cannot always account for the sources of their knowledge. Furthermore, some knowledgeable, but innocent witnesses to a crime might refuse to admit their knowledge due to fear of reprisal by the culprit.

The present study focuses on three major issues. First, it attempts to assess the robustness of the GKT to a violation of the critical assumption that only the guilty suspects have knowledge of the relevant information. Second, we hope to learn from this study about the mechanisms that underlie the phenomenon of differential autonomic responding to the relevant items. In particular, we are concerned with the assumption made by Lykken (1974), as well as by other cognitive approaches to psychophysiological detection (e.g., the dichotomization theory proposed by Ben-Shakhar, 1977 and by Lieblich, Kugelmass & Ben-Shakhar, 1970), that knowledge of the relevant items is sufficient to create the pattern of differential autonomic responding to these items. Third, an attempt was made to reduce the rate of false-positive outcomes among informed innocent examinees by introducing target stimuli (i.e. items known to all examinees, but unrelated to the crime), to which examinees have to respond (e.g., by pressing a key), while answering the standard GKT questions. The use of such target stimuli in a GKT task was employed by Farwell and Donchin (1991), who used an oddball paradigm for detecting information with ERP measures, but they have not been used in typical GKT experiments with autonomic measures. Recently, Elaad (1997) showed that the introduction of target stimuli does not affect the correct detection of guilty examinees, based on autonomic measures. We hypothesized that these targets would differentially attract the attention of the informed innocents (thus attenuating their responses to the relevant items), while having only a small effect on the guilty participants.

A number of studies examined the effects of exposing relevant information to innocent suspects on the validity of the GKT. The first two studies (Giesen & Rollison, 1980; Stern, Breen, Watanabe & Perry, 1981), examined this issue by utilizing mock crime experiments in which the same relevant information was presented to all subjects, but some received it in the context of a crime; while others were presented with the very same information, but in a neutral context. Thus, the critical items used in the GKT had a special meaning to all subjects. Nevertheless, the results indicated that the crime-related items produced stronger differential responsivity than the same items in an innocent context. Moreover, it was possible to discriminate between "guilty" and "informed innocent" participants on the basis of the electrodermal measure, with very few false positive outcomes (none in the former study and 11% in the latter).

Subsequent studies, conducted by Bradley and his colleagues, examined this issue using somewhat different procedures. In the studies reported by Bradley and Warfield (1984), and Bradley & Rettinger, (1992), both guilty and informed innocents received the relevant information in a crime context, but only the participants simulating the guilty actually performed the mock crime, while the informed innocents were just informed about the relevant details. In addition, these authors used a different version of the GKT, called the Guilty Action Test (GAT), in which suspects are asked if they actually committed the crime (e.g., "Did you murder the victim in ---?"), rather than if they knew about the crime (e.g., "Did the murder take place in---?"). The results of these studies revealed much larger false-positive rates among the informed innocents (25% in Bradley & Warfield, 1984, and 50% in Bradley & Rettinger, 1992), than the rates reported by Giesen and Rollison (1980), and Stern, et al. (1981).

In a more recent study, Bradley, MacLaren & Carle (1996) manipulated two important factors, in addition to the leakage of the relevant information: First, they compared the standard GKT with the GAT variation. This comparison is important because it differentiates between deception and mere knowledge. Thus, while both guilty and informed innocent suspects know the relevant details, only members of the former group are deceiving in their answers to the GAT questions. Second, they manipulated the verbal responses to the GKT and GAT questions. The results of this study resembled those obtained by Bradley and Rettinger (1992) in showing 50% false-positive rate among informed innocent subjects, under the GAT and a "No" response. In addition, they obtained a dramatic difference in the outcomes of the informed innocents between the two questioning formats (e.g., a 90% rate of false positives was obtained with the informed innocents under the "No" response condition in the GKT). The response mode also made a significant difference and informed innocents who answered "No" to the questions were more frequently classified as guilty than those remaining silent and not responding verbally to the questions.

The results of Bradley et al. (1996) imply that deception plays an important role in creating the pattern of differential responding to the relevant items. This issue was examined by several other researchers, who either manipulated the verbal responses to the GKT questions (e.g., Elaad & Ben-Shakhar, 1989; Furedy & Ben-Shakhar, 1991; Horneman & O'Gorman, 1985; Gudjonsson, 1982; Kugelmass, Lieblich & Bergman, 1967), or utilized the "differentiation of deception" paradigm (e.g., Furedy, Davis, & Gurevich, 1988; Furedy, Gigliotti, & Ben-Shakhar, 1994; Furedy, Posner, & Vincent, 1991). The conclusion that can be drawn from these results is that while deception is not a necessary condition for differential responding to the relevant questions, such a response pattern is typically increased by deception.

The purpose of the present study was to further investigate the effect of exposing the relevant information to innocent examinees on the validity of the GKT, and to examine whether this effect can be mitigated by the use of the target-items task. In addition, we examined whether the differences between guilty and informed innocent subjects could be accounted for by differences in the number of relevant items recalled by these two groups. We used the GAT version of questions' presentation for two reasons: (1) In the standard GKT procedure, informed innocents are differentiated from the uninformed innocents by both their knowledge of the critical items, and by their deceptive responses to the questions. Under the GAT format, both informed and uninformed innocents are telling the truth, and knowledge of the critical items is the only factor differentiating those two groups. Indeed, the results reported by Bradley et al. (1996) suggest that the use of the GAT format reduces false-positive outcomes in that group, as compared with the standard GKT format. (2) We believe that this formulation is particularly important in a simulation setup, because under the neutral and impersonal formulation of the GKT questions, participants in mock-crime studies might perceive the situation as irrelevant and not involving. The more personal formulation of the GAT questions may make these participants more concerned and more interested in the test, and thus create a setup, which is more similar to a realistic interrogation. It could be argued that the accusatory formulation of the questions, used in the GAT procedure may cause innocent suspects to react more strongly to the relevant questions. However, even if the accusatory format increases the general arousal of innocent suspects, there is no reason that they would show stronger reactions to the critical alternatives, than to neutral control alternatives (which are similarly formulated), as long as they do not possess the guilty knowledge.

Method

Participants. One hundred and eight undergraduate students participated in the experiment, for course credit or payment.

Instruments. Skin conductance was measured by a constant voltage system (0.5V ASR Atlas Researches), and two Ag/AgCl electrodes (0.8 cm diameter). Respiration was recorded by a pneumatic tube positioned around the thoracic area. The experiment was conducted in an air-conditioned laboratory, and was monitored from a control room separated from the laboratory by a one-way mirror. A Macintosh II computer was used to control the stimulus presentation and compute the physiological responses.

Design. A mock-crime procedure was used and participants were randomly allocated into the following three conditions (with 36 in each condition): (1) Guilty examinees who actually performed the mock crime; (2) informed innocents who did not perform the mock crime, but were exposed to the relevant items in the mock-crime context; (3) uninformed innocent participants who did not perform the mock crime and had no knowledge of the relevant information. An additional factor (the task of responding to target items) was manipulated within participants, with the following three levels: (a) No target items were included; (b) examinees were instructed to count the target items silently[1]; (c) participants were instructed to press a key as soon as they heard a target item. Each target-item condition was presented with a different question (e.g., the "count-item" condition was coupled with the question about the amount of money stolen), and one of the neutral alternative answers to this question was defined as the target item[2]. The order of the three target-item conditions and the pairing of questions with conditions were counterbalanced across participants within each guilt condition.

Procedure. Participants simulating the guilty were instructed to enter a locked room, using a key that was handed to them. In this room, they had to search for a colored envelope located in a certain specified place. They were instructed to "steal" this envelope, which contained a sum of money ranging from 3 to 8 NIS (about $1.2 to $3.2 at the time of the experiment), and an article of jewelry, to hide the money and the jewelry in their pocket, and to enter the examination room. Three classes of relevant items were used: The color of the envelope, the exact sum of money found in the envelope, and the type of jewelry found in the envelope. All participants simulating the innocents were instructed to walk by the locked room downstairs to the examination room and to wait for about one minute before entering it, but those who simulated the informed innocents were informed about the relevant details prior to the polygraph interrogation.

An experimenter who was unaware of the type of the "stolen" envelope and the experimental condition to which the examinee was assigned, attached the polygraph devices, and conducted the GKT examination. Participants were told that the experiment was designed to test whether they could cope with the polygraph test and convince the examiner that they are innocent of stealing the envelope with the money and the jewelry. They were promised a bonus of five NIS for a successful performance of the task. All examinees were presented with three different questions, each focusing on a different feature of the mock crime (color of the stolen envelope, the amount of money contained in the stolen envelope, and the type of jewelry found in that envelope). The questions, which were pre-recorded were presented through the Macintosh II computer, and were formulated according to the GAT version (e.g., "Was the color of the envelope you stole---Blue?").

Five alternative answers were used for each question, and each of these 5 items was repeated twice following the presentation of the question. Examinees were requested to respond "no" to every item. A buffer item followed the initial presentation of the question, and thus there were a total of 11 alternative answers for each question (a buffer item followed by two repetitions of each of the five alternative items). The order of the five items presented following each question was randomly determined and the inter-stimulus interval ranged from 16 to 24 s, with a mean ISI of 20 s. The interval between the end of one question and the presentation of the next, was used for a short rest, and prior to the presentation of the new question, its topic was declared, and the appropriate instructions regarding the target items were given. Each question was presented with a different target task (i.e., no target items, counting target items, and pressing a key in response to the target items). The questions were presented in a predetermined order, counterbalanced across examinees within each guilt condition. At the end of the questioning session, all participants were asked whether they recall the relevant items. In addition, they were, requested to report the number of target items counted in the "count items" condition. Finally, all participants were debriefed and paid.

Response Scoring and Analysis

(a) Electrodermal responses: Responses were transmitted in real time to the Macintosh II computer. The maximal conductance change obtained from the examinee, from 1 s to 5 s after stimulus onset, was computed using an A/D (NB-MIO-16) converter with a sampling rate of 1000 per second. To eliminate individual differences in responsivity and permit a meaningful summation of the responses of different examinees, each participant's conductance changes were transformed into within-examinees standard scores (Ben-Shakhar, 1985). To minimize habituation effects, within-questions standard scores were used (Ben-Shakhar & Dolev, 1996). Thus, the Z scores used in this study were computed relative to the mean and standard deviation of the participant's responses to 9 of the 11 items (excluding the two repetitions of the target item) of each question.

(b) Respiration:[3] The respiration responses were defined as the total respiration line length (RLL) during the 15 s interval following stimulus onset. Each RLL was computed using a sampling rate of 20 per second. Similar standardization transformation was applied for the RLL as the one described above in relation to the electrodermal measure, but in the case of respiration, guilty knowledge is reflected by smaller rather than larger RLLs.

The variables of interest in the GKT paradigm are the relative responses evoked by the relevant stimuli (i.e., the features of the stolen envelope). Each "guilty" examinee actually took an envelope, and the features of that envelope defined the relevant stimuli for him/her. The features that were disclosed to the informed innocent participants defined the relevant stimuli for these participants. Finally, an envelope was randomly chosen for each uninformed "innocent" examinee, and its features defined the relevant stimuli for that examinee. The Z scores corresponding to the responses evoked by these relevant stimuli were used as the dependent variables in all subsequent statistical analyses. A rejection region of $p<.05$ was used for all statistical tests.

Results

An initial analysis was performed to check whether the target-item manipulation produced the expected response pattern. For this purpose, the mean standardized responses to the target items were computed across the two presentations of the target items and across participants within each condition. The mean SCR Z scores, computed for the 3 target-items conditions, across guilt conditions, revealed the expected order (0.13, 0.75 and 1.05 for the "no target", "count targets", and "key press" conditions, respectively). The RLL mean Z scores did not show the same pattern (the 3 means were, 0.06, -0.09, and -0.06, for the "no target", "count targets" and "key press", respectively). Two 3 by 3 ANOVAs were conducted on these data, with the 3 guilt conditions serving as a between-participants factor and the 3 target-item conditions serving as a within-participants factor. A statistically significant main effect was obtained for the target item factor with the SCR measure ($F_{2, 210}$ =74.25, ε=0.98). No significant main effect was obtained for the guilt factor, and no significant interaction between the 2 factors was obtained. The ANOVA conducted on the RLL measure did not reveal any statistically significant outcomes. These results suggest that the target item manipulation did attract the participant's attention and produced the expected pattern of orienting responses, but this was reflected only by the electrodermal component of the orienting response and not by the respiration component.

To examine the main hypotheses of this study, the mean standardized response of each examinee on each measure (SCR, RLL and their combination, defined as the difference between the SCR Z score and the RLL Z score) was computed across the two presentations of the relevant item within each target condition, and across target conditions. These means, which were averaged across participants within each guilt condition, are displayed in Table 1. A 3 by 3 ANOVA, with repeated measures for the three target-item conditions, was conducted on the data of Table 1, for each measure. In all cases, only the between-participants factor of guilt produced statistically significant effects ($F_{2, 105}$ =36.23, for the SCR; $F_{2, 80}$ =6.13, for the RLL; and $F_{2, 80}$ =30.48, for the combined measure).

Post-hoc comparisons, using the Scheffe method, conducted across target conditions, revealed a statistically significant differentiation between the guilty and the informed innocent participants with all three measures ($F_{2, 105}$ =25.80, for the SCR; $F_{2, 80}$ =10.94, for the RLL; and $F_{2, 80}$ =30.90, for the combined measure). In all these cases, guilty participants showed larger differential responsivity to the relevant items than the informed innocents. Statistically significant differentiation between informed (Guilty and informed innocents), and uninformed participants was obtained with the SCR ($F_{2, 105}$ =47.30) and the combined measure ($F_{2, 80}$ =32.70), but not with the RLL. Finally, only the SCR measure significantly differentiated between the informed and uninformed innocents ($F_{2, 105}$ =10.70).

Insert Table 1 about here

In addition to group data, it is interesting to analyze and compare classification accuracy rates of individual participants. However, because in this study a within-subjects manipulation of the target item conditions was employed, each target condition was based on a single question. Because accuracy rates typically increase as a function of the number of GKT questions, it is clear that the accuracy rates obtained within each condition of this study are bound to be smaller than those typically obtained in GKT studies (which utilize at least four, but often six, and more different GKT questions). Nevertheless, we decided to present accuracy rates for each group of participants, on the basis of each measure, and in each experimental condition, as well as across target conditions.

Because we compared detection accuracies obtained from a single condition (and a single question), and a single physiological measure, with accuracies obtained from combinations of three target conditions and two physiological measures, it was necessary to transform the various detection measures into a unified scale (otherwise, each detection measure will have a different variance, which will affect the probability of exceeding the cutoff score). To achieve this goal, we followed the procedure, described in detail by Elaad and Ben-Shakhar (1997), and standardized each detection measure across the entire sample. This allowed us to set a single cutoff score, which has a similar meaning for all detection measures. A cutoff was set at 0.20, and each detection score of each examinee was compared with this cutoff score, such that all participants scoring below it (above it in the case of RLL) were classified as innocents, and all other participants were classified as guilty. Rates of correct classifications of guilty and innocent participants based on each measure, within each target condition, and across target conditions are presented in Table 2.

Insert Table 2 about here

Inspection of Table 2 reveals that, as expected, detection rates based on a single question are rather low. However, when pooling the data across conditions and physiological measures, detection rates are much higher (90% of the uninformed innocents and 79% of the guilty participants were correctly classified). Moreover, only 58% of the informed innocents were correctly classified as innocents, and this rate is more or less similar to the findings of Bradley et al. (1996) with the GAT questioning format. A comparison of the rates of guilty classifications among the guilty participants (correct classifications), and the informed innocents (false-positive classifications) reveals statistically significant[4] differences with the SCR measure ($Z=2.82$), and the combined measure ($Z=2.74$), but not with the RLL ($Z=1.73$). On the other hand, comparisons between correct classification rates of the 2 innocent groups revealed that, with the SCR and the combined measure, informed innocents were significantly less accurately classified as innocents than the uninformed innocents ($Z=2.69$ for the SCR measure, and $Z=2.76$ for the combined measure). These results are, more or less similar to those obtained with the continuous measures, and show that, at least with the SCR, the informed innocents fall in between the other two groups, in terms of their responses to the critical items, and their guilty-classification rates (false-positive rates).

With regard to the target items manipulation, the classification-rate analysis highlights two interesting features of the results: (a) No indication was found that the introduction of target items interferes in any way with the detection of guilty participants. Surprisingly enough, there are even slight improvements in the detection rates of guilty participants (for both physiological measures), with the introduction of the target items. (b) Inspection of Table 2 reveals also that at least when the key- press condition is compared with the "no target condition", the correct detection rates of informed innocents tend to improve. This trend seems stronger for the combined measure, where the correct detection rate of the informed innocents increased from 54% in the "no-target condition", to 71% in the "count condition", and to 79% in the "key-press condition". However, these observations should be treated very cautiously because the differences are not statistically significant.

Because the correct classification data depend on a single, arbitrary, cutoff point, and because it is difficult to compare different experimental conditions, on the basis of correct classification rates (i.e., gains in one type of classification are often accompanied by losses in the other classification category), an additional approach for describing and comparing detection efficiency was adopted from Signal Detection Theory. Following the practice applied in previous studies (e.g., Ben-Shakhar & Gati, 1987; Elaad & Ben-Shakhar, 1989, 1997), a statistic describing detection efficiency by comparing the entire distributions of Z scores to the relevant alternatives of guilty (or informed innocent) participants and uninformed innocents was computed for each measure within each experimental condition, as well as across target conditions. On the basis of these distributions, a Receiver Operating Characteristic (ROC) curve was generated for each group (guilty and informed innocents) under each experimental condition. Figure 1 describes the ROC curves, computed, on the basis of the combined measure, for the guilty and the informed innocents across target item conditions. The Figure demonstrates the differences between guilty and informed innocent participants, and show that for any possible cutoff point, the correct detection rate of guilty participants exceeds the false classification rate of the informed innocents.

In addition, the area under each ROC curve was computed. The area under the

ROC curve is a measure of detection efficiency, which does not depend on a single cutoff point, but rather reflects detection efficiency across all possible cutoff points. It assumes values between 0 and 1, such that an area of 0.5 means that the two distributions (the distributions of mean Z scores, across the relevant items, of guilty and innocent examinees) are undifferentiated, and therefore it is impossible to use the responses for detecting whether an examinee is guilty or not. An area of 1 means that there is no overlap between the two distributions and therefore a perfect classification of guilty and innocent examinees would be possible on the basis of the mean Z scores. A more detailed description of signal detection theory and its applications can be found in several sources (e.g., Green & Swets, 1966; Swets, Tanner & Birdsall, 1961).

Bamber (1975) described a method for estimating the variance of the area statistic and for computing confidence intervals for the true area. Using this method, we computed 90% confidence intervals for the area in each experimental condition with each physiological measure. The areas under the ROC curves along with the corresponding 90% confidence intervals are displayed in Table 3.

Insert Figure 1 and Table 3 about here

Inspection of Table 3 reveals that while no systematic reduction in the areas under the ROC curves of guilty examinees was obtained as a result of introducing the target-items, the areas under the ROC curves of the informed innocents tended to decrease with the introduction of these items. In particular, while the SCR areas for guilty examinees were identical under the key-press task and the control, no-task conditions, the areas obtained with the informed innocents tended to decrease, and under the key-press condition it did not significantly differ from a chance area of 0.50.

The RLL areas were generally, smaller, but it is important to note that for the informed innocents, they did not differ significantly from a chance area, in all 3 target conditions.

The most remarkable results were obtained with the combined measure. For guilty examinees, the areas were practically the same under all target-item conditions, but for the informed innocents, a gradual reduction was observed from 0.69 under the no-target condition to 0.61 under the count condition, and 0.45 under the key-press condition. This means that under the key press condition, the informed innocents were undifferentiated from the uninformed innocents.

Finally, we examined whether the physiological responses to the relevant items were related to memory for these items. It turned out that all guilty participants correctly recalled all three relevant items, so no physiological differentiation could be found, within this group, as a function of recall. However, some variability in recall was observed among the informed innocents, and in this group recall of the relevant items seemed to be related to the SCRs elicited by these items. Table 4 displays mean SCR Z scores and areas under the ROC curves as a function of the number of relevant items recalled by the informed innocent participants. The table reveals that SCR responses to the relevant items increase as a function of recall. On the other hand, the RLL showed no relationship to the number of items recalled

Insert Table 4 about here

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The within participants manipulation of the target-items factor raises a possibility of carry over effects. Specifically, it could be argued that if the "count-target" condition followed the "key-press" condition, participants could guess that the target will be repeated twice, and therefore their cognitive load will be reduced, as compared with participants for whom the "count" condition preceded the "key press" condition. To examine this possibility, we analyzed the responses to both the relevant and target items under the "count-target", and examined whether they were affected by order (whether the "count" condition followed or preceded the "key-press" condition). We also examined whether the memory scores obtained by the informed innocents were affected by the same order variable. The results of these analyses revealed that no order effects were obtained, neither with the physiological measures, nor with the memory scores.

Discussion

The results of this study raise several issues, related to both theoretical and applied aspects of psychophysiological detection. First, the present results are consistent with those obtained in previous studies (e.g., Bradley et al., 1996; Bradley & Rettinger, 1992; Bradley & Warfield, 1984), in demonstrating that informed innocent participants showed relatively larger electrodermal responses to the critical items than uninformed innocents, but smaller than guilty participants (across target conditions, the areas under the ROC curve were 0.92 for guilty examinees, and only 0.75 for the informed innocents). This finding implies that mere knowledge of the relevant information in itself is not sufficient to create the differential response pattern to the relevant items that is typically observed in guilty participants. In other words, additional factors are affecting differential responding to the relevant information. This conclusion is consistent with the results of several studies demonstrating that both verbal deception and motivation to avoid detection may increase differential responsivity in the GKT paradigm (e.g., Elaad & Ben-Shakhar, 1989; Furedy & Ben-Shakhar, 1991; Horneman & O'Gorman, 1985), and that deception affects electrodermal responsivity under the differentiation of deception paradigm (e.g., Furedy, et al., 1988, 1991, 1994). These studies showed that although some psychophysiological differentiation between guilty and innocent participants can be demonstrated, even without deception (e.g., when no verbal responses are required, or when "yes" responses are given to all questions), and even under low motivational condition, deceptive responses and increased motivation contribute to increase differential responding to the relevant items, and thus increase the efficiency of psychophysiological detection. Thus, mere knowledge without an actual involvement with the event, may be analogous to a low motivation and non-deceptive context.

When the respiration measure was used, no differences between informed and uninformed innocent participants were obtained. It is not clear why the RLL measure is not affected by knowledge of the relevant information, but it is important to note that this measure was less affected than the electrodermal measure by other manipulations. For example, two recent studies reported that mental countermeasures affected psychophysiological detection with the electrodermal, but not with the respiration measure (Ben-Shakhar & Dolev, 1996; Honts, Devitt, Winbush, & Kircher, 1996). In addition, the target manipulation employed in this study affected the SCRs elicited by the targets, but not the RLLs.

The second goal of this study was to examine the possibility that introducing an additional task will draw the attention of the informed innocents from the relevant items, without affecting the guilty participants. The present results provide an initial demonstration that this manipulation might indeed be effective. The use of the target items tended to reduce the differences between informed and uninformed innocents. For example, the average SCR Z score to the relevant items decreased, in the informed innocents, from 0.32 in the control, no target, condition to 0.18 and 0.15 in the count and key-press conditions, respectively. Similarly, the RLL Z scores increased from -0.17 in the control condition to -0.10 and +0.11, in the two target conditions.

The ROC results showed no consistent trend with the electrodermal measure, but showed a gradual decrease with the combined measure (from 0.69 under the no-target condition, through 0.61 under the count condition, to 0.45 under the key-press condition). These results are consistent with the notion that knowledge of the relevant information is not sufficient for differential autonomic responsivity, and that introducing another task may differentially attract the attention of informed innocents. This conclusion may be significant from an applied perspective, because if it could be generalized to the real-world context, it might reduce the risk of false-positive outcomes in informed innocent examinees. Furthermore, a successful application of the target-items procedure may enhance the use of the GKT, instead of less standardized and controlled methods of psychophysiological detection.

A third issue that was examined in this study was the relationship between memory for the relevant items and relative responding to these items. The findings indicate that such a relationship was demonstrated for the electrodermal measure. This result is not surprising and is consistent both with previous findings and with theoretical accounts, relating electrodermal reactivity to attention (e.g., Corteen, 1969; Waid, Orne, Cook, & Orne, 1978; Waid, Orne, & Orne, 1981). It is interesting to note, however, that even when memory was controlled for (by looking only on those who recalled all 3 items), larger mean responses to the relevant items were observed in the guilty examinees than in the informed innocents. This result indicates that memory in itself is not sufficient to account for the differential autonomic responsivity to the relevant items. Furthermore, it supports our conclusion that knowledge, and awareness of the relevant information are not the only factors determining differential autonomic responding to the relevant items, and that additional factors, such as personal involvement with the event, verbal deception and motivation to avoid detection may increase differential responsivity in the GKT (or GAT) paradigm.

Finally, this study provides further information about the relative efficiency of different physiological measures in psychophysiological detection. In this respect the present results are inconsistent with several recent studies, which demonstrated that the RLL measure is as efficient as the electrodermal measure (e.g., Ben-Shakhar & Dolev, 1996; Elaad, & Ben-Shakhar, 1997; Elaad, et al., 1992; Timm, 1982, 1987). The efficiency of the RLL for differentiating between guilty and innocent participants was considerably less than that of the electrodermal measure. However, the RLL does contribute to the combined measure, which seems to perform slightly better than the SCR for the detection of guilty participants. Moreover, the RLL contributes to reduce false-positive outcomes in the informed innocents (across target conditions the ROC area for differentiating informed and uninformed innocents with the combined measure is only 0.65, as compared with 0.75 for the SCR). Moreover, if only the strong target condition is considered, the informed and uninformed innocents are undifferentiated with the combined measure, while the guilty participants are detected as efficiently as they are with the electrodermal measure.

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AUTHORS' NOTES

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FOOTNOTES

1. The purpose of the count instructions was to attract attention of the participants to a neutral item, and they were not asked to provide any verbal report of their count during the interrogation. The target item was presented twice under each target-item condition, so counting in itself was not a cognitively loaded task, but it forced participants to pay attention to the designated item. Indeed, all participants recalled the designated target items in this condition.

2. This was done in all target-item conditions, but in the "no-target" condition, no target item was specified to the participants, and the target item was used only for the statistical analyses (e.g., for the manipulation check). Thus, from the participants' perspective there were only two target-item conditions ("count" and "key-press").

3. Due to mechanical problems with the respiration-measurement equipment, the RLL data of several subjects were lost (8 guilty, 12 informed innocents, and 5 uninformed innocents). Thus, all the analyses of the RLL and the combined measure are based on restricted sample sizes.

4. For these comparisons, a 0.025 criterion for statistical significance was used, because two dependent comparisons were made for each measure (comparing correct detection of guilty and informed innocents, and comparing correct detection rates of the two innocent groups.

Table 1. **Means (and standard deviations) of the mean standardized responses to the relevant items, within each target condition and across target conditions**

1. The SCR measure:

Guilt Condition	N	No Target Condition	Weak Target Condition	Strong Target Condition	Across Target Conditions
Guilty	36	0.70	0.65	0.68	0.68
Participants		(0.70)	(0.60)	(0.66)	(0.46)
Informed	36	0.32	0.18	0.15	0.21
Innocents		(0.73)	(0.65)	(0.60)	(0.37)
Uninformed	36	-0.03	-0.25	-0.03	-0.10
Innocents		(0.58)	(0.49)	(0.66)	(0.34)

2. The RLL measure:

Guilt Condition	N	No Target Condition	Weak Target Condition	Strong Target Condition	Across Target Conditions
Guilty	28	-0.26	-0.40	-0.45	-0.37
Participants		(0.69)	(0.75)	(0.58)	(0.45)
Informed	24	-0.17	-0.10	0.11	-0.06
Innocents		(0.60)	(0.53)	(0.61)	(0.28)
Uninformed	31	-0.13	-0.10	-0.11	-0.09
Innocents		(0.57)	(0.53)	(0.62)	(0.30)

3. The combined measure:

Guilt Condition	N	No Target Condition	Weak Target Condition	Strong Target Condition	Across Target Conditions
Guilty	28	0.75	0.59	0.58	0.64
Participants		(0.78)	(0.68)	(0.55)	(0.44)
Informed	24	0.34	0.06	-0.15	0.09
Innocents		(0.69)	(0.60)	(0.62)	(0.39)
Uninformed		-0.06	–0.19	-0.01	-0.10
Innocents	31	(0.58)	(0.51)	(0.61)	(0.27)

SCR – Skin Conductance Response; RLL – Respiration Line Length

For the RLL measure, stronger responses are reflected by smaller values

<u>Table 2.</u> Correct Classification rates of Guilty, Informed and uninformed innocent participants, under each target condition and across target conditions, obtained with each physiological measure and their combination

1. The SCR measure:

Guilt Condition	N	No Target Condition	Weak Target Condition	Strong Target Condition	Across Target Conditions
Guilty Participants	36	0.67	0.72	0.72	0.72
Informed Innocents	36	0.64	0.61	0.69	0.61
Uninformed Innocents	36	0.83	0.83	0.75	0.89

2. The RLL measure:

Guilt Condition	N	No Target Condition	Weak Target Condition	Strong Target Condition	Across Target Conditions
Guilty Participants	28	0.36	0.64	0.68	0.57
Informed Innocents	24	0.63	0.67	0.75	0.67
Uninformed Innocents	31	0.55	0.55	0.58	0.71

3. The combined measure:

Guilt Condition	N	No Target Condition	Weak Target Condition	Strong Target Condition	Across Target Conditions
Guilty Participants	28	0.68	0.57	0.71	0.79
Informed Innocents	24	0.54	0.71	0.79	0.58
Uninformed Innocents	31	0.87	0.84	0.74	0.90

<u>Table 3.</u> Area under the ROC curves (and 90% confidence intervals) computed within each target condition and across target conditions

1.The SCR measure:

Guilt Condition	N	No Target Condition	Weak Target Condition	Strong Target Condition	Across Target Conditions
Guilty Participants	36	0.78 (0.69, 0.87)	0.87 (0.80, 0.95)	0.78 (0.69, 0.87)	0.92 (0.87, 0.96)
Informed Innocents	36	0.64 (0.53, 0.75)	0.69 (0.58, 0.79)	0.57 (0.46,0.68)	0.75 (0.66, 0.84)

Number of uninformed innocents = 36.

2. The RLL measure:

Guilt Condition	N	No Target Condition	Weak Target Condition	Strong Target Condition	Across Target Conditions
Guilty Participants	28	0.56 (0.43, 0.68)	0.66 (0.54, 0.78)	0.68 (0.56, 0.79)	0.70 (0.59, 0.81)
Informed Innocents	24	0.51 (0.38, 0.64)	0.49 (0.36, 0.62)	0.42 (0.29, 0.54)	0.48 (0.36, 0.60)

Number of uninformed innocents = 31.

3. The combined measure:

Guilt Condition	N	No Target Condition	Weak Target Condition	Strong Target Condition	Across Target Conditions
Guilty Participants	28	0.80 (0.71, 0.90)	0.82 (0.73, 0.91)	0.77 (0.67, 0.87)	0.94 (0.89, 0.98)
Informed Innocents	24	0.69 (0.57, 0.81)	0.61 (0.49, 0.74)	0.45 (0.33, 0.58)	0.65 (0.52, 0.78)

Number of uninformed innocents = 31.

<u>Table 4.</u> SCR mean standardized responses to the relevant items and ROC areas, as a function of the number of items recalled by the informed innocents

	0-1 items	2 items	3 items	The statistic Value (for differences between 0-1 items and 3 items)
N	14	11	11	
Means (and standard deviations)	0.09 (0.37)	0.15 (0.37)	0.44 (0.30)	$T_{23}= 2.53^*$
ROC areas (and 90% confidence intervals)	0.68 (0.55, 0.81)	0.69 (0.55, 0.83)	0.88 (0.81, 0.96)	$Z = 2.23^*$

***- A statistically significant result**

FIGURE CAPTIONS

Figure 1: ROC curves, computed on the basis of the combined measure, for guilty and informed innocent participants, across target-item conditions.