The Guilty Knowledge Test (GKT) as an Application of Psychophysiology: Future Prospects and Obstacles

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Introduction

The controversy around the polygraph has been focused almost exclusively on the validity and application of the "Control Questions Test" (see, e.g., Ben-Shakhar & Furedy, 1990; Furedy & Heslegrave, 1991; Iacono & Lykken, 1997, 1999; Lykken, 1974, 1978; Raskin, 1982, 1989; Raskin, Honts, Amato & Kircher, 1999; Raskin, Honts & Kircher, 1997; Saxe, Dougherty & Cross, 1983, 1985). Unfortunately too little attention has been paid to research and discussions of other methods of psychophysiological detection. In particular, we are referring to the Guilty Knowledge Test (GKT), also called the Concealed Information Test (CIT).

The GKT (Lykken, 1959, 1960), 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, 1998). Typically, if the suspect's physiological responses to the relevant alternative are consistently larger than to the neutral alternatives, knowledge about the event (e.g., crime) is inferred. As long as information about the event has not leaked out, the probability that an innocent suspect would show consistently larger responses to the relevant than to the neutral alternatives depends only on the number of questions and the number of alternative answers per question. Thus, the rate of false-positive errors (innocent examinees classified as guilty) can be controlled such that maximal protection for the innocent is provided.

Indeed, laboratory research has supported this hypothesis, and most studies conducted to estimate the validity of the GKT have reported high accuracy rates, particularly among innocent examinees. For example, Ben-Shakhar and Furedy (1990) reviewed and summarized 10 GKT laboratory experiments and showed that

across these studies, 83.9% of 248 guilty examinees and 94.2% of 208 innocent examinees were correctly classified. They acknowledged that the number of studies they analyzed was too small to allow for a statistical examination of the sources of the between-studies variability, but they speculated that the number of GKT questions used is a natural candidate for accounting for at least some of this variability. They noted that the two studies that used the largest number of questions (Bradley & Ainsworth, 1984; Bradley & Warfield, 1984, nine and ten, respectively) demonstrated the largest rates of correct classifications. Ben-Shakhar and Furedy (1990) concluded that with a sufficiently large number of GKT questions the method could be used quite efficiently. More recently, Elaad (1998) reviewed 15 mock crime studies attempting to estimate the validity of the GKT and reached similar conclusions. Elaad (1998) estimated the accuracy rates among guilty and innocent examinees as 80.6% and 95.9%, respectively, and noted that in 11 of these 15 studies no false-positive errors were documented.

In spite of the research findings, which suggest that the GKT can be efficiently applied for detecting relevant information, this method is not being used very much in actual investigations. Furthermore, almost no advances have been made towards an implementation of the GKT. This is particularly surprising because the GKT is protected against most of the criticisms that have been directed towards the Control Question Test (CQT), which is a widely used method of psychophysiological detection. The purpose of this chapter is to call for a shift in our research efforts. In particular, we should explore ways to make the GKT more usable. In the next section, we shall discuss several features of the GKT, which highlight the potential of this method as an applied technique for detecting involvement in criminal events. Then, we shall discuss the weaknesses of the GKT, and the reasons for its infrequent usage.

The concluding section will be devoted to various means that should be adopted to overcome the weaknesses of the GKT and to broaden its usage as an aid in criminal investigation, and possibly in legal proceedings.

Features of the GKT which make it an attractive method for forensic applications

Several features of the GKT make this method an attractive application of psychophysiology. Furthermore, some of these features highlight the advantages of the GKT over alternative methods of psychophysiological detection. In this section we shall review and discuss these features.

1. The GKT is based on proper control questions, and thus it supplies sufficient protection for innocent suspects.

As described above, the GKT is structured such that as long as relevant information has not leaked, innocent examinees could not discriminate between the critical and the neutral, control items. Thus, if sufficient number of questions are used, the probability that an innocent (uninformed) examinee will show consistently larger physiological responses to the relevant than to the neutral, control items could be minimized. This feature of the GKT does not characterize any of the alternative methods of psychophysiological detection, in which the relevant and control questions differ on several dimensions.

2. The GKT stands on well established psychophysiological foundations.

Any scientifically-based technology must be based on sound theoretical foundations. From this respect the case of the GKT, unlike other methods of psychophysiological detection, is relatively simple. This method is based on extensive research and theory on orienting responses (ORs) and habituation processes in

humans (e.g., Siddle, 1991; Sokolov, 1963, 1966). OR is a complex of physiological and behavioral reactions evoked by any novel stimulus or by any change in stimulation (e.g., Berlyne, 1960; Sokolov, 1963). In principle, each item presented to the subject, whether guilty or innocent, in the course of the GKT is capable of evoking an OR. Naturally, these ORs will display a habituation process -- a gradual decline in response magnitude with repeated presentations of the stimuli (Sokolov, 1963). The interesting feature of orientation, which provides this concept with an explanatory power for the detection phenomenon, is that significant stimuli (i.e., stimuli that have a signal value) evoke enhanced ORs (Gati & Ben-Shakhar, 1990). Lykken (1974) made the connection arguing that: "... for the guilty subject only, the `correct' alternative will have a special significance, an added `signal value' which will tend to produce a stronger orienting reflex than that subject will show to other alternatives" (p. 728). In other words, it is assumed that the guilty knowledge endows a subset of the items with significance, or signal value, and therefore those items will evoke stronger ORs. Clearly, for subjects who do not possess the guilty knowledge, all items are equivalent and evoke similar ORs that will habituate with repetitions.

Ben-Shakhar and Furedy (1990) labeled this approach to psychophysiological detection a cognitive approach, because it emphasizes the fact that an individual knows something, rather than the individual's emotions, concerns, fears, conditioned responses, or deception. This approach is compatible with findings that demonstrate how relevant information can be detected even under mild conditions where no motivational instructions are given to the subjects and where no verbal response is required (e.g., Ben-Shakhar, 1977; Ben-Shakhar & Lieblich, 1982; Elaad & Ben-Shakhar, 1989). It is compatible also with the surprising detection-without awareness effect reported by Thackray and Orne (1968).

3. The GKT is based on a standardized procedure.

Standardization is another important feature of scientifically-based techniques and tests, because it guarantees that the different examinees undergo the same experience. Only when a given test is based on standardized procedures do the resulting scores (or evaluations) have a uniform meaning, allowing comparisons between different people who took the test. The GKT can be designed in a standardized fashion, and once salient features of the event are identified, it is easy to formulate the relevant and control alternatives. Furthermore, it is easy to check whether the alternative items formulated for each question are equivalent (see e.g., Lykken, 1998). Unlike alternative psychophysiological detection methods, the choice of relevant and control items in the GKT does not depend on a pre-test interview with the examinee and on the examiner-examinee interaction. They can be formulated before the polygraph investigation, and used uniformly to test all the suspects in a given case. Finally, the GKT can easily be administered using a "blind" procedure (i.e., by an examiner who is himself unaware of the critical items).

4. Contamination with non-physiological information can be avoided with the GKT.

One of the major criticism expressed towards the use of polygraph test as an aid in legal proceedings is the fact that judgments made on the basis of their results are based on more information than is contained in the physiological measures alone (e.g., the opinion of the examiner formed during the pre-test interview, rumors the examiner heard prior to the administration of the test). In addition, during the investigation the polygraphist is in the position to watch and monitor the totality of a suspect's behavior, and not just the physiological changes alone. An experienced interrogator might well use these characteristics. Thus, it is always uncertain whether, and to what extent, a given judgment made by a polygraph examiner results from the

physiological responses to the questions, or from other factors. This feature, which characterizes all polygraph investigations conducted by law-enforcement agencies, was labeled “contamination” (Ben-Shakhar, 1991; Ben-Shakhar, Bar-Hillel, & Lieblich, 1986; Elaad, Ginton, & Ben-Shakhar, 1994, but see also, Elaad, Ginton & Ben-Shakhar, 1998). The damaging consequences of contaminated polygraph examination, from a legal perspective, were discussed by Ben-Shakhar et al. (1986). They argued that the use of contaminated polygraph test results as admissible evidence could open the door for a type of “laundering” of inadmissible evidence, or evidence obtained through illegal means, without legal checks. Such evidence could accrue unknown weight through the influence it exerts on the opinions of the polygraphist, who has prior acquaintance with it.

But, while it may be difficult to decontaminate the CQT, contamination can be completely avoided with the GKT, because there is no need for a pre-test interview, and the test can be designed and administered by experts, unfamiliar with the case, or the suspects. Furthermore, the questions can be pre-recorded by someone who has no information about the case under investigation. In addition, interpretation, quantification and integration of the physiological data can be conducted with the GKT, in an objective way, using mechanical, computerized rules (in principle, this can be achieved with the CQT as well, see, Kircher & Raskin, 1988, but it is not typically the case in practice). Thus, the interpretation of the GKT outcomes and the conclusions drawn from them would not be affected in any way by the prior knowledge and the impressions formed by the investigators prior to conducting the GKT.

5. Estimating the accuracy of the GKT from laboratory studies.

So far we have discussed various features of the GKT that were derived from the structure of this procedure. But, the crucial question regarding all methods of psychophysiological detection is whether they can discriminate between guilty (those that were actually involved with a criminal act) and innocent individuals. An extensive research attempting to estimate the accuracy of the various detection methods has been conducted in the past 3 decades (for reviews see, Ben-Shakhar & Furedy, 1990; Elaad, 1998; Kircher, Horowitz & Raskin, 1988; Saxe et al., 1983 1985). However, several methodological questions have been raised regarding this research (e.g., Ben-Shakhar & Furedy, 1990). One of the major problems is whether the results of controlled experiments conducted in laboratory settings can be generalized to the realistic context of criminal investigations. In the typical laboratory experiment, subjects designated as "guilty" are asked by the experimenter to steal an envelope containing money, or some other item. Then, all the participants (both "guilty" who are asked by the experimenter to hide their connection to the simulated crime and "innocent" who did not commit the mock crime), are examined by a polygraph interrogator. When the experiment is over, they are given a monetary reward, thanked, and sent on their way. Obviously, these conditions do not begin to resemble the conditions of a real life investigation. There is no deception in the conventional sense of the word, and there is no anxiety about the consequences of the exam (either for the "guilty" or for the "innocent").

However, while this problem is particularly acute in the case of the CQT, it seems that results of laboratory studies, conducted to assess the validity of the GKT, can, at least partially, be generalized to the realistic context. This view is based on the nature of the GKT as a method, which does not depend of factors such as realistic stress, fear of punishment, or genuine deception. In particular, it is clear that estimates

of false-positive rates can be generalized from simulation studies. This is possible as long as critical information has not leaked to innocent examinees because there is no reason that uninformed examinees would show consistently stronger physiological reactions to the critical than to the neutral items. Assessing the rate of false-negative outcomes may be more difficult because the artificial conditions of simulated studies guarantee that the critical items are perceived and remembered by those simulating the guilty suspects. This may not be the case in actual criminal investigations that are often conducted long after the crime has occurred. Indeed, the only field studies that have been conducted so far to estimate the accuracy of the GKT (Elaad, 1990; Elaad, Ginton, & Jungman, 1992), produced results that are consistent with our assertions. While the rates of false-positive errors obtained in these studies were as low as those reported in laboratory experiments (2% in the former study, which relied only on the electrodermal measure, and 5% in the latter study, which utilized a combination of electrodermal and respiration measures), the rates of false-negative errors were much larger (42% in the former study and 20% in the latter). It should be noted that the mean number of questions used in the field studies reported by Elaad (1990) and Elaad et al. (1992) were 2 and 1.8, respectively. Thus, it is possible that the relatively high rates of false-negative errors, obtained in these studies, resulted from the use of a small number of GKT questions. However, until more GKT field studies are conducted, it would be impossible to provide proper estimates of the false-negative error rates obtained with this method.

6. Advantages of the GKT from a legal perspective

The main advantage of the GKT from the perspective of criminal law is the protection it provides to the innocent suspects. In a recent study, Elaad (1999) demonstrated that the GKT is less vulnerable to false-positive errors than several

forensic techniques that are routinely being admitted in court (e.g., voice identification, handwriting identification). It should be noted, in addition, that unlike any other forensic technique, the rate of false-positive errors that would result from a GKT can be specified and presented to the court along with the outcomes of the specific test administered to a specific defendant. This is possible because if the basic assumption underlying the GKT (that the critical information is known only to the guilty suspects) is met, then the probability of a false-positive outcome is a simple function of the number of GKT questions and the number of alternative answers per question. Presenting the outcomes of a GKT in court along with the expected rate of false-positive error would enable the court to give this evidence an appropriate weight.

Weaknesses of the GKT and reasons for its infrequent usage

In the previous sections, we discussed the GKT and highlighted several advantages of this technique over alternative methods of psychophysiological detection. Therefore, the rare application of the GKT is surprising. In this section, we shall discuss weaknesses of this method, and possible reasons for its infrequent usage.

1. Difficulties in formulating proper GKT questions.

It is difficult to identify a sufficient number of salient features of the event, which can be used to formulate proper GKT questions. A proper GKT question refers to a specific feature of the event that is very likely to be noticed by a guilty person. Furthermore, it is crucial that guilty individuals not only notice the designated feature, but also remember it during the polygraph investigation, which may occur long after the event. Podlesny (1993) estimated that the GKT might have been used in only 13.1% of FBI cases for which polygraphs have been used. This estimate is based on

the assumption that at least 4 different GKT questions are required to construct a GKT.

2. Leakage of GKT items.

Once salient features of the event have been identified, it is very difficult to keep them from being leaked to innocent examinees. Leakage of the critical items might put the innocent suspects in great danger because knowledge of the critical items might be sufficient for producing differential responding to these items. Thus, avoiding leakage of critical items is crucial for a successful implementation of the GKT because the main advantage of this technique is the protection supplied to the innocent suspects. Notwithstanding, it should be kept in mind that the GKT, unlike other psychophysiological detection methods (e.g., the CQT), is aimed at detecting knowledge, rather than deception. Consequently, innocent suspects failing a GKT due to leakage of some critical items, could explain how they became aware of the critical information (e.g., they could cite a newspaper that mentioned this information while describing the crime). In this respect, the GKT outcomes are similar to circumstantial evidence, which is frequently presented in criminal trials. The CQT, on the other hand, indicates that the suspect is either deceptive or truthful when denying the charges. Hence, the CQT takes the role of the judge and jury in deciding whether or not the suspect's version is credible. Hence, with no strong evidence to the contrary, suspects would not be able to protect themselves against false-positive errors made with the CQT.

3. The problem of countermeasures.

A number of experiments (e.g., Ben-Shakhar & Dolev, 1996; Elaad & Ben-Shakhar, 1991; Honts, Devitt, Winbush, & Kircher, 1996; Honts, Raskin, & Kircher, 1987, 1994; Kubis, 1962) have indicated that it is possible, indeed quite easy, to train

guilty examinees and prepare them for a polygraph examination (either CQT, or GKT) in such a way that with a high probability they will be found truthful. This can be done by adopting some rather simple techniques (that can be picked up with little effort), which can cause very strong reactions to the control questions. These techniques rely either on the use of physical means (such as biting one's tongue), or mental means (calling to mind an exciting or frightening event, or engaging in mental activities that require effort) each time a control question is asked. A series of experiments conducted by Honts and his colleagues demonstrated that the use of such countermeasures could be most effective. They showed in different experiments that the error rate produced by polygraphists testing "guilty" examinees who were using countermeasures ranged between 50 and 70 percent. Clearly, countermeasures may increase false-negative outcomes (guilty suspects classified as "innocents"), but they have no effect on innocent examinees.

It should be pointed out that the type of countermeasures that are most detrimental for all psychophysiological-detection techniques are mental countermeasures, because mental manipulations cannot be detected even by the most experienced examiners. Two recent studies demonstrated that mental countermeasures can be used effectively under both the GKT and the CQT (Ben-Shakhar & Dolev, 1996; Honts et al., 1996).

Future directions in GKT research: Attempting to overcome the weaknesses and increase its potential usage

In this section, we shall discuss various ideas, and some recent research results that show how the weaknesses of the GKT could be dealt with, such that a wider application of this technique would be achieved.

1. The GKT must rely on sufficient number of proper GKT questions

Identification of a sufficient number of GKT questions is clearly necessary for a successful implementation of this technique. Typically, it has been assumed that at least four different questions are necessary (e.g., Podlesny, 1993). But this assumption has not been tested empirically. It is clear that a single presentation of a GKT question with 5 or 6 alternative answers would be insufficient because an innocent, uninformed examinee would show the largest response to the critical alternative with a fairly large probability (0.16, or 0.20, in our example). But in principle it is possible to reduce the probability of a false-positive error by using many repetitions of just one or two different questions, and by using several physiological measures.

Recently, we conducted two studies to test the efficiency of the GKT, based on a single question repeated several times, with two physiological measures (changes in skin conductance and in respiration). Our first study (Elaad & Ben-Shakhar, 1997) produced very encouraging results and suggested that a single GKT question can produce an efficient discrimination between guilty and innocent examinees. Specifically, two experiments were conducted, in which a GKT based on 4 different questions, each repeated 3 times was compared with a GKT based on 12 repetitions of a single question. Both experiments revealed that similar detection efficiencies were observed in these two conditions (for example, in the first experiment a combination of the two physiological measures yielded ROC areas of 0.86 for the single-question condition, and 0.88 for the multiple-questions condition).

This result was rather unexpected, and therefore we decided to conduct a constructive replication of the Elaad and Ben-Shakhar (1997) study. In this replication (Ben-Shakhar & Elaad, 1999) we added a third experimental condition, in which 12 different questions were used. In addition, instead of a mock-crime experiment we

used a list of biographical details (e.g., mother's name, place of birth). The results of this study differed from those reported by Elaad and Ben-Shakhar (1997) and a clear advantage for the multiple-questions condition emerged in this experiment, with the electrodermal measure, but not with the respiration measure. Although statistically significant differentiation between "Guilty" and "innocent" individuals was observed under all 3 conditions, the use of multiple questions produced higher detection efficiencies (the areas under the ROC curves, obtained with a combination of the electrodermal and respiration measures, were 0.80, 0.88 and 0.99, in the single-question, 4-questions and 12-questions conditions, respectively).

Clearly, these results indicate that using several GKT questions is desirable. But at the same time, it seems that relatively high levels of detection efficiency could be obtained, even with a single question, provided that it is repeated many times and that several physiological measures are used. Further research is required to examine this issue in the real-life context. If this research show similar results, it would mean that GKT could be more widely applied.

Another direction which also points out that a single GKT question may be sufficient, was taken by MacLaren (1998) who demonstrated that expectancy conditioning might allow effective guilt discrimination using a single item of concealed information.

2. Dealing with the problem of information leakage.

The results of the field studies reported by Elaad and his colleagues (Elaad, 1990; Elaad et al., 1992) suggest that leakage of relevant (crime-related) information did not affect the results of GKTs administered by the Israeli police. But the issue of information leakage and its effect on the outcomes of the GKT must be carefully examined before a wider application of the GKT can be recommended.

The effects of leakage of relevant information to innocent examinees have been studied extensively by Bradley and his colleagues (Bradley, MacLaren, & Carle, 1996; Bradley & Rettinger, 1992; Bradley & Warfield, 1984). These studies demonstrated that although informed innocent participants show larger responsivity to the critical items, as compared with uninformed innocents, they could be differentiated from guilty participants. In other words, other factors in addition to knowledge of the critical items play a role in determining differential responsivity to the critical items. In addition, Bradley and his colleagues showed that an alternative formulation of the GKT questions (the guilty action test) could reduce false-positive outcomes among informed innocent suspects.

A recent study conducted in our laboratory (Ben-Shakhar, Gronau & Elaad, 1999) demonstrated that introducing an additional task (responding to target items, which are unrelated to the event under investigation, while answering the GKT questions) may differentially attract the attention of informed innocent participants and reduce false-positive outcomes in this group. These studies suggest that the risk associated with false-positive outcomes, due to leakage of relevant information, may be reduced by introducing new variations and improvements to the GKT.

A different approach to the problem of information leakage is to modify police practices, such that critical features of the event are identified and concealed at the outset of the investigation, as a standard investigative practice. Furthermore, GKTs could be conducted by investigators who are familiar with the scene of the crime and are trained to look for salient features that could be utilized as GKT questions. The fact that the GKT has been used for many years by Japanese law enforcement agencies as the preferred method of psychophysiological detection (Ben-Shakhar &

Furedy, 1990; Fukumoto, 1980; Yamamura, & Miata, 1990) demonstrates that these changes are possible.

3. Dealing with the problem of countermeasures.

Finally, the problem of countermeasures that has been shown to affect the GKT, as much as it affects the CQT (Honts, et al., 1996) must be dealt with. A possible approach for dealing with countermeasure manipulations is the use of GKTs that are based on Event-Related Potentials (ERPs) instead of autonomic measures. Several studies have demonstrated that guilty and innocent participants can be differentiated quite effectively with ERPs (e.g., Allen, Iacono, & Danielson, 1992; Farwell & Donchin, 1991; Rosenfeld, Angell, Johnson & Qian, 1991; Rosenfeld, Cantwell, Nasman, Wojdac, Ivanov & Mazzeiri, 1988). ERP measures seem to be immune against countermeasures because they are based on a repeated rapid presentation of the items (e.g., one item per second). When items are presented at such a rapid pace, it is virtually impossible to execute countermeasures to the control items. This idea may require additional research, but it could lead to a GKT, which would be protected against countermeasures.

Summary and conclusions

In this chapter we analyzed the GKT and discussed both its advantages over alternative methods of psychophysiological detection, and its weaknesses. We showed that the GKT is based on proper controls, such that if the critical, crime-related information has not been leaked, maximal protection can be provided for innocent suspects. This feature of the GKT makes it an attractive aid in criminal investigations and possibly in legal proceedings (see, a recent discussion of the possible use of GKT results as admissible evidence in criminal trials in Ben-Shakhar, Bar-Hillel &

Kremnitzer, 1999). In addition, the GKT can be designed in a standardized manner, and the interpretation of its results can be made on the basis of objective and quantified measurement procedures. These features of the GKT guarantee that it can be administered in a non-contaminated manner. Finally, the GKT is based on well established psychophysiological research and theory.

Our discussion revealed, in addition, three weaknesses of the GKT, which may explain why this method is not being used very much as an aid in criminal investigations in North America. In many cases it is difficult to identify a sufficient number of salient features of the event (features that are likely to be noticed and remembered by guilty individuals). Once such features have been identified, it is difficult to keep them concealed from the general public and from innocent suspects. Leakage of critical items might increase the likelihood of false-positive outcomes. Finally, the use of mental or physical countermeasures might affect the outcome of the GKT and increase the rate of false-negative outcomes.

In the final section, we reviewed recent studies that examined various means that can be used to modify the GKT, such that the effects of its weaknesses would be limited. First, it seems that the use of just one or two proper GKT questions with many repetitions and several physiological measures may produce relatively high levels of detection efficiency. Second, a modification of police-investigation procedures may minimize the possibility that critical information would be leaked out. Furthermore, changes in the structure of the GKT and in the formulation of its questions may reduce the effects of information leakage. Finally, we argued that the use of ERPs, in addition to the standard autonomic measures might be an important protection against the use of countermeasures.

Clearly, further research is required to examine whether these ideas can indeed be applied, such that the GKT will become an efficient and feasible forensic method. In particular, more field studies seem necessary to examine how the GKT, with the various modifications, would function in realistic conditions. But we are certain that such efforts will be fruitful because we believe that the GKT has an excellent potential as a forensic application of psychophysiology.

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