CHAPTER-II

REVIEW OF LITERATURE

This chapter presents a detailed account of researches related to the major variables under study in the present investigation. The present investigation focuses on the use of subliminal stimuli as deterrent to countermeasures in lie detection. Subliminal perception, which is also referred to as perception without awareness occurs whenever stimuli presented below the threshold or limen for awareness are found to influence thoughts, feelings, or actions. Countermeasures are deliberate techniques that some guilty people use in order to beat the polygraph test or an innocent subject may also use to influence the outcome of the test. Use of countermeasures during lie detection results in reduction of the accuracy of lie detection.

Initially, an abstract based search was conducted where American Psychological Abstracts were scanned along with a web based study using search engines like Google, Pub Med, Science Direct, Metapress etc. The obtained literature provided the base for a journal based search for compilation of the primary sources from State Forensic Laboratory (SFL) Madhuban, Haryana; National Medical Library, New Delhi and Central Library, Maharshi Dayanand University, Rohtak. The major journals consulted were Psychophysiology, Journal of Forensic Sciences, Journal of Applied Psychology, Experimental Psychology, Applied Cognitive Psychology, Journal of Perceptual Motor Skills, Journal of Experimental Psychology: Learning, Memory, and Cognition, Journal of Behavioral Decision Making, Personality and Individual Differences, etc. Besides these journals, various books of Forensic Psychology (i.e. Handbook of Polygraph Testing, Scientific validity of Polygraph Testing, The Polygraph Test-Lies, Truth and Sciences, The Lie- Behind The Lie Detector) dealing with the subject matter under study were also referred.

Researches related to validity and accuracy of lie detection, efficacy of countermeasures in undermining detection along with studies where subliminal stimuli have been found to result in detectable physiological changes have been reviewed. The resume of related researches has been presented under the following four sections i.e. Validity of Lie Detection; Subliminal Stimuli and Physiological
Changes; Countermeasures and Lie detection: Lie Detection, Subliminal Stimuli and Countermeasures.

**Validity of Lie Detection**

This section deals with studies related to the validity of lie detection procedures such as CQT, RIT, GKT and DLT. Different forms of validity have been assessed with polygraph examination depending on the type of polygraph test as well as on its use (e.g., employee screening / investigation of a criminal suspect).

Lykken (1959) demonstrated that the detection of incriminating knowledge about a crime can be done more accurately than the detection of a lie about the crime. In Lykken’s study, 49 male college students were randomly assigned to four categories of guilt in conducting two mock crimes. Subjects either committed a staged “theft,” a staged “murder,” both, or neither. An experimenter then conducted two GKT polygraph examinations with each subject, one for each crime. Each test in Lykken’s study included six questions about details related to the “murder” situation and “theft” situation (e.g., asking the subject to identify an object present in the “murder” room). To make subjects anxious about the accuracy of their responses during the examination, they were told they would be given an electric shock if the examiner felt their responses indicated guilt; in fact, subjects received an electric shock after every question. The relevant alternative in each question was randomly varied among an average of five possibilities. If the question about the relevant detail produced the EDR with the greatest amplitude, it received a score of ‘2.’ If it was the second largest in amplitude, it received a “1.” A perfect guilty score on each test was “12,” and a perfect innocent score was “0.” A score of seven or greater was categorized as guilty for the purpose of analysis, and a score of six or less was categorized as innocent. The guilty knowledge test was accurate to a significant degree in identifying subjects who committed both, either, or neither of the crimes. On the basis of this experiment, Lykken argued that GKT, with some refinements, could be applicable in criminal investigations.

Heckel, Brokaw, Salzberg and Wiggins (1962) used a staged crime to investigate the differential accuracy of CQT with psychotic, neurotic, and normal subjects. Fifteen subjects (five from each of the above three groups) were given the opportunity to
steal money from the wallet of an experimenter who was staging a session of psychological testing. The experimenter later alleged that $20 had been stolen, and arranged for polygraph examinations of the 15 subjects by a field examiner. No money had actually been stolen, so the subjects were actually innocent. Four polygraph experts later rated the charts. Averaging the results for these independent evaluators, 11 of the subjects were correctly labeled innocent, 1 was called guilty, and 3 were placed in an inconclusive category. The one error and one inconclusive were psychotic subjects, and the other two inconclusive were neurotic subjects. Because only innocent subjects were included, a lambda was not calculated for this study.

Abrams (1963) differentiates between the laboratory and “actual criminal cases. He reviewed reports of the polygraph’s accuracy dating from 1917, including anecdotal as well as experimental data. He calculated approximate estimates of overall accuracy from this data, noting, however, that “it is almost meaningless to total and average these findings because of the great discrepancy in experimental paradigms and the instruments employed.” He reported that in studies with complete verification of ground truth, diagnoses were 100 percent correct. In other field studies prior to 1963 Abrams calculated an accuracy rate of 98 percent. In laboratory experiments prior to 1963, Abrams estimated the average accuracy rate of 81 percent. Averaging the results of the reports between 1963 and 1973, Abrams estimate of laboratory and field research accuracy was 83 and 98 percent, respectively.

Davidson (1968) examined GKT’s validity under conditions that varied motivation level and that he claimed were, in general, more “ego-involving” for subjects. In this study, 48 college students were recruited and assigned randomly to 12 groups of 4. Three of the four were instructed to attempt to commit specific mock murders, and the fourth served as a control. The mock crimes were arranged such that one subject would “commit” the crime, one would try to fail, one was motivated but never had the opportunity, and one (the control) had no knowledge of the crime. Half of the subjects who “committed” the murders received a large amount of money ($25 to $50) and half received a small sum ($10 to $1). The different amounts were presumed to create a different level of motivation in the subjects. The subjects were
then examined with the use of GKT. Six multiple choice questions with five
alternatives were presented to the subjects, and the EDR was recorded. Using a
weighted average, 98 percent of the classifications were correct against a chance
level of 25 percent. The only error was one false negative.

Barland and Raskin (1975) conduct a study on 72 students, where “guilty” and
“innocent” volunteers were randomly assigned to one of three “feedback”
conditions. The positive feedback subjects were instructed that the polygraph was
effective; the negative feedback students were told that the machine was not
working properly, and the other students received no feedback. Subjects then
underwent a complete polygraph examination including a pretest interview. The
Federal version of the ZOC technique was employed, with standard control
questions used for all subjects. On average, the CQT identified 53 percent of all
subjects correctly. Twelve percent were identified incorrectly and 35 percent of the
examinations were inconclusive of the errors, three (4 percent of the entire sample)
were false negatives and six (8 percent) were false positives.

Widacki and Horvath (1978) designed an experiment to examine the polygraph’s
efficacy in comparison to other techniques in the mock investigation of a mock
crime. They recruited 80 Polish student volunteers and had all of them provide
writing specimens, photographs of themselves, and fingerprints. Subjects were then
assigned to 20 groups of four subjects each. Within each group, one subject was
randomly assigned to be the perpetrator, and the other three were innocent suspects.
Each group was thus an “investigative case.” Because of this feature of the design,
the decisions of guilty and innocent were not independent. Widacki and Horwath
found that the polygraph produced the most correct decisions (n = 18), the fewest
(along with handwriting) incorrect decisions (n = 1), and the fewest inconclusive
decisions (n = 1). Widacki and Horvath note, however, that a direct comparison of
these four investigative methods may be invalid because the experimental
procedures could not ensure a comparable level of quality of evidence for each
method (e.g., fingerprints were not detectable in the majority of cases). Because of
its experimental design that had the examiner make decisions on four suspects as a
group, the study produces data about the accuracy of the polygraph that is difficult
to interpret. But it does shed light on the efficacy of the polygraph relative to other investigatory techniques that might be the alternative.

Podlesny and Raskin (1978) conduct a more extensive experiment to examine the accuracy of CQT using three different types of control questions. They also tested the accuracy of behavioral observations of the examinee in detecting deception, since this type of information is used in many field examinations and could possibly affect the validity of the technique. They compared as well the capability of different physiological measures in differentiating between guilty and innocent subjects. A GKT was also conducted with 20 subjects. In this study, subjects were community members who responded to newspaper advertisements. The experimenters drew from the Reid method in their design of the pretest interview. During the polygraph examination they included two special types of control questions among the set of questions asked of the subjects. One was a “guilt complex question,” which asked the subject if he committed a fictitious crime of the same nature as the real crime. In this study, the guilt complex question was, “Did you take that watch from room 702?” There was, of course, no watch stolen from room 702. The experimenters also varied the wording on some of the control questions, so that half the subjects received “nonexclusive” and half “exclusive” control questions.

In the pretest interview, the examiners followed the usual field procedure of reviewing the control questions with the subjects, and the questions were adjusted until they elicited a “no” response. The control question polygraph test then took place, with three or more charts obtained from each subject, although only the first three were used in the objective scoring. Immediately after testing, the first three charts obtained were scored blind on electrodermal response (EDR), respiration, and cardio measures. Later, an independent rater scored the tests, using the numerical scoring system devised by Barland and Raskin. The experimenters also used objective measurements of all physiological response measures with the aid of computers and persons who had no knowledge of the field evaluations or treatments administered. The experimenters used the decisions made by the independent blind evaluator to assess the validity of the polygraph test. This was, however, equivalent to using the polygraph examiner’s decision, because the independent rater and the
examiner agreed on 100 percent of their decisions. The results for both types of control questions combined (with an inconclusive zone used) were 80 percent correct, 10 percent incorrect, and 10 percent inconclusive. There were three false negatives (8 percent) and one false positive (2 percent). The accuracy of CQT differed depending on whether exclusive or inclusive control questions were used. When the exclusive control questions were used, 85 percent of the subjects were identified correctly, 5 percent incorrectly, and 10 percent inconclusively. Of the assessments of the 20 subjects in this condition, one (5 percent) was a false negative and there were no false positives. When nonexclusive control questions were used, 75 percent were correct, 15 percent incorrect and 10 percent inconclusive. Of these 20, two (10 percent) were false negatives and one (5 percent) was a false positive. The evaluative scores for each physiological component were analyzed to determine if the scores differed between guilty and innocent subjects. Only the EDR and plethysmograph scores yielded significant differences. Behavioral observations, by themselves, yielded a significant number of correct decisions, but this differed greatly between innocent and guilty subjects. Of the guilty subjects, 86 percent of the decisions made were correct (25 deceptive, 4 nondeceptive, and 1 inconclusive); however, only 48 percent of the innocent subjects were correctly identified (12 deceptive, 11 nondeceptive, 7 inconclusive). An objective quantitative analysis for each physiological measure was employed to determine if each was effective in discriminating between guilty and innocent. Most of the measures yielded significant discriminations, with the exception of a few of the cardiovascular measures.

Balloun and Holmes (1979) used GKT to detect guilt in a “real” crime arranged by the experimenters. They were also interested in the effect of psychopathy and of repeated examinations on the accuracy of GKT. They selected 18 male college students with high scores on the psychopathic deviate (Pd) scale of the Minnesota Multiphasic Personality Inventory (MMPI) and 16 with low scores. The Pd scale was originally designed to make the diagnosis of psychopathic personality and was used as a scale to measure relative “amounts” of psychopathy. The experimenters acknowledge, however, that the Pd scale may be an inadequate measure of this diagnosis. These subjects took a fake intelligence test with two other students (actually confederates of the examiner). The confederates urged subjects to cheat
and supplied test answers to those who were willing. Eighteen of the thirty four students cheated. Later, the subjects underwent a polygraph examination using GKT. They were reminded that cheating on exams could lead to academic dismissal, and that the experimenters knew that some had cheated on the “intelligence test.” Information from the intelligence tests that only the cheaters would know served as the incriminating details on GKT. Another GKT with the same content, but a different order of questions was then administered to see if the subjects would adapt to GKT and, thus, reduce its accuracy. Balloun and Holmes scored GKT using Lykken’s method with three physiological measures (EDR, heart rate, and finger pulse volume), but only EDR produced significant results. On the first test, guilty subjects scored significantly higher and were detected with significant accuracy. However, on the second test, though the guilty subjects had significantly greater scores, they were not great enough for significantly accurate detection of guilt at the criterion level (5.5 out of 10) used. There was no difference between the high and low Pd subjects on either administration of GKT.

Rovner, Raskin, and Kircher (1979) examined the effect of information and practice on the accuracy of polygraph examinations. Seventy-two subjects recruited from the community took part in this mock crime experiment. One third of the subjects (12 innocent and 12 guilty) were given in-depth information about the polygraph and about countermeasures used to appear innocent (information condition). Another third received this information and underwent two practice polygraph examinations about which they received “feedback” (information and practice condition). The other third had no such intervention (standard). A blind field evaluation performed some time later produced the scores for decisions of guilt or innocence, and for analysis of the physiological responses. Accuracy for the standard group and the information group was identical: 88 percent correct, 4 percent incorrect, and 8 percent inconclusive. But accuracy for the information and practice condition was lower: 62.5 percent correct, 25 percent incorrect, and 12.5 percent inconclusive. There was one error in the standard group and one in the information group—both false positives. The six errors in the information and practice conditions were three false positives and three false negatives.
Hammond (1980) conducted a mock crime study to test the hypotheses that: 1) alcoholics would be less detectable than normal subjects, 2) psychopaths would be as detectable as normal subjects, and 3) student examiners would not be as accurate as an expert examiner. He was also interested in the overall value of polygraph examinations for forensic psychology. The subjects in Hammond’s study were volunteers solicited through sign-up sheets in a college fraternity (normals), alcoholism treatment centers (alcoholics), and ex-offender programs (psychopaths) as well as through newspaper advertisements and other means. Psychological tests (e.g., subscales of the MMPI) as well as polygraph examinations were given to the subjects. The polygraph examinations were conducted by students near the end of their training at the Backster School of Lie Detection. Examiners used a version of Backster’s control question technique, and Backster’s numerical scoring system. Charts were scored using several levels of inconclusive zone by both the student examiners and an expert examiner who scored the charts blindly. Two polygraph charts, rather than the standards three, were conducted for each subject. Results show that approximately 72 percent of the guilty subjects and 40 percent of the innocent subjects were scored correctly. However, alcoholics, normal, and psychopaths showed differences in detectability. In addition, there were no differences between the numerical scores of the student examiners and the blind expert examiner. However, using the standard *8 cutoff as inconclusive zone, expert evaluators had more inconclusive (and fewer innocent “hits”) than the student examiners. While Hammond concluded that his study supported the validity of polygraph testing, he believed that certain factors in his study could account for the failure to show differences by subject category. In particular, all subject groups actually turned out to be relatively heavy drinkers. Hammond also contended that overall accuracy rates would have been higher with more experienced polygraph examiners. He observed that the examiners in his study were unskilled at detecting countermeasures and at calibrating the polygraph instrument.

Dawson (1980) focused on the effect of “cognitive countermeasures” on validity. His study was unique in that the subjects were actors trained in the Stanislavsky method of acting, which teaches actors to use their own experience to create emotional states appropriate for a role. Studying the attempts of “method” actors to foil the polygraph may help determine whether guilty subjects can be trained to use
cognitive countermeasures to appear innocent. Dawson was also interested in analyzing separately responses during two distinct phases of the questioning: while subjects listened to questions and while they responded. In this study, the sample consisted of 24 student actors, half of whom were randomly assigned to the “guilty” group and half to the “innocent” group. They were instructed to use the Stanislavsky method to appear innocent on the polygraph examination. After the mock crime, four charts were obtained from ZOC control question test about the crime. On two of the charts, the subjects were instructed not to respond until they received a signal 8 seconds after a question. This served to separate responding associated with the questions from responding associated with answering. Dawson found that the subjects’ immediate physiological responses to the questions, whether they were answering immediately or not, led to decisions which were 88 percent correct, 8 percent incorrect, and 4 percent inconclusive (frequencies across two conditions were summed). The delayed answer response yielded a rate of 29 percent correct, 8 percent incorrect and 62 percent inconclusive. The incorrect decisions made were entirely false positives. A quantitative analysis revealed that the EDR and cardiovascular measures differentiated significantly between innocent and guilty, but respiration did not. The major outcomes of this study suggested that the polygraph was not susceptible to cognitive countermeasures of the sort used by the actors and that scoreable responses generally occur immediately after questions.

Kircher (1981) compared the accuracy of a computer decision making process to the accuracy of assessments of a field examiner. The computerized analysis cannot be included in the statistical analysis of this technical memorandum, because it is not presently a field scoring method, but the decisions of an independent evaluator who was used can be. This mock crime study followed the basic procedures of Podlesny and Raskin (1978) with 100 subjects from the community. The accuracy of the original examiner was not reported though the results of an independent evaluator were. The independent evaluator, who numerically scored the charts blindly, correctly diagnosed 87 percent of the subjects; misdiagnosed 6 percent; and made a judgment of inconclusive on 7 percent. The six errors were evenly divided between three false negatives and three false positives. In comparison, different computer decision models, on the average, correctly identified 84.9 percent of subjects, misidentified 7.85 percent, and placed 7.2 percent in an inconclusive category.
Bradley and Janisse (1981) also tested the 192 subjects with the GKT after the CQT had been conducted. The questions concerned four relevant details. They were scored using the Lykken method. With EDR data, the GKT classified an average of 74 percent of subjects correctly, and 26 percent incorrectly with 11 false positives and 39 false negatives. With the measure of heart rate change, the GKT categorized 63.5 percent of subjects correctly and 36.5 incorrectly, with 17 false positives and 53 false negatives, neither the degree of threat nor the demonstrated effectiveness of the polygraph test had a significant effect on the discrimination between deceptive and truthful subjects.

A somewhat different approach to assessing the validity of the polygraph was taken by Szucko and Kleinmuntz (1981). They directly compared the ability of polygraph examiners to assess deception against the ability of computers to do the same using a digitalized form of the same data. They had a sample of 30 psychology undergraduate volunteers and randomly assigned them to the guilty or innocent conditions. The mock crime involved the “theft” of a $5 bill. Polygraph tests were administered by four examiner-trainees from a polygraph firm near Szucko and Kleinmuntz’s university. The recordings of the physiological measures were transformed into digital form for computer analysis. Six experienced polygraph examiners independently evaluated the charts. No inconclusive category was allowed in the study. Digital polygraph data was evaluated by computer. A lens model equation drawn from studies of human judgment was used. The results of this analysis indicated that five of the six polygraph raters were able to detect deception significantly better than chance, but four of them also had fairly high rates of false positives. Szucko and Kleinmuntz estimate that the judges detected on the average 71 percent of guilty subjects, but also called half of the innocent subject’s deceptive (false positive). Szucko and Kleinmuntz state that 80 percent of the protocols could be classified correctly using a purely statistical analysis, but they do not state the detection rate, false positive rate, and false negative rate of their statistical analysis.

Bradley and Janisse (1981) studied the effects of two other variables hypothesized to influence the validity of the polygraph: the degree of threat involved in the punishment for being judged guilty and successful demonstration to the subjects of
the technique’s accuracy. A mock crime was carried out using procedures similar to those used by Barland and Raskin (1975). Subjects were also given a series of stimulation tests. Results of these tests were manipulated such that they made the polygraph test appear perfectly effective, partially effective, and ineffective. In addition, half the subjects were told they would receive a painful electric shock if found guilty, though no shock was ever given. The degree of manipulated effectiveness had no direct effect on scores, but did tend to increase the accuracy of detection. Threat of punishment did not affect accuracy of detection, although it did have an overall effect on heart rate. EDR and heart rate change were significantly accurate in differentiating guilty and innocent, although another measure, pupil size change, was not.

Ginton, Netzer, and Elaand (1982) conduct a study on 21 Israeli policemen and test the relative effectiveness of behavioral observations, global evaluations, including behavioral observations, and numerical scoring based on the charts alone. Subjects in They were given paper and pencil tests that were presented as required aptitude tests. Subjects were asked to score their own tests, which provided an opportunity to cheat, i.e., to revise their initial answers. The test answer sheets, however, were chemically treated so that cheating could be detected. Seven of the twenty one subjects actually changed their initial answers. Later, subjects were told they were suspected of cheating, were offered an opportunity to take a polygraph examination, and were told their careers might depend on the outcome. Fifteen subjects actually underwent the polygraph testing, only two of whom had actually cheated. A CQT was administered, and each subject was evaluated by three polygraph experts who had conducted or witnessed the particular examination being evaluated. One examiner (an observer) relied on behavioral observation, another (a rater) used only the charts, and a third (the actual examiner) used both sources of information. The evaluations were made globally. Five other polygraph examiners evaluated the charts later using both the Utah group’s scoring system and global evaluations. The original three performed a second analysis in this way, too. Both guilty subjects who took the test were correctly detected. However 15 percent of the no cheaters were incorrectly identified as deceptive.
Timm (1982) examined the effect of the administration of a placebo on the validity of GKT. Also included in the experiment was an investigation of the effect on GKT accuracy of differential feedback from the stimulation test. In the experiment all 270 college student subjects committed a mock crime. There were no “innocent” subjects. Before the mock crime, subjects were either: 1) given a placebo and told it would help them “beat” the test; 2) given a placebo and told it would make it more difficult to deceive the examiner; or 3) not given a placebo. The stimulation or number test was arranged to produce three different feedback conditions. One-third of the subjects’ numbers were detected, one-third were not, and one-third did not receive the results of the stimulation test. After the GKT was conducted on each subject, charts were scored according to the Lykken method. Adequate charts were obtained for 237 subjects. Of these subjects, 70.4 to 80.8 percent of them produced scores indicative of guilt, depending on how conservative a cutoff point for the score was used. Neither the placebo condition nor the feedback condition produced a significant effect on detection ability. Because of the absence of “innocent” subjects in this study (i.e., a base rate of guilty of 100 percent), the study tells us nothing about the accuracy of GKT with the innocent subjects. And even the results with guilty subjects are difficult to interpret when there is no comparison to results with innocent subjects. Also, without innocent subjects, a lambda is impossible to calculate background.

Honts and Raskin (1988) have reported the only field study of the Directed Lie Test (DLT). They conducted polygraph tests of criminal suspects over a four-year period and obtained 25 confirmed tests in which one personal directed-lie was included along with probable-lie comparison questions. Each of the investigators then performed blind interpretations of the charts obtained by the other investigator, scoring them with and without the use of the directed-lie question. The results of the Honts and Raskin study indicated that inclusion of the directed-lie question in the numerical evaluation of the charts had a noticeable effect on the confirmed innocent suspects, reducing the false positive rate from 20% to 0%. For the confirmed guilty suspects, it had the slight effect of changing one inconclusive outcome to a false negative. The effects of the directed-lie question on the numerical scores were more dramatic. Inclusion of the directed-lie comparisons almost doubled the size of the total numerical scores for the confirmed innocent suspects, raising the mean score.
from +4.7 to +9.0. It had a lesser effect on the scores of the confirmed guilty suspects, lowering them from -13.8 to -11.5. Thus, the directed-lie question had the effect of raising the mean score for innocent suspects from the inconclusive range into the definite truthful area, while leaving the mean score for guilty suspects clearly in the deceptive area. The main impact of the directed-lie question was a reduction in false positive errors.

Kircher, Horowitz, and Raskin (1988) reported that polygraph accuracy (measured as Pearson’s $r$ between test results and actual truthfulness or deception) was correlated with three study characteristics across 14 polygraph studies of comparison question tests. The characteristics were examinee population (college students or others), incentive strength (the presence or absence of a tangible consequence of being judged deceptive, for both innocent and guilty examinees), and whether or not the study used field testing techniques that allowed examiners to conduct three or more charts in order to get a conclusive result. Because these characteristics were highly correlated with each other in the 14 studies, and with whether or not the studies were conducted in the authors’ laboratory, it is difficult to attribute the observed associations to any specific characteristic. Authors do not place much confidence in the reliability of the correlations because of the instability of the estimates for such a small number of studies and because of the inherent limits of Pearson’s $r$ as an index of polygraph accuracy. Moreover, our examination of one of these variables (strength of incentive) failed to reveal an association with test accuracy in our sample of studies, which is larger and covers a broader range of incentives. Kircher and colleagues coded incentive strength as high for studies that offered as little as a $5 bonus to examinees for producing a nondeceptive result; only one study in the Kircher meta-analysis involved an incentive stronger than a $20 bonus.

Ben-Shakhar and Elaad (2002) examined 169 experimental conditions from 80 laboratory studies of concealed information tests. The study included a large number of studies that did not include a comparison group that lacked any concealed information. Positive associations of accuracy were reported with three moderator variables: number of sets of relevant and comparison questions, the presence of motivational instructions or monetary incentives, and the presence of the
requirement that deceptive examinees make a deceptive answer (rather than a nonresponsive).

The present review reveals and confirms the validity of Lie Detection procedures. Most of the studies assessed the accuracy of identification of guilty and innocent subjects (Davidson, 1968; Barland & Raskin, 1975; Podlesny & Raskin, 1978; Ginton et al., 1982). Perusal of the studies reviewed in this section indicates that majority of the researchers were conducted prior to 1990. A review of 80 laboratory studies was done by Ben-Shakhar and Elaad in 2002. Majority of the studies reviewed in this section were laboratory experimental studies. (Lykken, 1959; Barland and Raskin, 1975; Widacki & Horvath, 1978; Rowner, Raskin & Kircher, 1981; Balloun & Holmes, 1979; Hammond, 1980; Davidson, 1968; Ginton et al., 1982; Bradley & Janisse, 1981; Szucko & Kleinmuntz, 1981; Podlesny & Raskin, 1978; Timm, 1982; Honts & Raskin, 1988 and Kircher et al., 1988) based on mock crime investigation, real crime, guilty or innocent conditions, criminal suspected research. The sample consisted of young male participants (Lykken, 1959; Davidson, 1968; Barland & Raskin, 1975; Balloun & Holmes, 1979; Szucko & Kleinmuntz, 1981; Timm, 1982). Some studies (Heckel et al., 1962; Balloun & Holmes, 1979; Hammond, 1980) included psychotic, neurotic and normal subjects. This type of selected sample indicates the psychopathology nature of the researches. However, in some studies, (Rovner, Raskin & Kircher, 1979; Kircher, 1981; Ginton et al., 1982; ) police personnel and community workers were selected as participants in the research.

Abrams (1963) reviewed laboratory and field studies form 1963-1973 and reported a higher accuracy for field studies (98 % field studies; 83 % laboratory studies). For GKT, 98% correct classification was reported with just one error, a false negative by Davidson (1968) while for CQT, Barland and Raskin in 1975(53% correct identification, 12% incorrect and 35% inconclusive) and Podlesny and Raskin in 1978( 80% correct, 10% incorrect & 10 incorrect ) reported lesser accuracy. However, Ginton et al., (1982) reported much better accuracy for CQT where the identification of the guilty was 100% but 15% of innocent was falsely identified as guilty. Honts and Raskin(1988) reported that use of DLT helped to reduce the false positive from 20 to 0%. Polygraph accuracy was found to be correlated with examinee population, incentive strength and number of chart used (Kircher et al.,
Retest of the suspects (even when question order was changed) led to reduction in accuracy of detection (Balloun & Holmes, 1979).

Comparison of the efficacy of EDR and heart rate revealed that EDR was a better measure for lie detection (EDR: correct 74%; incorrect 26%; Heart Rate: correct 63.5%; incorrect 36.5%) while pupil size change was not found to be a good indicator (Bradley & Janisse, 1981). Comparative evaluation of the polygraph recordings by human examiner and computer analysis did not reveal much variation (Kircher, 1981). However, Szucko and Kleinmuntz (1981) reported better classification where analysis was done on statistical basis.

Effect of use of countermeasures by the suspect on accuracy of detection has been studied by a number of researchers (Dawson, 1980; Rovner et al., 1979; Timm, 1982). Rovner et al. reported that information about countermeasures did not influence the accuracy of detection but information along with practice and feedback led to decrement in correct identification and increase in both incorrect and inclusive categorization. Contrary results were reported by Timm (1982) where neither placebo administration nor feedback produced any significant effect on detection.

Considered together these studies indicate that the major limitation of the lie detection procedures is the incorrect or inconclusive identification of the innocent. Also EDR appears to be a more efficient index for lie detection than other physiological parameters. Information about the lie detection procedure and countermeasures do not influence the results but practice (both in terms of test as well as practice of countermeasure) has a detrimental effect, may be because the suspect learns to manipulate his/her physiological responses either incidentally or consciously. Thus, it appears that lie detection should be used with caution in criminal as well as screening procedures and procedures which reduce the chances of manipulation by the suspect would go a long way in further improving the viability and accuracy of lie detection.
Subliminal Stimuli and Physiological Changes

Research in the area of experimental psychology has indicated that brief or ambiguous presentation of a stimulus may lead to the unconscious processing of the stimulus even though it does not enter into conscious awareness. This section deals with the physiological effects of subliminal stimuli which do not transgress conscious awareness, yet they lead to changes in physiological responses (GSR, EDR, BP, heart rate, respiration, EEG, EMG etc.).

Emrich and Heinemann (1966) conducted a study where emotional and neutral words slowly becoming visible with increasing brightness on a translucent screen were observed by 16 healthy subjects whose electroencephalograms and electrocardiograms were continuously recorded. They had to signal the appearance of light, the visibility of contours or letters, the moment when they could guess a word, and the moment when the word was plainly visible. For the subliminal range significant differences were found between in EEG and ECG for emotional and neutral words. Taking into consideration similar findings by other authors an absolute threshold is postulated; the threshold of conscious perception (1st signal) is higher and inconstant. During the exposition of emotional words the abundance of alpha waves was higher. The ECG differences disappeared in the supraliminal range.

Lee and Tyrer (1981) conduct a study on six groups of volunteer students were shown a series of four 90-second pictures: and anxiety inducing, one neutral, and two control sequences with no information content, under both subliminal and supraliminal conditions. Self-report and physiological responses to each picture were recorded. Each group was shown the same set of eight motion pictures, in counterbalanced order, but the level of subliminal presentation was varied from completely subliminal in group 1 to a level at which all the subjects could recognize the material in group 6. The results showed that although the anxiety-provoking motion pictures produced significantly greater anxiety responses under supraliminal conditions, there were no significant differences between responses to the pictures at any level of subliminal exposure.

Borgeat and Goulet (1983) examined to measure eventual psychophysiological changes resulting from auditory subliminal activation or deactivation suggestions.
18 subjects were alternately exposed to a control situation and to 25-dB activating and deactivating suggestions masked by a 40-dB white noise. Physiological measures (EMG, heart rate, skin-conductance levels and responses, and skin temperature) were recorded while subjects listened passively to the suggestions, during a stressing task that followed and after that task. Multivariate analysis of variance showed a significant effect of the activation subliminal suggestions during and following the stressing task. This result is discussed as indicating effects of consciously unrecognized perceptions on psychophysiological responses.

Dixon (1983) suggested that whatever the paradigm in which unconscious perception is brought about and whatever the research context in which these paradigms are used, there is hardly a single finding from subliminal perception, microgenesis, and sleep and dream research that does not implicate 2-way interaction between sensory inflow, emotional appraisal, and the unconscious memory-storage systems of the human brain. Data from different areas of research are reviewed to develop a flow model to explain how physiological events in the brain give rise to representations in the mind. The model depicts conditions for achieving conscious representations of sensory inflow, which include physical, physiological, and mental factors; whatever the mechanism through which the transition from physiological to phenomenal representation is achieved, it is potentially sensitive to these 3 factors. The model also encompasses consciousness and energy; temporal parameters of consciousness; and the ubiquity of subliminal effects across receptors, sensory dimensions, and modalities.

Kilbourne, Painton and Ridley (1985) conducted two empirical studies to assess the effectiveness of sexual embedding (subliminal messages) in advertising. In Study 1, 424 undergraduates viewed and evaluated two advertisements (ads) with embeds or two matched ads without embeds. Results indicate that embedding was effective in raising attitudinal evaluations of a liquor ad but not cigarette ads. In Study 2, galvanic skin response (GSR) measurements were taken on 36 undergraduates while they viewed both versions (with and without embeds) of 2 ads. Results indicate that embedding was effective in increasing GSR measurements for the version of the ads with embeds. Results of both studies suggest that the use of sexual embeds in magazine advertisements influences viewers' evaluations of the ads.
Borgeat, Elie, Chaloult, and Chabot (1985) studied psychophysiological responses to masked auditory verbal stimuli of increasing intensities in (n=20) twenty healthy women. Two experimental sessions corresponding to two stimulation contents (neutral or emotional) were conducted. At each session, two different sets of instructions (attending or not attending to stimuli) were used successively. Verbal stimuli, masked by a 40-dB white noise, were presented to the subject at increasing intensities by increments of 5 dB starting at 0 dB. At each increment, frontal EMG, skin conductance and heart rate were recorded. The data were submitted to analyses of variance and covariance. Psychophysiological responses to stimuli below the thresholds of identification and detection were observed. The instruction not to attend the stimuli modified the patterns of physiological responses. The effect of the affective content of the stimuli on responses was stronger when not attending. The results show the possibility of psychophysiological responses to masked auditory stimuli and suggest that psychophysiological parameters can constitute objective and useful measures for research in auditory subliminal perception.

Kostandov and Arzumanov (1986) conduct a study on P300 component of the evoked potential recorded over both hemispheres in order to study inter hemispheric differences in the process of perception of subliminal verbal stimuli. The subliminal words, neutral and emotional were presented at random to the left or right visual fields. In response to an unrecognized emotional word, the amplitude of P300 wave increased diffusely over both hemispheres as compared to that to a neutral word, with no charges in inter hemispheric differences. The inter hemispheric difference changed considerably in the presence of an 'unaccountable' emotion caused by a subliminal word. This suggests unilateral activation of the right hemisphere and a predominant role of this hemisphere in the cortical organization of the unconscious function 'unaccountable' emotion. Subliminal emotional words connected with the subject's conflict situation evoke the P300 of significantly larger amplitude than subliminal neutral words. The increase is generalized over occipital and associative areas, and at the vertex. Thus, the study of relations between unconscious mental phenomena and hemispheric functional asymmetry reveals two aspects of the problem. Firstly, there are hemispheric relations in the perception of subliminal emotions stimuli. Authors could not find any peculiarities, and accordingly, they
cannot speak about a dominant or particular role of one hemisphere in the processing of subliminal verbal information. Apparently 'perception without awareness' is performed with both hemispheres acting in cooperation and each one contributes to the whole function. Secondly, there is the problem of hemispheric asymmetry after unrecognized emotional verbal stimulation. The clearly functional asymmetry observed in this case suggests the dominant role of the right hemisphere in the forming of such an unconscious mental process as unaccountable emotion.

Kemp-Wheeler and Hill (1987) examined two groups of undergraduates (n=14 in each) matched for level of trait anxiety participated in the experiment. One group (E) was presented with 20 emotional' words 10 percent below detection threshold while the other group (N) was presented with 20 emotionally neutral words under the same conditions. Ratings of several psychological variables were taken before and after stimulation and two psychophysiological measure, heart and respiration rate, were also taken. It is concluded that manifest anxiety and some features of anxiety having somatic referents can be induced by subliminal experience of mild stress.

Goncalves and Ivey (1987) studied the effects of tachistoscopic presentation of affective words on subjects' conceptualizations, intentions, and responses to a simulated client. The participants, 36 counseling students were assigned randomly to one of the following treatments: (1) subliminal presentation of negative emotional concepts; (2) subliminal presentation of positive emotional concepts; (3) supraliminal presentation of positive emotional concepts. After the tachistoscopic presentations, all subjects were exposed to a simulated client, whom they were asked to evaluate, respond to, and report the cognitive intentions that guided their responses. Significant effects were found in the subliminal presentation of positive emotional concepts on subjects' conceptualizations, intentions, and responses. Some significant effects also were found for the supraliminal presentation, but only for the client evaluation measure.

Another approach in studying subliminal perception in healthy subjects is the earlier mentioned study of GSR for stimuli presented below the threshold of conscious detection. In an experimental study, Kotze and Moller (1990) presented emotional
and neutral words subliminally while recording the GSR. Their results showed a significant increase in GSR response for emotional but not for neutral words. The authors conclude that their results confirm the hypothesis that auditory subliminal stimulation would produce an increase in the GSR. In effect, these studies demonstrate that even complex stimuli (such as words and faces) can be processed outside awareness.

Gläscher and Adolphs (2003) studied that the amygdala is known to play an important role in conscious and unconscious processing of emotional and highly arousing stimuli. Neuroanatomical evidence suggests that the amygdala participates in the control of autonomic responses, such as skin conductance responses (SCRs), elicited by emotionally salient stimuli, but little is known regarding its functional role in such control. Authors investigated this issue by showing emotional visual stimuli of varying arousal to patients with left (n = 12), right (n = 8), and bilateral (n = 3) amygdala damage and compared their results with those from 38 normal controls. Stimuli were presented both subliminally (using backward masking) and supraliminally under lateralized presentation to one visual hemi field. Investigators collected skin conductance responses (SCRs) as a physiological index of emotional responses. Subjects subsequently rated each stimulus on valence and arousal under free viewing conditions. There were two key findings: (1) impaired overall skin conductance responses (SCR) after right amygdala damage; and (2) impaired correlation of skin conductance responses (SCR) with the rated arousal of the stimuli after left amygdala damage. The second finding was strengthened further by finding a positive correlation between the evoked skin conductance responses (SCR) magnitude and postsurgery amygdala volume, indicating impaired autonomic responses with larger tissue damage. Bilateral amygdala damage resulted in severe impairments on both of the above measures. These results provide support for the hypothesis that the left and right amygdalae subserve different functions in emotion processing: the left may decode the arousal signaled by the specific stimulus, whereas the right may provide a global level of autonomic activation triggered automatically by any arousing stimulus.

This section reviewed a number of studies (Lee & Tyrer, 1981; Borgeat & Goulet, 1983; Glascher & Adolphs, 2003) where subliminal stimuli were reported to have an impact on physiological responses such as EMG, Heart Rate, GSR, Blood
Pressure, and Respiration. On the basis of the resume of researches given in this section, it is evident that subliminal stimuli have significant effects on physiological responses, especially when they are anxiety producing (Lee & Tyrer, 1981), the subject is in a stressful situation (Borgeat & Goulet, 1983) or the subject is not consciously attending to the stimuli (Borgeat et al., 1985). Subliminal presentation of emotional words leads to an increase in GSR response in comparison to neutral words (Kotze & Moller, 1990). A study of inter hemispheric differences in the process of perception of subliminal verbal stimuli 'perception without awareness' by recording of P300, an event-related potential was conducted by Kostandov and Arzumanov (1986) where both hemispheres were found to act in cooperation and each one contributed to the whole function. However, hemispheric asymmetry was observed after unrecognized emotional verbal stimulation where a dominant role of the right hemisphere was observed in the formation of an unconscious mental process in response to an unaccountable emotion. Support for the role of the left hemisphere in processing of unaccountable stimuli is evident from a recent research by Glascher and Adolphs (2003) where the left amygdala was found to decoded arousal signals in response to specific stimuli while the right provided automatic activation to any arousing stimuli, thereby implicating a role of the right amygdala in subliminal stimulation.

Countermeasures and Lie Detection

This section is deals with use of countermeasures in different lie detection procedures and explores the types of countermeasures used by the subjects in avoiding detection.

In an early laboratory study conducted by Gustafson and Orne (1965), subjects were given a stimulation test and feedback concerning its outcome. Feedback was manipulated so that some subjects thought they had successfully avoided detection and others thought that they had not. Subjects were motivated on a subsequent trial to avoid detection (they were told; “only mature and stable individuals are able to fool the lie detector”). The results indicated that subjects who believed that they had avoided detection were much less detectable on the second trial (13 out of 16 were
not detected, while only 1 of 16 in a control group was able to avoid detection). It should be noted that a stimulation test is a form of a concealed information test and the result may be due to lowered overall arousal. “Beating” a CQT represents a somewhat different problem.

Another countermeasure is based on research about the bogus pipeline, by Jones and Sigall (1971) and the role of the setting in inducing valid outcomes. If the validity of polygraph testing is dependent on the belief by subjects in the efficacy of the procedure, then a possible countermeasure would involve training subjects to believe that the polygraph does not work. This might be done, for example, by providing subjects with false feedback on a polygraph examination. Unfortunately there is little research in this area, and the two studies that have been conducted come to different conclusions about the effect of belief in the techniques’ effectiveness.

Corcoran, Lewis, and Garver (1978) have examined the effects of biofeedback training on suppressing EDR. They found that both hypnosis and biofeedback groups were able to reduce detectability after training as compared to a control group. In another study, Rovner, Raskin, and Kircher (1979) reported that subjects who received extensive information about the nature of lie detection and practiced using countermeasures were detected significantly less than subjects without such training. It seems clear that if hypnosis or biofeedback operates as countermeasures, especially with commonly used tests such as CQT, that extensive training would have to accompany their use.

Podlesny and Raskin (1978) included GKT in their study of a variety of polygraph techniques and physiological measures. Their experiment was unique in that it employed GKT in the same context as CQT (see above). Thus, they were able to compare the accuracy rates of the two techniques, although they claimed that a different statistical comparison was impossible because the two techniques use very different methods to assess guilt. Podlesny and Raskin also were the first to test GKT with physiological measures other than EDR. To make assessments of guilt, they used the traditional polygraph respiration and cardio measures, and another vascular measure that was a composite of finger blood volume and finger blood
amplitude. This latter measure was recorded by the photoplethysmograph mentioned above. In addition, Podlesny and Raskin performed a quantitative analysis of differences between guilty and innocent subjects on several other physiological measures. GKT was conducted after the same mock theft Podlesny and Raskin used to study CQT. Twenty subjects (10 guilty and 10 innocent) were examined with GKT, which included five questions with six alternatives each. The relevant alternatives were placed among the other alternatives in a “pseudo-random” order. The GKT charts were scored by the same method used by Lykken and Davidson. Podlesny and Raskin also scored the charts in another way, with the addition of an inconclusive zone of scores five or six. This scoring system for assessing guilt was used with the photoplethysmograph, respiration, and cardio measure as well as EDR. Their findings were that GKT with EDR was correct for 90 percent of the subjects and incorrect for 10 percent, all false negatives. Using an inconclusive zone did not add significantly to the accuracy of the technique, however: 80 percent of assessments were correct, 10 percent incorrect (all false negatives), and 10 percent inconclusive.

Rovner, Raskin and Kircher (1979), tested a similar hypothesis in a CQT examination. Several groups of subjects were placed in a mock crime situation. One group was given information about the nature of a CQT examination and information on what physiological reactions they should try to simulate. Another group was given information plus two practice tests involving actual physiological recordings after which they were told whether or not they had beat the polygraph. A third group served as a control and was given a typical polygraph examination. The results indicated that the information only and control group were not able to avoid detection; however 25 percent of the guilty subjects in the information plus practice group were able to avoid detection. Raskin maintains that this 25-percent error rate should be considered the “upper limit” because, in actual field situations, motivation would be much higher. Although Raskin is, perhaps, correct, it is also possible that in actual situations (where motivation is high), subjects might engage in more practice.

Giesen and Rollison (1980) studied the effects on GKT of the subjects’ trait anxiety levels and of the possibility that crime-related details could be relevant to innocent
subjects because of associations unrelated to the crime. Trait anxiety is anxiety that is characteristic of one’s personality and would be relatively stable over time. Both trait anxiety and “innocent associations” could conceivably confound the detection of guilt with GKT. Giesen and Rollison selected 40 female undergraduates who responded positively to a questionnaire item on “palmar sweating.” EDR is related to sweating. Thus, this sample may have tended to produce higher EDRs than the norm. This group was divided into two groups of 20: those who scored high on a questionnaire measure of anxiety (Lykken’s activity preference questionnaire) and those who scored low. Ten subjects in each group were then assigned to the guilty knowledge condition, and to the “innocent associations” condition. The guilty subjects were told to pretend to be secret agents who had committed a murder. They read a narrative about the crime, and role-played the act of burning an incriminating picture. Innocent subjects also played secret agents, but read an narrative containing several details (e.g., how much money was involved), which in the guilty condition were related to the crime. They had, therefore, as much exposure to this information as the guilty subjects, but in an innocent context. Using GKT with EDR, experimenters asked subjects eight crime-related questions, each with five alternatives. Those details common to both conditions were used as the crime-relevant items in GKT questions. Scoring followed Lykken’s method.

There is little research evidence available to ascertain the potential of these techniques. Only one study on the use of such cognitive countermeasures appears to have been conducted, and it does not provide much information. In this study, Dawson (1980) used as subjects actors trained in the “method” school of acting. Subjects were instructed to try to defeat the polygraph in a CQT examination. The results indicated that without exception the actors were detected and were not able to control their affective responses. It should be noted, however, that the actors in Dawson’s study were merely told to “appear innocent” and were not told what would make them appear no deceptive on a polygraph test.

Giesen and Rollison (1980) found that GKT was highly accurate, correctly classifying all of the innocent subjects and detecting all but one of the guilty subjects (an average of 97.5 percent correct). In addition, they found that the EDR measure was significantly different between guilty and innocent subjects. Trait anxiety level
had no effect on EDR by itself, but the more anxious subjects in the guilty condition had significantly greater EDR than the less anxious, especially in response to the relevant items. These findings would suggest that anxiety alone does not confound GKT results, but anxiety in guilty subjects might indeed augment the accuracy of the technique. The study also suggests that GKT may be accurate even when innocent subjects have greater associations with crime-relevant items than with neutral items. This finding, however, must be tempered by the fact that the entire sample was selected for their tendency for palmar sweating under stress and, thus, may be unrepresentative of polygraph subjects in general.

Recent research by Waid (1981) indicates that the tranquilizer, meprobamate ("Miltown"), permits subjects who are being deceptive to increase their ability to avoid detection in a polygraph examination. One feature of tranquilizers such as meprobamate is that they suppress autonomic activity which may not be accompanied by any observable psychomotor differences. In Waid, et al. (1981) study a GKT was used in a polygraph test. Subjects were all male and divided into three groups: 1) a tranquilizer group; 2) a placebo group; and 3) a control group. Only 3 of 11 guilty subjects who had taken meprobamate were scored as deceptive.

Bradley and Janisse (1981) tested the hypothesis by rigging a stimulation test at various levels of effective detection. Depending on the condition, subjects were “detected” on one, two, or three trials to create the impression that the detection measures were ineffective, sometimes effective, or perfectly effective. For the EDR measure, the more effective the apparatus appeared to be, the more the innocent subjects scored as nondeceptive and the more the guilty subjects scored as deceptive. In an earlier study, however, Timm, 1962 found that feedback about the techniques’ effectiveness had no effect on whether subject’s deceptiveness or nondeceptiveness could be detected. The theoretical support provided by research on the bogus pipeline indicates that subjects’ belief in the technique may be important, and that additional research is needed to assess the effects of belief in the machine on actual polygraph tests.

Bradley and Janisse (1981) also tested the 192 subjects with the GKT after the CQT had been conducted. The questions concerned four relevant details. They were
scored using the Lykken method. With EDR data, the GKT classified an average of 74 percent of subjects correctly, and 26 percent incorrectly with 11 false positives and 39 false negatives. With the measure of heart rate change, the GKT categorized 63.5 percent of subjects correctly and 36.5 incorrectly, with 17 false positives and 53 false negatives, neither the degree of threat nor the demonstrated effectiveness of the polygraph test had a significant effect on the discrimination between deceptive and truthful subjects.

Honts and Hodes (1982) conducted primarily for the purpose of testing whether polygraph examiners could detect the use of physical countermeasures by subjects. In the first study, subjects were college students who received extra credit toward their final grades for their participation. “Guilty” suspects participated in a mock crime (theft of an examination); innocent suspects were only told of the theft. All subjects were motivated to produce truthful outcomes on the polygraph test by an offer of twice the number of credits if the examiner reported them as truthful. In addition to participation in the mock crime, 24 of the guilty subjects participated in 15-minute training sessions in which they were told about the theory of CQT and shown how to use either tongue biting (12 subjects) or toe pressing (12 subjects) as countermeasures during presentation of the control questions. They were also instructed to try to relax as much as possible during presentation of the relevant questions.

According to Raskin (1982), a different problem would be encountered by attempts to utilize tranquilizers to defeat an examination employing CQT. The use of such drugs in a CQT polygraph examination would be more likely to yield inconclusive findings, rather than errors, because the drugs would likely result in no difference between the responses to control and relevant questions. This interpretation is supported by the recent analog study of Gatchel, et al. (1983), which found that the use of propranolol, a beta-blocking drug, resulted in a 32.2-percent inconclusive rate, although the overall error rate was low.

Another experiment on countermeasures, Honts and Hodes (1982) used approximately the same procedures and subject pool, with the exception that subjects were asked to employ both countermeasures simultaneously, were given 30 minutes of training, including a practice session, and were asked to practice at home.
A cardio cuff was added to the polygraph instrument, and a card test was conducted prior to the administration of the first test. Overall, results of the second study replicated the first. The categorizations of the original examiner were 51 percent correct, 14 percent incorrect, and 35 percent inconclusive. Twenty-six percent of the countermeasure subjects compared to none of the guilty/no countermeasure subjects were incorrectly classified as truthful. Examiners were not able to detect successful countermeasure users.

Kleinmuntz and Szucko (1984) reported a case of a convict (Floyd Buzz Fay), who was falsely convicted of murder on the basis of a failed polygraph examination, took it on himself to become a polygraph expert during his 2 and half years of wrongful imprisonment. The convict coached 27 inmates, all of whom Farley confessed to him that they were guilty, on how to beat the control question polygraph test. After 20 minutes of instruction, 23 of 27(85%) were successful in foiling the polygraph examination. Countermeasures against the GKT when used with polygraph have also been demonstrated.

Lacono, Boisvenu and Fleming (1984) studied the effect of the tranquillizer valium and stimulant Ritalin in defeating a CIT, and found that ingestion of neither 10 milligrams of diazepam (Valium”) nor 20 milligrams of methylophenidate (Ritalin affected the accuracy of detection. Results in both active drug conditions were more accurate than when subjects ingested a placebo (a capsule containing lactose).

Honts, Hodes, and Raskin (1985) conduct a study to see the effects of physical countermeasures on the physiological detection of deception. In Exp I, (n=48) undergraduates were divided into 4 groups, 3 of which enacted a mock crime. Two of these guilty groups were trained in the use of a countermeasure, either biting the tongue (pain countermeasure) or pressing the toes against the floor (muscle countermeasure) during the control question zones of the control question test (CQT). All countermeasure Ss were given extensive information about the nature of the CQT. Results show that no significant effects for countermeasures were found. In Exp II, (n=57) Ss were divided into 3 groups, 2 of which enacted a mock crime, to assess the effects of additional training and concurrent use of both countermeasures. Results show that countermeasure Ss produced 47% false negative outcomes as
compared to no false negatives for guilty control Ss. False negative outcomes occurred when Ss were able to produce physiological responses that were larger to control questions than to relevant questions. Findings should be qualified by the possibility that the countermeasure task would be more difficult if the relevant questions dealt with a real crime in an actual investigation. It is concluded that a substantial number of Ss can be trained to defeat a CQT in a laboratory paradigm.

A study conducted by Honts, Hodes, and Raskin, 1985, concluded that when guilty parties are trained and practice various techniques, specific point countermeasures can reduce accurate classifications of deceptive examinations. The study included three comparison groups: innocent, guilty with no countermeasures, and guilty with countermeasures (the CQT method was used). Guilty participants who were trained and practiced the techniques produced 47% of the false negatives compared to none of the guilty participants who were not coached. Figures provided in Table 2 indicate stability in classifications across evaluations of the results by three different polygraphers (note: percent properly classified does not include inconclusive results). It appears that pain countermeasures were more successful in reducing the number properly classified as deceptive across examiners, but measures using muscles varied in producing inconclusive results.

Elaad and Ben-Shakhar (1991) investigated the effects of mental countermeasures on psychophysiological detection in a guilty knowledge paradigm. Two experiments which utilized a 3 x 2 between subjects factorial design were conducted. Two types of mental countermeasures (specific dissociations from the relevant stimulus and continuous dissociation throughout the entire test, as well as a control-no countermeasure condition were used). Each group was further subdivided into two conditions—a high attention condition created by motivational instructions and a deceptive verbal response to the relevant question; and a low attention condition in which no motivational instructions were provided and no verbal response was required. The results of both experiments (one was conducted in a field set up, and the other utilized more standard experimental equipment and measurement procedures) revealed the following pattern: the item-specific countermeasures tended to increase psychophysiological detection, whereas the continuous dissociations tended to decrease detection efficiencies. The pattern was consistent
across attention conditions and experiments but it was stronger in the field experiment where overall detection efficiency was relatively high. In other respects the present results replicated previous findings and revealed a significant effect for the attention factor.

Iacono Cerri, Patrick, and Fleming (1992) evaluate whether antianxiety drugs enable guilty subjects to appear innocent on polygraph tests, we compared the effects of diazepam, meprobamate, and propranolol on the outcome of a guilty knowledge test (GKT). Seventy-five undergraduate students were evenly divided among one innocent and four guilty groups. Subjects in each of the guilty groups received either one of the drugs or a placebo prior to the administration of the GKT and after viewing a videotape that depicted a burglary as seen from the perspective of the burglar. The results showed that drug status had no influence on the outcome of the GKT. Innocent subjects who coincidentally obtained high scores on a recognition memory test covering details of the mock crime tended to obtain higher guilt scores on the GKT.

Honts and Kircher (1994) examined the effect of countermeasures on the control-question polygraph test were examined in an experiment with 120 Ss recruited from the general community. Ss were given polygraph tests by an examiner who used field techniques. 20 subjects were innocent, and of the 100 guilty subjects, 80 were trained in the use of either a physical countermeasure (biting the tongue or pressing the toes to the floor) or a mental countermeasure (counting backward by 7) to be applied while control questions were being presented during their examinations. The mental and physical countermeasures were equally effective: Each enabled approximately 50% of the Ss to defeat the polygraph test. The strongest countermeasure effects were observed in the cardiovascular measures. Moreover, the countermeasures were difficult to detect either instrumentally or through observation.

Honts Devitt, Winbush, and Kircher (1996) studied the effects of a physical (pressing the toes to the floor) and a mental (counting backward by sevens) countermeasures on the concealed knowledge test (CKT) were examined in a mock crime experiment with 40 subjects. Some knowledgeable subjects were informed
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about the nature of the CKT and were trained in the use of a countermeasure, whereas others remained uninformed. All subjects were offered a monetary reward if they could produce a truthful outcome. Subjects were tested using standard field techniques and instrumentation. The physical and, to a lesser extent, the mental countermeasures reduced the accuracy of the CKT. These results clearly demonstrate that the CKT has no special immunity to the effects of countermeasures.

Ben-Shakhar and Dolev (1996) studied the effects of mental countermeasures on the efficiency of psychophysiological detection with the Guilty Knowledge Technique were examined in a mock-crime experiment with 4 groups of participants: innocent participants who were not involved in the mock crime, guilty controls who committed the mock crime but received no countermeasure instructions, and guilty participants who received countermeasure instructions, and guilty participants who received countermeasure instructions and were allowed to practice the countermeasures. The countermeasure instructions encouraged participants to recall emotional situations from their past and imagine themselves in these situations during presentation of irrelevant questions. Results revealed a significant reduction in electrodermal detection efficiency under the 2 countermeasure conditions with no differences between them. No countermeasures effects were observed with the respiration line length measure.

Rosenfeld, Labkovsky, Winograd, Lui, Vandenboom, and Chedid, (2008) found countermeasures to protocols using P300 in concealed information tests. One, the "six-probe" protocol, in Experiment 1, uses six different crime details in one run. The countermeasure: generate covert responses to irrelevant stimuli for each probe category. Hit rates were 82% in the guilty group; 18% in the countermeasure group. The average reaction time (RT) distinguished these two groups, but with overlap in RT distributions. The "one-probe" protocol, in the second experiment, uses one crime detail as a probe. Here, one group was run in 3 weeks as a guilty group, a countermeasure group, and again as in Week 1. Countermeasure: Covert responses to irrelevant stimuli. In Week 1, hit rate was 92%. In Week 2, it was 50%. In Week 3, 58%. There was no overlap in the irrelevant RT distribution in Week 2: Countermeasure use was detectable. However, in Week 3, the RT distributions
resembled those of Week 1; test-beaters could not be caught. These studies have shown that tests of deception detection based on P300 amplitude as a recognition index may be readily defeated with simple countermeasures that can be easily learned.

Mertens and Allen (2008) examined whether the use of ERP-based deception detection alternatives have sufficient validity for applied use. The present study was designed to replicate and extend J. P. Rosenfeld, M. Soskins, G. Bosh, and A. Ryan's (2004) study by utilizing a virtual reality crime scenario to determine whether ERP-based procedures, including brain fingerprinting, can be rendered less effective by participant manipulation by employing a virtual reality crime scenario and multiple countermeasures. Bayesian and bootstrapping analytic approaches were used to classify individuals as guilty or innocent. Guilty subjects were detected significantly less frequently compared to previous studies; countermeasures further reduced the overall hit rates. Innocent participants remained protected from being falsely accused. Reaction times did not prove suitable for accurate classification. Results suggested that guilty verdicts from ERP-based deception detection approaches are likely to be accurate, but that innocent (or indeterminate) verdicts yield no useful interpretation in an applied setting.

Elaad and Ben-Shakhar (2009) examined the effects of physical and mental countermeasures on the accuracy of the concealed information test (CIT) were examined in a mock crime experiment with 64 participants. To combat countermeasures, two covert respiration measures, hidden in the seat and back of the examination chair, were used in addition to the standard physiological measures (SCR, FPWL, RLL). Some guilty participants were trained to use either physical or mental countermeasures and apply them to distort the outcomes of the CIT. In the second phase of the experiment participants were detached from the standard polygraph devices and examined solely with the two covert measures. Results indicated that physical countermeasures lowered SCR accuracy but had a relatively small effect on the other standard measures. On the other hand, SCR was relatively resistant to mental countermeasures. Both covert measures were resistant to physical countermeasures in the polygraph phase. When the standard devices were removed, the covert seat measure was effective in the no countermeasure and in the mental
countermeasure conditions but not when physical countermeasures were applied. The back measure was entirely ineffective.

In this section a number of researchers identified the use of various countermeasures (mental, physical, drugs, biofeedback training etc.) during polygraph testing. Many researchers (Jones & Sigall, 1971; Corcoran, Lewis & Garver, 1978; Waid, 1981; Honts & Hodes, 1982; Kleinmuntz & Szucko, 1984; Lacano, Boisvenu & Fleming, 1984; Elaad & Ben-Shakhar, 1991; Honts & Kircher, 1994; Ben-Shakhar & Dolev, 1996 & Elaad & Ben-Shakhar, 2009) provided evidence of the use of various countermeasures during polygraph. Number of studies (Podelesny & Raskin, 1978; Rovner et al., 1979; Giesen & Rollision, 1980; Dawson, 1980; Bradley & Janisse, 1981; Honts et al., 1985; Lacono et al., 1992) demonstrate that the countermeasures are used by the suspected people against polygraph procedures. Researches confirm that the use of countermeasures in various lie detection procedures affect the physiological responses during polygraph examination (Rosenfeld et al., 2004; Mertens & Allen, 2008; Elaad & Ben-Shakhar, 2009). The use of Physical and Mental countermeasures was examined in a number of researches ( Elaad & Ben-Shakhar, 1991; Honts et al., 1996; Honts & Kircher, 1994; Ben-Shakhar & Dolev, 1996; Honts, Hodes & Raskin, 1985; Eelaad & Ben-Shakhar, 2009). In recent study, the effects of physical and mental countermeasures on the accuracy of the concealed information test (CIT) were examined in a mock crime experiment by Elaad and Ben-Shakhar (2009). However, Ben-Shakhar and Dolev (1996) studied the effects of mental countermeasures on the efficiency of psychophysiological detection with the Guilty Knowledge Technique and a significant reduction in electrodermal detection efficiency under the 2 countermeasure conditions with no differences between them. Honts, Devitt, Winbush, and Kircher (1996) studied the effects of a physical (pressing the toes to the floor) and a mental (counting backward by sevens) countermeasures on the concealed knowledge test (CKT) and reported that the physical and, to a lesser extent, the mental countermeasures reduced the accuracy of the CKT. Infact, protocols using P300 in concealed information tests were also not immune to countermeasures(Rosenfeld et al., 2008).Thus, this review indicated that countermeasures undermine the efficacy of the lie detection procedure.
Lie detection, Subliminal Stimuli and Countermeasures

In the lie detection procedure, perception of an emotion producing stimulus can lead to execution of countermeasures in order to escape detection or false prosecution. The effectiveness of subliminal stimulation has been demonstrated in stimulation of mild emotional activity. Application of the concept of ‘perception without awareness’ has been widespread in the area of marketing where it is used in advertisements to increase persuasiveness of the message. Since in the lie detection procedure it is assumed that a guilty subject will fake his responses to the incriminating evidence (information or questions), conscious awareness of the evidence can be considered as a prerequisite to the execution of a countermeasure. This section examines the use of subliminal stimuli in eliciting physiological and/or conscious (recognition) responses.

Victor (2009) examined the use of classical conditioning paradigms, which focus on reflexive responses to stimuli, in the investigation of the probability and magnitude of electrodermal responses elicited by stimuli below awareness levels (subliminal). Thirty male college students were randomly assigned to either a supraliminal or subliminal treatment group (15 per group). During conditioning employing a partial reinforcement schedule, one of three geometric shapes presented at awareness level (supraliminal) was paired with a 1 to 4 milliampere electrical shock of 250 milliseconds duration. After conditioning had occurred, subjects electrodermal responses to sub- and supraliminally presented stimuli (the geometric shapes) were measured. Backward masking was used to reduce the probability of accurate stimulus recognition during the subliminal treatment condition. Data analysis showed that subjects in both conditions responded more frequently to target stimuli (CS+) than to stimuli which had not been previously paired with shock (Cs-). While subliminally presented stimulus recognition accuracy did not differ significantly from chance level, the frequency and magnitude of subliminal treatment group responses to both the CS+ and Cs- were greater than those of the supraliminal group. These results suggest that subliminally presented visual stimuli can elicit differential autonomic nervous system responding to CS+ and Cs-. The higher rate of responding and larger response magnitudes observed in the subliminal group may, however, have been due to generalized Cs+ expectancy in a situation where the stimuli could not be accurately identified.
Lui and Rosenfeld (2009) studied a lie detection protocol immune to countermeasures. The 4 stimulus conditions were (1 and 2) supraliminal acquaintance name primed by subliminal acquaintance name (A-A) versus subliminal nonacquaintance name (N-A) and (3 and 4) supraliminal nonacquaintance name primed by subliminal acquaintance name (A-N) versus subliminal nonacquaintance name (N-N). In Experiment 1 and replication, principal components analysis-derived event-related potential components revealed significant differences between dishonestly answered supraliminal acquaintance conditions with differing primes (A-A vs. N-A). In Experiment 2 subjects were required to lie in A-N and N-N conditions, in contrast to Experiment 1, in which subjects lied in A-A and N-A conditions. No significant effects were found. In Experiment 3, the lying task was removed and no significant differences were found. They concluded that subliminal primes modulate ERPs in conditions with supraliminal acquaintance name when the task involves lying.

In the last section only two studies were presented. The first study (Victor, 2009) showed that subliminally presented visual stimuli can elicit differential autonomic nervous system responding to CS+ and Cs- while the second study (Lui and Rosenfeld, 2009) demonstrated that subliminal primes modulate ERPs in conditions where the supraliminal stimulus provides a bases for lying due to the influence of the subliminal prime.

On the basis of the review of literature, problem and hypotheses were framed and have been presented in the next chapter.