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Using Conditioning to Elicit Skin Conductance Responses to Deception

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Abstract

Lie detection research has focused on developing new methods of measuring physiological responses exhibited during deception. Little research has gone into the understanding the contingencies that shape these physiological responses to deception. Using a conditioning procedure, participants' deceptive responses on a Cluedo-type game were paired with mild electric shock. The results suggest that such conditioning significantly increases the discriminative skin conductance response exhibited during deception. Implications of these findings for interpretation of traditional lie detection tests are discussed, as well as how the above procedures can be practically implemented.

Keywords: Deception, lie detection, conditioning, skin conductance response, verbal stimuli.

There has been much interest in developing and enhancing methods of lie detection (e.g., Walczyk, Schwartz, Clifton, Adams, Wei, Peijia, 2005; Sartori, Agosta, Zogmaister, Ferrara, Castiello, 2008; Tsiamyrtzis, Dowdall, Shastri, Pavlidis, Frank, Ekman, 2007; Vrij, 2008; Vrij, Granhag, Mann, & Leal, 2011). There are two major categories of approach to detecting deception: comparison question tests (CQT; American Polygraph Association, 2011; National Research Council, 2003; Raskin & Kircher, 2014), and the guilty-knowledge or concealed information tests (CIT; Rosenfeld, Ben-Shakhar, & Ganis, 2012; Verschuere, Ben-Shakhar, & Meijer, 2011; Vrij, 2008). Proponents of both of these approaches argue that they have a high and acceptable degree of accuracy of deception detection (Raskin & Kircher, 2014; Vrij, 2008). However, questions concerning the validity of such lie detection tests have been raised (Iacono, 2001; National Research Council 2003) and fall in two brood areas: their theoretical underpinnings, and their actual degree of accuracy. In the light of these concerns, attention has been turned to procedures that may establish better links between deception and observable or measurable behaviours associated with this act which rely on strongly established links between underlying psychological states and the produced behaviors (see Tomash & Reed, 2013b).

The basic principles of many of these deception detection methods involve detecting physiological changes that are assumed to be produced by underlying psychological states, such as fear of detection, enhanced attention to cues, orienting responses, and increased arousal (Honts, 2014; Kleiner, 2002; Vrij, 2008). These psychological states are assumed to trigger a ‘flight or fight’ response that, in turn, results in measurable physiological responses (e.g., increased skin conductance), and a number of theories have been proposed to accommodate this relationship (e.g., Handler & Honts, 2008; Kleiner, 2002). However, despite these efforts, there is still no accepted view that establishes such a psychological state-physiological outcome relationship in connection to deception (see Ben-Shakhar, 2008; Iacono, 2001; National Research Council, 2003, for reviews). Furthermore, there is a general consensus, even among deception-detection proponents, that there is a no specific 'lie response' (Ben-Shakhar, 2008).

In the light of these concerns, some have suggested a move to behavioural rather than physiological measures, such as reaction times (e.g. Seymour, Seifert, Shafto, & Mosmann, 2000), or even reliance on fMRI procedures (Ganis, Kosslyn, Stose, Thompson, & Yurgelun-Todd, 2003), but these approaches are not without their own problems (see Spence, 2008), and also do not have well established links between such outcomes and the underlying psychology of deception, and these arguments do not increase the validity of lie detection procedures (National Research Council, 2003).

Other authors have attempted to produce stronger theoretical accounts of the relationship between the psychological causes and physiological correlates of deception (e.g., Handler & Honts, 2008; Kleiner, 2002). In many cases this has relied on some variant of a conditioning explanation to relate these responses to a psychological process (Handler & Honts, 2008). Skinner (1953) presented a simple explanation of how deception comes to elicit physiological responses. According to this theory (Skinner, 1953, p. 187), the responses physiological responses exhibited are a side-effect of the punishment individuals often receive in everyday life when their deception is detected. Tomash and Reed (2013b) corroborated this suggestion by showing that self-reports of previous punishment for swearing was associated with measures of autonomic activity in current situations where deception was practiced. However, despite claims that conditioning may offer a theoretical explanation for the deception-behavior relationship, experimental evidence for this relationship is not abundant, especially when it is considered that the assumed stimulus or response in this case (lying in general) is an abstract and not a punctate physical stimulus (see Tomash & Reed, 2013b). One aim of the current study is to provide further evidence that such an association between an abstract event (deception) and an outcome can be conditioned.

The relationship between previous outcomes for deception and the physiological correlates of current deception have been studied using a variety of conditioning procedures. For instance, Jaffee, Millman, and Gorman (1966; see also Fleming, Grant, North, & Levy, 1968; Fleming, Grant, North, & Levy, 1968) classically conditioned an eyeblink response to instances of verbal deception, by pairing instances of deception with a corneal airpuff. Their results supported the notion that deception can serve as a conditioned stimulus, but there have been few, if any, attempts to expand upon this research. One such attempt was reported by Tomash and Reed (2013b), and involved the use of conditioning procedures to associate deceptive responses with a mild shock, in an attempt to increase subsequent levels of galvanic skin response (GSR) when deception was practiced.

The present experiment explored the conditioning of a skin conductance response to instances of deception that were made true or false by the context of the experiment. An internally consistent context was developed in which participant’s could answer questions truthfully or deceptively, while, at the same time, minimizing the influence of personally relevant variables that would normally increase SCR. It was expected that deception within this contextually-controlled setting could come to serve as a conditioned stimulus.

This experiment used a paradigm similar to the game Cluedo™. In this variation, participants had to deceive the computer regarding the identity of a murderer in a series of questions. Over the course of these trials, some deceptive answers were paired with mild electric shocks in order to see if this would impact on the skin conductance response obtained from other examples of deception (i.e. to see if this procedure could enhance the physiological response seen in instances of deception while leaving other responses unaltered).

There are two aspects of the comparisons made in this experiment that need some comment. Firstly, rather than deliver no shock in a comparison condition (a condition employed by Tomash and Reed, 2013b), a parametric variation of the shock procedure was employed; so that one group received a strong shock, and one group received a weak shock. Conditioning should be greater in the strong shock group. Secondly, two variants of the conditioning procedure were employed: one using a continuous reinforcement schedule and one using a partial reinforcement schedule. In a classical conditioning eyeblink procedure, Fleming et al. (1968) found that better conditioning to the truth value of a statement was noted with a partial than a continuous reinforcement schedule. However, Tomash and Reed (under review) found the opposite results using a SCR procedure. As it is unclear which type of schedule will produce stronger conditioning to truth-value, the current study also compared a continuous with a partial schedule.

Method

Participants

Forty-eight Swansea University Psychology students (27 female), and had a mean age of 22.8 (± 2.9 SD) years. They were recruited through Swansea University's Psychology Department's online subject pool, and they received course credits for their participation. All participants provided informed written consent prior to participating. The research, including permission to deliver shocks to participants, was approved by the Department of Psychology Ethics Committee, Swansea University.

Apparatus

Participant's SCR was measured using the ADInstruments© PowerLab 2/25 data acquisition system (ML825), which sampled continuously at 1k/sec. Finger Electrodes were attached to the palmer surface of the first and third fingers of the participant's non-dominant hand. The SCR for each trial were scored as the magnitude (in microSiemens) from trough to peak of the first response occurring with an onset latency of 1-4s after the participant's keyboard response. These responses were normalized within each subject prior to analysis by dividing the SCR on each trial by the maximum SCR exhibited by that subject during the session.

The outcome was a mild electrical shock presented from ADInstruments© Stimulus Isolator (ML180), and delivered via electrodes attached to the participant's inner lower dominant arm. The shock intensity was individually adjusted for each participant using a shock workup procedure- by starting at a setting so low they could not feel it, and increasing it slightly in steps until the subject rated it as "uncomfortable, but not painful." To accomplish this, a shock workup procedure was used. For each participant, the intensity of the shock was initially set far below the threshold at which they could feel it. An initial shock was delivered at this setting (1mA), and the participant was asked if they could feel it (none reported that they could). Following this, the intensity of the shock was increased by .3mA, and another shock was delivered. The participant was asked if they could feel this, and if they said no the shock was again increased by the same amount. This was repeated until the participant reported that they could feel the shock, and they were then asked if the shock was "alright" and if they minded going any higher. If they said they didn't mind going higher, the shock was again increased by the same amount. As soon as the participant said they preferred not going higher, they were asked if they were comfortable at the current level, or if they would rather lower it. The shock intensity was therefore set according to their wishes at this point. This produced a mean shock of 4.0mA for this group (range 3.1mS to 5.0mA). In the low-shock condition, the final intensity was then reduced by half- resulting in a shock that the subject could barely feel. This produced a mean shock level of 2.0mA (range 1.3mA to 2.2mA).

Procedure

To provide a context in which participants could answer questions both deceptively or truthfully a scenario similar to the game Cluedo™ was used. After the electrodes were attached, the participants were given instructions. They were told that they would take part in a game similar to the game Cluedo™, and, at the beginning of each new game (set of trials), they would be presented with a picture of a murderer and a murder weapon. They were also informed that that they would need to memorize these pictures. They were also told that they would play a series of such games, and the identity of the murderer and weapon might change from game to game. They were told that they would be asked a series of questions at the end of each game (set of trials) regarding this murderer and murder weapon, for example: "Was this the murderer?" [showing a card with a suspect on it]; and: "Was this the murder weapon?" [showing a card with a weapon on it]. Participants were instructed that they could answer these questions using the keyboard: pressing the 'z' key for no, and the 'm' key for yes.

Additionally, participants were told to: "try to deceive the program regarding the identity of the murderer," and that this would involve them not only answering "no", when asked whether the proposed murderer was the actual murderer, but also ""framing" one of the innocent suspects, by saying that they were the murderer. Participants were told that they did not need to always claim the false murderer was the same person across games (trials), and it was up to them to choose which person to claim the murderer was.

Figure 1 about here

At the beginning of each game (set of six trials), the computer presented one randomly selected card from a possible six representing the murderer, and one randomly card from a possible six representing the murder weapon (see Figure 1 for an example). Participants were asked to memorize these cards. Participants were then presented with a series of six trials, in which the murderer and two randomly selected innocent suspects were presented, and in which the murder weapon and two randomly selected other weapons were presented on the screen. The order of suspects and weapons was random. The participants were asked whether this picture represented either the murderer or the murder weapon, respectively.

At the beginning of each trial, the program paused 5s to provide a baseline. The card and question were then presented on the computer monitor (Figure 2). Once the participant answered using keystrokes, the program determined whether their answer was truthful or deceptive. On reinforced trials, the shock followed 3s after deceptive answers. If the answer was deceptive, an electric shock was delivered- depending on the group (see below). No electric shocks were delivered on truthful trials.

Figure 2 about here

For each set of 6 trials, the subject was instructed to answer deceptively twice: once to say that the murderer was not the murderer, and once to say that an innocent subject was the murderer. Following the set of six trials, the program presented a feedback screen telling the participant whether they had: “successfully deceived the program”, i.e. whether they had answered truthfully regarding the murder weapons, and lied twice regarding the identity of the murderer. There was then a pause of 15s, and the next series of trials (game) was presented. In total there were 10 such sets of 6 trials (games). It should be noted that as the characters and weapons were randomly selected for each trial, then it was possible for a character to be a murder on one trial and innocent on the next.

For conditioning, participants were divided into 4 groups, based on two variables: shock intensity and outcome probability. The shock intensity was varied between participants, with half receiving the full electric shock [high-shock group] and half receiving a much milder shock [low-shock group] (see procedure). The outcome probability was varied so that half the participants received the shock following every deceptive answer [100% group], and half received the shock following 60% of their deceptive answers.

To only include the fully learned responses, only the last half (30 trials) of the trials from each subject were used in the analysis. For statistical analysis, the SCR on deceptive and truthful trials for each subject were averaged separately to produce a final subject mean for deceptive and for truthful trials. An analysis involving shock intensity, outcome probability, truth value of the stimulus, and trial was conducted, and revealed no significant main effect of trial nor interaction involving trial, suggesting that trial was not an important factor across the last sessions of training, nor that there was confusion due to the potential for characters to be murders on one trial and innocent on future trials, which would have tended to reduce the effect noted.

Results

Figure 3 about here

Figure 3 displays the group-mean SCR to both deceptive and truthful answers over the last 30 trials (high shock vs. low shock; 100% vs. 60%). Inspection of these data shows that there was a greater SCR to deceptive (conditioned) than to truthful (non-conditioned) answers for all groups. However, this difference was greater in the high-shock conditions compared to the low shock conditions.

A mixed-model three-factor analysis of variance, with shock intensity (low versus high), and outcome probability (100% versus 60%) as between-subject factors, and response type (Deceptive versus Truthful) as a within-subject factor, was conducted. This analysis found a statistically significant main effect of response type: $F(1,86) = 5.61$, $p < .05$, *partial* $eta^2 = .061$, indicating a discriminated responding between deceptive and truthful answers across all groups. There was also a statistically significant interaction between response type (deceptive versus truthful) and shock intensity, $F(1,86) = 4.49$, $p < .05$, *partial* $eta^2 = .050$, indicating that in the high-shock condition the difference between deceptive and truthful responses was significantly different than that between the low-shock condition. There were no other statistically significant main effects or interactions, all *p*s > .30.

To further analyze these data, the results were averaged across the probability of an outcome, and the simple effect of response type (deceptive versus truthful) for the high shock intensity, and low shock intensity were performed. This analysis for the high shock intensity revealed a statistically significant simple effect of response type, $F(1,86) = 15.00$, $p < .001$, *partial* $eta^2 = .379$. However, the simple effect of response type (deceptive versus truthful) for the low intensity group was only marginally statistically significant, $F(1,86) = 3.00$, $p < .08$, *partial* $eta^2 = .135$. The simple effect of shock intensity for the deceptive and the truthful statements were also computed. These analyses revealed no statistically significant effect of shock intensity for the deceptive statements, $F < 1$, nor for the truthful statements, $F(1,86) = .12$, $p > .20$.

Discussion

The present experiment found a significantly higher SCR to deception than to truthful answers when the outcome was a more intense electric shock, but not when it was a milder shock. This suggests that the conditioning procedure had an effect on the SCR to deception (see also Fleming et al., 1968; Tomash & Reed, 2013b). Given that deception was the only stimulus that predicted the presentation of the shock, this shows that it was the abstract deception that was serving as the response, as has previously been shown by Tomash and Reed (2013b; see also Fleming et al., 1968). The probability of shock presentation had no effect on the SCR differentiation.

It has been known for some time that physiological arousal (including GSR) can be classically conditioned (Dawson & Furedy, 1976; Tomash & Reed, 2013a). Likewise it is known that deception, in some situations, elicits a strong physiological response, and that deception tends to occur in situations where punishment is likely. Despite several suggestions that conditioning is involved in generating the physiological signs observed during deception (Handler & Honts, 2008), this theory not received has a great deal of empirical testing. This study presents further direct evidence that deception in the abstract can be conditioned to elicit a strong SCR.

One question that remains to be resolved is whether the current procedure is a classical or an instrumental procedure. In a classical conditioning procedure, conditioning involves the experimenter presenting a CS and following it by a US, regardless of what the subject does. In the current procedure, subjects emit a response (pressing a ‘yes’ or ‘no’ key) to a question, and then are shocked for deceptive responses but not for truthful responses. Thus, it is unclear whether it is the abstract stimulus of deception or the act of deception that is being paired with the negative outcome. Thus, although the SCR procedure is typically thought of as classical, it is possible that, in this case, instrumental contingencies are also in operation. The latter suggestion is compatible with the suggestions made by Skinner (1953) regarding the impact of conditioning history on physiological correlates of deception (see also Tomash and Reed, 2013b).

The present results may have greater for the CQT procedure, where a within-subject comparison is made between two categories of questions, and the outcome of the test is determined by the more powerful category, as defined by magnitude of observed psychophysiological responses. Conditioning a skin conductance response prior to such a CQT procedure may serve to enhance the accuracy of that method by making the physiological response more differentiated across the two categories of response. Thus, the current new direction in understanding the responses a person exhibits during tests like the polygraph could have significant consequences for the development of these fields. This implies that the responses relied upon by the polygraph can be manipulated and strengthened in a more direct manner than has been previously possible.

There are a number of limitations that need to be acknowledged concerning the current experiment. Firstly, the present paper only considers within-subject differentiation of deception and truthfulness. However such differentiation is almost never the case in application of the CIT, where the subject of a deception-detection procedure is either guilty of innocent of some transgression (and, thus, does or does not have information about the transgression). Thus, the present study only addresses one category from the real world; that is, those individuals who are attempting deception, and the actually innocent are not considered.

Secondly, although it may be that applying procedures like those above prior to any test of deception could significantly improve the accuracy of the test, further research is needed to test generalization of these results to “real world” deception. It would also be necessary to compare the accuracy of such a procedure with that established for other techniques (see Rosenfeld et al., 2012; Verschuere et al., 2011).

In summary the current study examined the impact of conditioning a SCR response for deception on the SCR observed on subsequent deceptive episodes, and found that this procedure did serve to condition a SCR to an abstract property of a stimulus.

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Figure Captions

Figure 1. Screen shot of Clue task used in experiments, showing the screen in which the murderer and murder weapon were presented at the beginning of each set of trials.

Figure 2. Screen shot of Clue task used in experiment, showing the screen in which participants answered whether the presented card was the murderer or murder weapon.

Figure 3. Chart of the mean SCR across subjects for Deceptive and Truthful trials in 100%, 60%, high-shock and low-shock conditions. Error bars show standard error.

Figure 1


Here are the Murderer and Murder Weapon for the next set of questions. Please memorize this information.
Try to deceive the program regarding the Murderer
You will be presented with 3 suspects of each type
Murderer:
Murder Weapon:
Miss Scarlet
Miss Scarlet
CANDLESTICK
CANDLESTICK
CANDLESTICK
Press the Space Bar to Continue

Figure 2

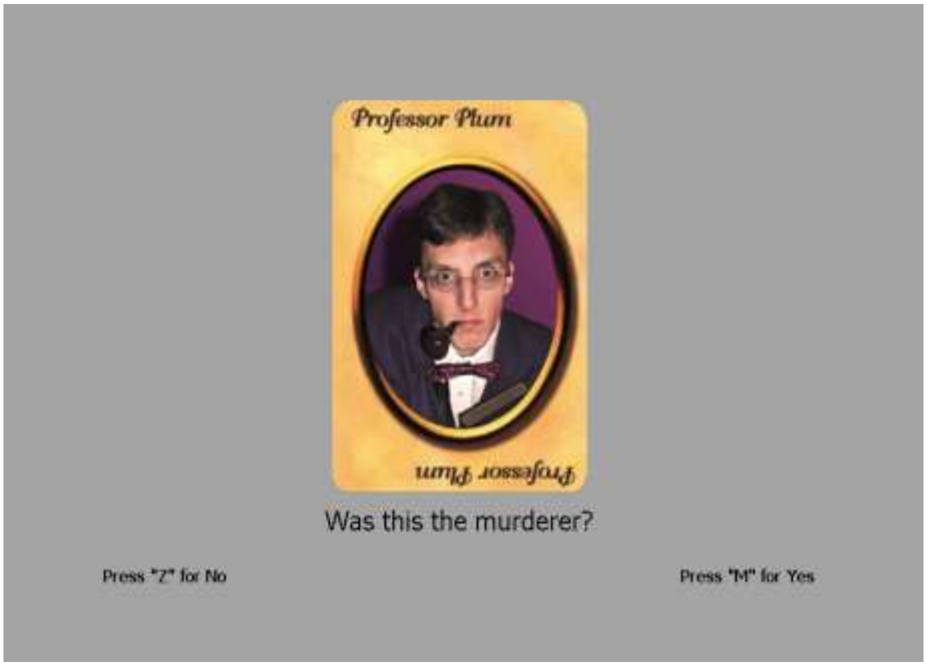
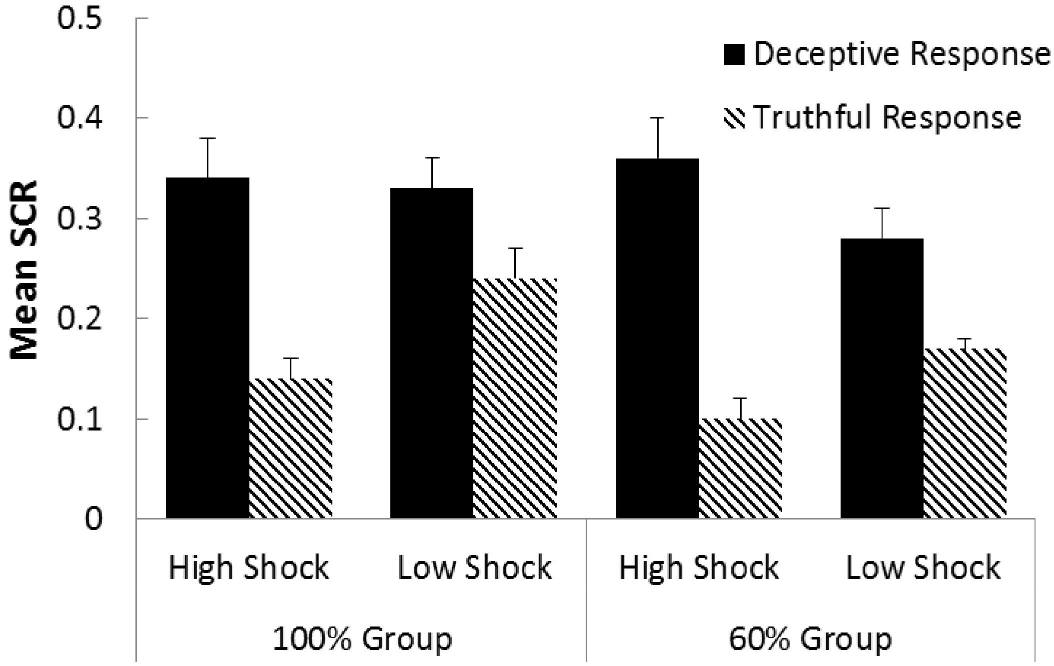

Professor Plum
Professor Plum
Was this the murderer?
Press "Z" for No
Press "M" for Yes

Figure 3


0.5
0.4
0.3
0.2
0.1
0
Mean SCR
Deceptive Response
Truthful Response
High Shock
Low Shock
High Shock
Low Shock
100% Group
60% Group