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The generalization of conditioned startle responses from known to unknown lies

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ABSTRACT

Throughout history, there has always been a need to find out whether people are telling the truth. Classical deception detection methods, such as polygraph-based techniques, have so far failed to accurately and reliably detect deception, as they are limited in various aspects. Therefore, results are susceptible to manipulation. In the current study, we attempt to improve lie detection using a classical conditioning procedure with startle response as an outcome variable. Thirty-six participants were asked to report true and false sentences (10 each) before the test procedure. We knew the truth value of only 50% of the sentences (the value of the other 50% was revealed after the experiment was over). Aversive conditioning was used, i.e. participants were presented with the unconditioned stimulus (air blast of 5 bar, 50 ms; contingency of 75%) when uttering *known lies*. There was a significant difference in participants' startle reaction to false statements compared to truths, both in the *known lies* category and, more importantly, in the *unknown lies* category. We recommend further investigation of this phenomenon by changing the conditioning parameters (duration, contingency) in order to optimize this promising method and achieve a higher level of accuracy.

1. Introduction

"Polygraph"-based techniques have been established as the principal methods for detecting deception (Bashore & Rapp, 1993). In general, the polygraph measures changes in the response of the sympathetic nervous system (e.g., heart rate, skin conductance response [SCR]) while subjects answer a series of questions (Ben-Shakhar & Elaad, 2003; Tomash & Reed, 2013). This procedure is based on the notion that the examination situation triggers fear of exposure and punishment and therefore results in heightened psychophysiological activation (Bashore & Rapp, 1993; National Research Council, 2003). In order to detect deception, polygraph measurements are combined with different techniques (Boucsein, 2012). During the Control Question Technique (CQT), participants are confronted with three different types of questions: relevant (questions related to the crime), control (questions on equally serious misbehavior) and irrelevant (questions on neutral topics) (Ben-Shakhar, 2002; Lubow & Fein, 1996). Guilty subjects are expected to show higher physiological reactions to relevant than to irrelvant or control questions (Boucsein, 2012; Raskin & Podlesny, 1979).

Abbreviations: EDA, electrodermal activity; EMG, electromyography; ERP, event-related potentials; SCR, skin conductance response; UCS, unconditioned stimulus

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During the Guilty Knowledge Test (GKT), the suspect is presented with several multiple-choice items each including one relevant response option (crime-related information only a guilty person would know) as well as a number of distractors (incorrect crime details equally plausible for an innocent person) (Ben-Shakhar & Dolev, 1996; Lykken, 1974). Unlike innocent participants, guilty subjects are thought to show increased responses to the relevant information compared to the distractors (Lykken, 1974). While interrater- and retest-reliabilities of polygraph-based deception detection techniques are acceptable (ranging from 0.71 to 0.96), evidence concerning validity is mixed, with 68–86% of guilty subjects and 49–76% of innocent participants correctly classified (Boucsein, 2012; Gudjonsson, 1986).

Overall, polygraph-based techniques are limited in various aspects. Results can be manipulated because subjects can control their own physiological reactions with the appropriate knowledge (Ekman, 1992; Iacono, 2007). The intake of sedatives, drugs, or caffeine (Nehlig, Daval, & Debry, 1992) affects the arousal level, which is indicated by skin conductance measurements (Boucsein, 2012) and, in turn, interferes with the test results. Generally, by measuring a broad variety of peripheral physiological reactions, polygraph-based measurements are prone to countermeasures and therefore distinguish poorly between anxious-and-guilty subjects and those who are innocent-but-anxious (Lykken, 1984; National Research Council, 2003), as the body reacts with a heightened state of arousal in both cases. Therefore, a reliable technique for detecting deception should be able to identify deception independently of peripheral physiological reactions. Furthermore, the results of polygraph tests essentially depend on the interpretation of the investigator and could thus be subject to bias.

For a long time, research on the detection of deception had been stagnant. Interestingly, however, over the past few years, new branches of research on the topic have evolved that might offer more innovative approaches, as they turn away from measuring the peripheral nervous system and “move beyond empirical evaluation to isolate brain structure and processes that underlie deception” (Ganis, Rosenfeld, Meixner, Kievit, & Schendan, 2011; Iacono, 2007). Analyses of event-related potentials (ERPs), measured by electroencephalography, and brain imaging techniques provide promising findings (Farah, Hutchinson, Phelps, & Wagner, 2014; Gamer & Ambach, 2014; Ganis et al., 2011). Within a short time, detection of deception using functional magnetic resonance imaging has progressed from basic research in the laboratory to commercial application in the real world (Farah et al., 2014) and promises significantly greater accuracy than the conventional polygraph. ERP analysis also resulted in higher rates of correct detection in guilty and innocent subjects compared to previously used methods (Abootalebi, Moradi, & Khalilzadeh, 2009). Although brain imaging provides usable and somewhat reliable results, it is still “well below perfection” (Monteleone et al., 2009). These alternative approaches are controversial, and their expensive costs prevent the extensive testing required for large sample studies.

An interesting recent approach by Tomash and Reed (2013) used the SCR as an indicator of autonomic arousal in a conditioning paradigm. During an initial conditioning phase, both the computer and the participant knew if the latter was telling the truth or not. In the experimental group, deceptive answers were paired with electric shocks with a contingency of 60%, but truthful answers did not receive electric shocks. Control subjects received no shocks for truthful or deceptive answers during this phase. Participants belonging to the experimental group showed significantly higher skin conductance responses to deceptive than to truthful answers, whereas there was no significant difference between truthful and deceptive answers in control subjects. Following the conditioning phase, there was a generalization phase (with no shocks being presented in either group) during which only participants (but not the computer) knew if the answers were true or deceptive. Interestingly, there was generalization from overt to covert lies with the experimental group exhibiting significantly higher SCR to deceptive answers than the control group. Regarding truths, there was no significant group difference.

Extending the work of Tomash and Reed (2013), we investigated the generalization from overt to covert lies using startle response, a measure frequently applied in fear conditioning studies (Lonsdorf et al., 2017), as a primary outcome variable for the truthfulness of a statement. In the context of a conditioning paradigm, startle response might be a more suitable measure to discriminate between true and false statements than electrodermal activity, as it is less dependent on the subjects’ anxiety. While electrodermal activity indicates arousal regardless of valence, startle responses are valence-dependent with increased responses for negative valence (Anders, Lotze, Erb, Grodd, & Birbaumer, 2004; Blumenthal et al., 2005; Lang et al., 1990; Lonsdorf et al., 2017; Vrana et al., 1988). Moreover, startle is an automatic subcortical measure and may therefore be less susceptible to intentional control (Grillon, 2008), making it the perfect tool for detecting deception (Ekman, 1992).

In the current study, participants were asked to generate true and false sentences. The truth value was either covert (only known to the participants) or overt. Therefore, four different kinds of sentences were generated: *known truths, known lies, unknown truths* and *unknown lies*. In a conditioning procedure, *known lies* were paired with an air blast. We hypothesized that having undergone fear conditioning, participants would show stronger reactions to *known lies* than to *known truths*. Furthermore, we expected them to show heightened reactions to *unknown lies* compared to *unknown truths* due to generalization effects.

2. Materials and methods

2.1. Participants

Thirty-six healthy participants (29 females, 7 males; age 18–31; M = 22.9, SD = 2.74), recruited via advertisement at the University of Regensburg, completed the study. Exclusion criteria, assessed via questionnaire, were an age below 18 or above 55 years, current intake of psychopharmacological medication, current involvement in psychiatric or psychotherapeutic treatment, and cardiovascular or neurologically related diseases. At the beginning of the experiment, written informed consent was obtained and signed by all participants involved in the study. All participants were psychology students from the University of Regensburg and received course credit for their participation. All participants had normal or corrected-to-normal vision. This study was approved by