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Effectiveness of Subliminal Stimuli in Lie Detection: Use of Physical Countermeasures

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ABSTRACT

The objective of the present investigation was to study the effectiveness of subliminal stimuli in reducing the probability of use of countermeasures during polygraph was considered. Further, use of countermeasures (physical) would be more for supraliminal stimuli as compared to subliminal stimuli. Purposive total samples of 79 adults with (age range between 20-28 years) were selected for the present study. Windows Based Computerised Lie Detector (CLD-118) and Aversion Therapy Instrument (MBT-498) were used in present study**.** For analyses of the data, Friedman Test (non-parametric) followed by Wilcoxon Signed-Rank Test (non-parametric), were applied. In the present investigation the effectiveness of subliminal stimuli in deterring the execution of countermeasures was studied, revealed that subliminal stimuli acted as a deterrent to physical countermeasures. The present findings indicate that subliminal stimuli can be used as a deterrent to countermeasures (Physical) in Lie Detection.

Keywords: Subliminal; Supraliminal; Physical countermeasures; GSR

1. INTRODUCTION

1.1 Countermeasures

Countermeasures are deliberate techniques that some guilty people use in order to beat the polygraph test[1-2]. It is possible that an innocent subject may sometime also use deliberate countermeasures to influence the outcome of the test[3] but there are no data available on this subject population[4]. Countermeasures are generally employed to increase arousal to control questions[5-6] thereby reducing the possibility of detection. ‘‘The most famous countermeasures test was probably conducted by Floyd ‘Buzz’ Fay, a man who was falsely convicted of murder. He took it on himself to become a polygraph expert during his two and half year of wrongful imprisonment. The convict coached 27 inmates, all of whom confessed to him that they were guilty, on how to beat the control question polygraph test however, after 20 min of instruction, 23 of 27 (85 %) were successful in foiling the polygraph examination”[7].

1.1.1 Physical Countermeasures

Many different physical manipulations can be used to distort the polygraph record but the most common ones consist of inducing either physical pain or muscle tension. i.e., biting one’s tongue in response to the control questions may create sufficient pain or discomfort to elect an artificial physiological response indistinguishable from that of a genuine one. Similarly, pressing the toes against the floor or the thighs against the chair the individual is sitting in has been shown to be effective techniques under certain circumstances.

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1.2 Subliminal Stimuli as Deterrent to Countermeasures in Lie Detection

Previous research investigating stimulus processing using subliminal presentation methods may be useful for resolving the question. Lui & Rosenfeld[8] applied presentation of subliminal stimuli in the CIT using the P300, demonstrating a subliminal priming effect on CIT performance. Recent countermeasure studies[9] have shown that subjects can be trained to make concealed responses (e.g., wiggling the toe) to the non meaningful items, which significantly increased P300 response (a specific brief electrical wave in a person’s electroencephalogram (EEG) which is a measure of the way the brain pays attention and discriminates between potentially important and non-important stimuli) to the irrelevant stimuli and therefore, no difference is found between guilty and irrelevant stimulus conditions.

Thus, it is probable that use of subliminal stimuli in lie detection would make the procedure immune to countermeasure use. If a key stimulus is presented subliminally, subjects would not be able to apply specific countermeasures to it because it would not be consciously perceived. Support for this contention is available from research where the priming of semantically related and unrelated words was found to modulate the amplitude and duration of ERP components[10]. Maoz[11], *et al.* examined subliminal presentation using the skin

conductance response (SCR), in which the probe itself was presented subliminally.

1.3 Rational of the Study

Research in the area of lie detection indicates that the major deterrent to accuracy, specifically identification of guilty, is the use of countermeasures. Research has shown that subliminal stimuli which do not elicit conscious awareness produce physiological as well as cortical activation. Thus use of subliminal stimuli could go a long way in attenuating the probability of use of countermeasures. Here we investigated the effects of aversive & neutral stimuli on GSR during the Lie detection under subliminal and supraliminal conditions.

2. MAIN OBJECTIVE OF THE RESEARCH

To study the effectiveness of subliminal stimuli in reducing the probability of use of countermeasure in lie detection.

2.1 Hypothesis

Use of Physical Countermeasure would be more for supraliminal stimuli as compared to subliminal stimuli.

3. METHODOLOGY

3.1 Research Design

For the present investigation single group/multi group repeated measure design has been used. The study was conducted in three phases.

Phase-I	Detection of Threshold (supraliminal &subliminal) Presentation of list of words (supraliminal:7 + subliminal:3). Physiological arousal responses to be recorded.	3 groups of subjects(n=10) 1 group of subjects(n=10)
Phase-II	Classical Conditioning of 2 neutral words in order to make them aversive. Presentation of list of neutral (7) and aversive (3) words (supraliminal7+subliminal3). Physiological arousal responses to be recorded at baseline as well as throughout the presentation.	1 group of subjects (n=28)
Phase –III	Classical Conditioning of 2 words in order to make them aversive. Training of mental/physical countermeasures. Presentation of a list of neutral (7) and aversive (3) words (supraliminal7+subliminal3). Subjects to use countermeasures for neutral words. Physiological arousal responses to be recorded at baseline as well as throughout the presentation	Single group of subjects (n=11) (Physical Countermeasures)

3.2 Sample

A purposive sample of 79 adults (phase-1+phase-II +phase-III) with mixed gender (age range between 20-28 years), who voluntary agree to participate in the study were selected for the present study. Mean age of the subjects was 25.4 years. Educational qualification of all participants was at least graduation. All subjects were from University Teaching Departments.

3.3 Tools

The details of the tools used in the present investigation are as follows.

3.3.1 Windows Based Computerised Lie Detector

Computerised Lie Detector (CLD-118) is a computerised system which gives a simultaneous recording of Galvanic Skin Response (GSR), Respiration Volume Waveform, Blood Pressure Changes, and Pulse Rate. Any one of the parameters in isolation or simultaneous recording of all parameters can be obtained as required.

3.3.2 Aversion Therapy Instrument

Instrument (MBT-498) was used for classical conditioning of the subjects in order to make neutral words aversive. Aversion therapy instrument is a part of Multi behavior Sex Therapy Instrument.

3.3.3 Verbal Material and Presentation Program

The verbal material to be used in the present study was discrete words. A set of neutral words were selected on the basis of pilot work. Some of these were made aversive by successive presentation with an aversive stimuli i.e. electric shock (classical conditioning). For presentation of the words, MS-office-2007 was used where a power point program was prepared by the investigator in which the presentation time of the word stimuli was varied as per the threshold level i.e. supraliminal (0.5 second) or subliminal (to be determined in phase I). Inter word interval was set at 9 seconds.

4. PROCEDURE

Classical conditioning training was given with the help of a power point presentation and aversion therapy instrument. A trial constituted of presentation of 10 neutral words, each for 1 second. Two of the words (Root and Habit) were selected by the investigator for aversive conditioning as result obtained in pilot work. Presentation of ROOT and HABIT words was followed successively by the delivery of an electric shock (stimulus onset-shock onset interval: 0.5 sec.) of 10 to 18.4 volts (level for each subject was estimated prior to the training procedure) for 0.5 second. Two more trials were given in this manner. On the fourth trial (test trial) no shock was given. The ten words were shown and the response of the subject to the conditioned words was observed by the investigator. Movement of finger was taken as an index of conditioning. If no movement was observed two more trials were given. Thus, minimum number of training trials per subject was 3 and maximum 5.

The subjects were initially trained to use physical countermeasures. Initially, the subject was familiarised with the lie detection procedure and significance of countermeasures was explained. Then, the subject was made to practice the countermeasures (toes to the floor/ biting the tongue). The

Table 1. GSR score in response to stimuli, where physical countermeasures were used on presentation of neutral stimuli.

	Stimulus Number									
	S_1 sup(N)	S_2 sup(N)	S_3 sub-A	S_4 sup(N)	S_5 sub-N	S_6 sup-A	S_7 sub-N	S_8 sup-N	S_9 sub-A	S_{10} sup-N
Mean	123.5	151	154	139.7	76.4	117.3	81.5	114	123	98.7

subject was instructed to execute the countermeasure whenever the investigator spoke a discrete, concrete word (e.g. Table, Fruit, and Rope etc.). After 10 min of practice the subject was given practice with visually presented words. A set of 10 words (exposure time: 1 s/word; inter word interval 5 s) was presented on the computer screen and the subject was asked to execute the countermeasure successively with the presentation of each word, and stop immediately after the disappearance of the word.

5. DATA ANALYSIS

Multi group design experiments were used to meet the objectives of the present study, therefore for analyses of the data, Friedman Test (non-parametric) followed by Wilcoxon Signed-Rank Test (non-parametric), were applied.

6. RESULT

The main objective of the present research was to study the effectiveness of subliminal stimuli in reducing the probability of use of countermeasures. The statistically converted GSR scores, in response to the ten stimuli where physical countermeasures were used, have been presented in Table 1.

Thus, the individual GSR mean scores show that the GSR scores in response to the supraliminal neutral stimuli are nearly similar to or more than those in response to the aversive stimuli (either supraliminal or subliminal) while the GSR scores in response to the two subliminal neutral stimuli were found to be consistently lower for all the subjects. This fact can be seen from the means also where the GSR scores in response to the two subliminal stimuli were 76.4 and 81.5 while that in response to the neutral supraliminal or aversive (subliminal or supraliminal) stimuli varied from 98.7 to 154. Thus it appears that countermeasures were executed in response to the supraliminal neutral stimuli but could not be given in response to the subliminal neutral stimuli.

Focused on emotional arousal, some studies have demonstrated that highly emotionally arousing stimuli elicit more pronounced P300 waves than low emotionally arousing stimuli, even when these stimuli are presented without awareness[12-13].

6.1 Assessment of GSR for Subliminal Stimuli

The GSR scores in response to the subliminal stimuli (neutral and aversive) were compared in order to ascertain whether the subliminal stimuli could elicit deferential physiological arousal (higher GSR in response to aversive stimuli) and whether this physiological response could be consciously manipulated (use of countermeasures against the neutral stimuli). The GSR scores in response to the four subliminal and six supraliminal stimuli have been presented in Table 2.

Table 2. Mean and SD of GSR scores in response to subliminal and supraliminal stimuli when physical countermeasures were used for neutral stimuli.

Subliminal/ Supraliminal	Mean	SD	Mean rank
N**(S_1)**	123.54	13.46	3.55
N**(S_2)**	151.00	56.82	5.00
A**(S3)**	154.00	59.36	3.73
N**(S_4)**	139.72	55.30	3.95
N**(S5)**	76.45	23.04	1.36
A**(S_6)**	117.36	38.76	3.50
N**(S7)**	81.54	28.78	1.64
N**(S_8)**	114.09	32.54	3.09
A**(S9)**	123.09	39.44	3.27
N**(S_{10})**	98.72	40.00	1.91

The mean GSR scores in response to subliminal stimuli have been presented in Table 2. The neutral stimuli had lower mean GSR scores as compared to the aversive stimuli. All stimuli were presented at subliminal level. Thus, On the basis of mean scores, it appears that the subjects could not use the countermeasure against subliminal neutral stimuli. In order to determine whether the difference among the GSR scores in response to the subliminal stimuli was statistically significant, Friedman Test was applied. Analysis revealed that there was a statistically significant difference in mean GSR among the subliminal stimuli (χ^2 (3) = 27.32, p = .000).

6.2 Assessment of GSR in Response Supraliminal Stimuli

The experimenter had presented six stimuli at supraliminal level where 5 were neutral and one was aversive. In order to determine whether the difference among the GSR scores in response to the six supraliminal stimuli was statistically significance, Friedman Test was applied. Analysis revealed that there was a statistically significance difference in mean GSR among the supraliminal stimuli. (χ2 (5) = 16.91, P = .005) The difference between the GSR scores of the various groups was analysed by applying Wilcoxon Test.

The Wilcoxon analysis showed that mean GSR scores in response to the subliminal stimuli were significantly lower than the GSR scores in response to the supraliminal stimuli while the difference between the GSR scores of the two subliminal neutral stimuli (S5 and S7) was non-significant (Z= -1.428, p=.156) as shown in Table 3.

6.3 Assessment of GSR in Response to Aversive Stimuli and Neutral Stimuli

The mean and SD of the GSR scores, in response to aversive

Table 3. Significance of difference between the GSR score of subliminal and supraliminal neutral stimuli when physical countermeasures had been used for neutral stimuli.

Subliminal		Supraliminal				
		S1	S2	S4	S8	S10
S5	Z scores	-2.936	-2.934	-2.936	-2.936	-2.936
	Significance	.003	.003	.003	.003	.003
S7	Z scores	-2.934	-2.936	-2.847	-2.934	-2.447
	Significance	.003	.003	.004	.003	.014

Table 4. Mean and SD of GSR scores when physical countermeasures were used for aversive stimuli.

	Stimulus	Mean	SD	Mean rank
Aversive	Sub(S3)	154.00	59.36	2.41
	Supra(S6)	117.36	38.76	1.64
	Sub(S9)	123.09	39.44	1.95
	Supra(S_1)	123.54	13.46	5.05
	Supra(S_2)	151.00	56.82	6.32
	Supra(S_4)	139.72	55.30	5.27
Neutral	*Sub(S_5)*	76.45	23.04	1.36
	Sub(S_7)	81.54	28.78	1.91
	Supra(S_8)	114.09	32.54	4.55
	Supra(S_{10})	98.72	40.00	3.55

stimuli are presented in Table 4. These results are similar to those observed in Phase II, where no significant difference was observed in response to the aversive stimuli presented at either supraliminal or subliminal level. Thus, it appears that the subliminal stimuli elicited a weaker physiological arousal as the subjects could not execute the countermeasure in the absence of conscious awareness, while countermeasures were definitely executed in response to some of the supraliminal neutral stimuli.

To determine whether the difference among the GSR scores in response to the seven neutral stimuli was statistically significance, Friedman test was applied. Analysis revealed that there was a statistically significant difference among the mean GSR scores in response to the seven neutral stimuli (χ^2 (6) = 47.47, p= .000).

From Table 5, it can be seen that all the pairs of neutral and aversive stimuli were significantly different from each other. The two aversive stimuli were significantly different from the neutral stimuli. Several previous studies demonstrated that aversive masked stimuli can elicit greater skin conductance responses than neutral stimuli[14-15].

7. DISCUSSION

These results clearly indicate that the subjects could not execute the countermeasure in response to the subliminal neutral stimuli. Thus, the present results confirm the hypothesis which predicted that use of physical countermeasures would be more for supraliminal stimuli as compared to subliminal stimuli[16-17]. Honts and his colleagues[18-20] suggested that training subjects in physical countermeasures or in a combination of physical and mental countermeasures substantially decreased the likelihood of detection of deceptive subjects by the polygraph[9,21]. There is evidence that the effect of countermeasure can be assessed particularly through the electro dermal channel[22]. Research in the area of subliminal perception has demonstrated that stimuli presented below the subjective subliminal but above the objective subliminal threshold elicits a physiological arousal response even though it does not result in conscious awareness[23-25].

8. CONCLUSION

Physical countermeasure could not be executed in response to its presentation and as a consequence the difference in physiological arousal was significantly lower for the subliminal stimuli in comparison to the response to the supraliminal stimuli (countermeasure was given in response to consciously perceived neutral stimuli). Thus, the present results show that the physical countermeasure could not be used for the subliminal stimuli.

8.1 Implication of the study

Aversive stimuli result to a strong physiological arousal even when presented in subliminal form. Subliminal stimuli

Table 5. Significance of difference between the GSR scores in response to subliminal/supraliminal (aversive and neutral) stimuli.

	Comparisons between	A_{S3}-N_{S5}	A_{S3}-N_{S7}	A_{S9}-N_{S5}	A_{S9}-N_{S7}	N_{S5}-N_{S7}	A_{S3}-A_{S9}
Subliminal	Z Score	-2.934[a]	-2.934[a]	-2.936[b]	-2.934[b]	-1.428[b]	-2.001[a]
	p	.003	.003	.003	.003	.153	.045
	Comparisons between	A_{S6}-N_{S1}	A_{S6}-N_{S2}	A_{S6}-N_{S4}	A_{S6}-N_{S8}	A_{S6}-N_{S10}	
Supraliminal	Z Score	-.561	-1.988	-1.40	-.533	-2.224	
	p	.575	.047	.161	.594	.026	

can be used as a deterrent to countermeasures (physical) in lie detection for investigation by investigation agencies. It can be incorporated in the GKT paradigm where the options can be presented in subliminal form or primed by using a lexical decision paradigm.

8.2 Limitations of the Study

The investigator had used a list of discrete words presented in a successive manner (with an inter stimulus of 9 s). As a consequence the physiological arousal response to one stimulus was confounded by that to the preceding/succeeding stimuli. Use of discrete trials, with each stimulus presented as an independent item (in a message or as multiple choice questions) could have helped to isolate the physiological response to each stimulus.

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In the current study he contributes in analysis of data within the paper.