ABSTRACT

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A series of five experiments were conducted to explore whether Greenwald, McGhee, & Schwartz's (1998) Implicit Association Test (IAT), which purportedly measures implicit affective evaluations, could be modified to differentiate between honest and deceptive responding to forced-choice questioning. Experiments 1 and 2 demonstrated that a dual-discrimination task can in fact be useful in deception detection but that the relative reaction time differences run opposite in direction from those expected from the typical IAT bias pattern. Subsequent experiments assessed the procedure's susceptibility to simple countermeasures (Experiment 4) and tested variations to its trial sequence (Experiment 3) and stimulus presentation (Experiment 5). Neither of the two procedure variants was successful in producing above-chance predictions and instructions to delay reactions times to a constant latency sufficiently undermined the original procedure's efficacy. The applied limitations notwithstanding, the present research extends the relevance of dual-discrimination methodologies and supports the idea that biographical information is cognitively represented such that what is known to be true or false is implicitly associated with one's general concepts of "truth" and "lie" respectively.

THE DEVELOPMENT AND TESTING OF AN IMPLICIT LIE DETECTION SYSTEM.

By

Scott Peter Roberts

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Dedication

In loving memory of a best friend and faithful shadow…
the light will never be as bright without her by my side.

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Chapter I: Implicit Lie Detection

Project Overview

One of the more contentious debates in the social-cognitive literature concerns the reliability, validity, and applicability of procedures designed to measure attitudes implicitly, most notably Greenwald, McGhee, & Schwartz's (1998) Implicit Association Test (IAT). The IAT consists of a computer-based reaction time task on which participants make rapid categorizations of stimuli as they appear on the screen. Central to the debate is the extent to which differences in response latencies can be interpreted as a measure of some concrete, independent entity separate from one's explicit attitude (e.g., Karpinski & Hilton, 2001). Nonetheless, the apparent ability of the IAT to reliably predict some meaningful differences (Greewald, Nosek, & Banaji, 2003; Lambert, Payne, Ramsey, & Shaffer, 2005) suggests that it is, at the very least, measuring the influence of cognitive associations between target stimuli and evaluative words in its dual-discrimination task.

Deception, by definition, is the "deliberate attempt… to create in another a belief which the communicator considers to be untrue" (Vrij, 2000, p.6). It should not be surprising that psychologists have taken considerable interest in deception, especially given the potentially negative interpersonal consequences of being deceived. Early research attempted to identify the individual characteristics of children that lie, and instead found that the decision to deceive is determined more by the social situation than personality (Hartshorne & May, 1928). Nonetheless there have been many attempts to develop questionnaires that measure integrity, though such measures appear to have little predictive validity (Goldberg, Grenier, Guion, Sechrest & Wing, 1991). Deception, especially in the context of psychological research, can often take the form of socially desirable responses (Rosenberg, 1965) and self-serving inferences (Johnson, Feigenbaum, & Weisbeg, 1964). As such, psychologists have developed strategies for circumventing deception, including the use of behavioral and "behavioroid" (Aronson & Carlsmith, 1969) measures, projective (e.g., Morgan & Murray's Thematic Apperception Test) and implicit measures (e.g., Greenwald et al., 1998), and by establishing the pretense that deception will be detected and is therefore futile (Jones & Sigall, 1971). The majority of psychological research has focused on detecting deception, giving a great deal of attention to non-verbal behavior (e.g., DePaulo, Stone, & Lassiter, 1985; Ekman, O'Sullivan & Frank, 1999; Mann, Vrij & Bull, 2004) and physiological arousal (e.g., Larson, 1932; Lykken, 1981; Iacono & Patrick, 1997; Raskin & Honts, 2002). Others have looked for indications of deception using electroencephalography (Bull et al., 2004), functional brain imaging (e.g., Kozel, Padgett, & George, 2004), linguistic content analysis (see Mermon, Vrij, & Bull, 2003), and voice stress analysis (Gunn & Gudjonsson, 1988) with limited success (National Research Council, 2003).

Regardless of whether the deception takes the form of falsification, concealment, or equivocation (Burgoon et al., 1994), in order to deceive one must cognitively represent both the actual state of affairs (the truth) and the state he or she wishes to project to a naïve other (the lie). Assuming that the matter of interest can objectively be considered either true or false (e.g., you either have or have not, knowingly, used an illegal drug at least once in your life), then a dishonest response must be associated with one's concept of a lie. If responses to forced-choice questioning (i.e., "yes" or "no") are cognitively represented as either being true or untrue then it may be possible to detect associations between those responses and their veracity (i.e., "truth" or "lie") much in the way that the IAT detects associations between target groups of interest and evaluatively positive or negative adjectives. The development of an implicit deception detector stands to offer both theoretical and methodological contributions to the existing body of implicit measurement literature and an applied contribution to psychological science of deception detection.

The present research examined whether an IAT-like procedure can effectively measure the association between one's response to questions regarding a specific behavior and the categorical concepts of "truth" and "lie." A series of five studies was conducted to test experimentally the usefulness of such a procedure for differentiating between honest and deceptive responses to focused questioning. Experiments 1 and 2 explored the predictive potential of the implicit procedure on participants randomly assigned to honestly or dishonestly confess or deny having engaged in some illegal activity. The third experiment assessed a variant of the procedure in which screen configurations were randomized on a per-trial basis rather than the customary (Greenwald et al., 1998; 2003) per-block configuration. If equally effective this variant would make it considerably more difficult to delay strategically specific responses as a function of question type and screen configurations in an attempt to avoid detection. Experiment 4 explored whether the procedure is easily countermeasured with a deliberate attempt to avoid detection by altering one's response profile. Lastly, Experiment 5 tested another variant of the procedure in which the target stimuli were simplified to single words (rather than entire sentences). The purpose of this study was to explore the possibility of reducing overall variability in reaction time patterns between and within subjects, thereby increasing predictive accuracy.

Methodological, Theoretical, & Applied Contributions

The contribution of this project is largely methodological in that it expands the parameters of both the social-cognitive and deception detection literature. Specifically it extends the relevance of implicit association procedures to include not only evaluative association but to beliefs about factual statements. Within the context of deception detection, above-chance predictions based on response latencies suggest that episodic information, both actual and fictional, is respectively linked to our cognitive representations of "the truth" and "our lies." In an extensive review of the literature Nosek, Greenwald, and Banaji (2007) insist that the IAT was never intended as a lie detector and cite the lack of any evidence for such an application. That is, whereas the IAT was intended to be a measure free of the social desirability and self-serving biases that plague explicit attitude measures (Clark & Tifft, 1966; Jones & Sigall, 1971; Paulhaus, 1984) Nosek et al. (2007) caution that discrepancies between implicit and explicit measures cannot necessarily be interpreted as evidence of deception on the latter. It is more likely, given their conceptualization of implicit attitudes, that individuals may simply be unaware of their ambivalence towards the target attitude object. Nonetheless many have argued that such a discrepancy is evidence that individuals are attempting to conceal socially undesirable attitudes and, in effect, lie about their true feelings (see Fazio & Olson, 2003). Such debate notwithstanding, the IAT's application to objectively true or false responses has yet to be explored, nor has any theory been advanced regarding the cognitive process by which such a procedure might work.

One important characteristic of such a cognitive process is that it should not, in theory, be confounded with the fear of detection. Currently the most widely used method is a psycho-physiological detection (PPD) procedure (i.e., the polygraph) which is regularly used to estimate the veracity of statements, detect breaches of national security, and even to measure a sex offender's intention to re-offend (Honts, 2004). Though the literature is plagued with contradictory findings and the methodologies used in deception detection research are often suspect, a meta-analysis of reputable experiments conducted by the National Academy of Science estimated the polygraph's reliability to be around 86% (National Research Council, 2003). The theoretical explanation for PPD's success rests on its ability to measure small changes in physiological arousal following responses to target questions and accusations of deceit. Consistent activation of the autonomic nervous system following relevant stimuli (as compared to baseline levels following control questions) suggests a fear response, presumably the fear of being detected (Bull et al., 2004). Thus, much like the Bogus Pipeline procedure (Jones & Sigall, 1971), PPD relies both on the belief that the procedure is effective and on the fear of being discovered (Saxe, 1991). In fact, Saxe, Schmitz, and Zaichkowsky (1985, as cited in Saxe, 1991) demonstrated that deceptive participants who were given strong reason to doubt the effectiveness of a polygraph went undetected.

Similar to other contemporary approaches using facial cues (for an extensive review see Ekman & Rosenberg, 2005) or an fMRI to detect neurological activity associated with familiarity (e.g., to crime scene photographs) or deception (e.g., Rosenfeld, Soskins, Bosh, & Ryan, 2004; Kozel et al., 2004), the present technique does not require faith in the procedure nor concern over its outcome. The activation of implicit associations in memory is an automatic and uncontrollable cognitive process (Bargh, 1992; Greenwald et al., 1998) and, in the case of deception, is fundamentally necessary to the act itself. That is, one cannot offer a deceptive response, whether spontaneously or with premeditation, without cognitively processing information that is implicitly categorized as untrue and therefore activating the concept "lying." Thus, detecting deception via the measurement of implicit associations may be less constrained than the classic PPD approaches with regards to the fear of detection.

An additional advantage to a cognitive approach to deception detection is the relative ease with which the procedure can be designed and deployed. The alternative psycho-physiological methodologies are cumbersome in that they require specialized equipment and extensively trained administrators. An implicit measurement procedure, on the other hand, can be run on any computer, can be completed in 20 minutes, and is highly cost-effective. Any new development in the detection field may be a useful in a wide variety of contexts (Gass & Seiter, 2007) as either an alternative when existing procedures are not logistically feasible or as a source of supplemental data to decrease the likelihood of incorrect conclusions.

Cognitive Deception Detection

There is a small body of literature that has attempted to detect deception via reaction times based on the premise that lying requires more cognitive effort than telling the truth. There is some support for the prediction that dishonest responses take longer to put forward (e.g., Walczyk, Roper, Seemann, & Humphrey, 2003), but other studies have yielded inconsistent or contradictory results (e.g., Hsu, Santelli, & Hsu, 1989). Gregg (2007), in what is perhaps the most conceptually similar study to the present experiments, had participants categorize stimuli as either true or false. Those statements included factual and inaccurate statements about the world (e.g., "Grass is green" or "Grass is blue") and about the participant (e.g., "I am a male" or "I am a female"). After completing a block of trials in which the two categories of statements were intermixed, participants were then instructed to complete a block in which they accurately categorized worldly statements but dishonestly categorized personal ones. Consistent with Gregg's (2007) predictions, latencies were longer when participants were forced to respond dishonestly to questions about their first name, age, gender, address, birthplace, marital status, citizenship, and diet.

Two important limitations to Gregg's (2007) study are relevant to the present proposal. First, participants were not attempting to conceal information about themselves with the goal of being believed, but rather were following instructions to categorize incorrectly statements that had already been established as true or false. That is, the participants were fully aware that the answers they were providing in later blocks of trials were already known to be false by virtue of the instructions given. As no meaningful lie was involved in the procedure it is difficult to conclude that Gregg's (2007) methodology is appropriate for field applications of deception detection. Second, the latency averages computed for the two critical blocks of testing were aggregates across the entire set of statements. The procedure was useful in detecting an overall delay when participants were required to provide counter-factual responses to a wide range of statements but was not designed to verify the veracity of any one of those statements. The present procedure, on the other hand, was designed to question participants about a single, specific behavior (e.g., illegal drug use, illegal file downloading, etc.) that they may or may not be attempting to conceal.

Of course the applied contribution of any deception detection procedure hinges on its ability to distinguish successfully honest and dishonest responses when participants are informed of specific strategies for altering their response profiles. One such strategy or avoiding detection would be to delay all responses to a constant integer within the required response window such that there are no detectable differences in one's latency profile. A more sophisticated approach would be to delay selectively responses on specific trials to produce the pattern indicative of truthful responding. Given that existing research on the malleability of the IAT has demonstrated it is quite difficult to control one's response profile in the desired directions without both explicit instructions on how to do so and extensive practice (see Steffens, 2004 for a recent review), it is reasonable to expect the same would hold true for the present application of the procedure. Further, as long as instructions alone are insufficient to negate the procedure, its practical value as a deception detection system would be equal to that of existing PPD procedures, all of which are similarly vulnerable to countermeasures from well-trained individuals (Honts & Amato 2002; Rovner, 1986).

Chapter II: Experiment 1

Introduction

The purpose of Experiment 1 was to test whether response profiles from an IAT-like procedure can be used to predict whether a participant's biographical claim is accurate or deceptive.

Methodology

Participants first completed a questionnaire asking them to report, among other things, whether they had ever used an illegal drug. The matter of one's drug history was chosen because pilot testing indicated that roughly 50% of students have used an illegal substance at least once while 50% have not. We can be reasonably certain that the information provided on the initial survey was accurate because it was explicitly explained that all data would be tracked only by a random subject number not in any way associated with their identities. Further, participants were asked to complete the anonymous survey privately, seal it in an envelope themselves, and place it in a sealed box to be opened only after the study was complete. Given the extent to which their anonymity was protected there is no reason to suspect that any substantial number of participants were motivated to lie out of concern of legal ramifications or social desirability.

Fully aware that the purpose of the study is to evaluate a new lie detection technique, participants were then randomly assigned either to confess or deny illegal drug use upon any further questioning by the researcher. By doing so the participants were, in effect, assigned to respond honestly or dishonestly without the researcher being aware of their condition. This helped create the desired impact in that only the participant was aware of whether he or she was lying or telling the truth. Additionally, the participants' actual drug history was not confounded with whether they were asked to lie or tell the truth.

Once they had been given instructions on how to respond participants were brought into a small testing room and orally questioned by the researcher about both their history with illegal drugs and control items to which we knew all participants are responding honestly (see Appendix A). Participants were then told that their truthfulness would be determined by their performance on the computerized lie detection system, and that in order to earn a passing score they must respond as quickly and as accurately as possible on every trial.

Because a reaction time task requires a certain level of persistent motivation on the part of the participant it was desirable that the computer task would be taken seriously as a lie detection system. To that effect an effort was made to present the system as an official and legitimate detector. The program (using PTS's E-Prime & Adobe PhotoShop) greeted participants with an official-looking BRASS (Binary Response

Authentication Software System) logo and welcome screen. Instructions were presented on the screen and read aloud by a pre-recorded voice to create the impression of a sophisticated, functional program.

The procedure, much like the traditional IAT, was organized into training and testing blocks. The first block of trials trained the discrimination task with target stimuli being Yes/No questions concerning whether they have used or abstained from using drugs, whether they are being honest or dishonest about their drug use, and whether they have drunk or abstained from drinking water. The water questions, on which all participants were instructed to respond honestly, were intended as filler items to ensure that those responding dishonestly about their drug use were cognizant of the distinction between their honest and deceitful responses.

Prior to and between trials the screen remained black with the response options, in white text, presented in the top-left and top-right corners. A question appeared and remained on the screen until a response button was pressed or until the response latency exceeded a limit of 4000_{ms}. Response windows were established based on averages obtained in pilot testing to ensure that participants were motivated to respond quickly. If the participant answered correctly within the 4000_{ms} window the stimulus disappeared and was followed by a 1500_{ms} inter-trial interval (ITI). If the participant answered incorrectly, the text turned red and a red "X" appeared below the question for 1000_{ms} before a 500_{ms} ITI. If participants failed to respond in time the trial was counted as an error, the text turned red and "Too Slow!" appeared below for

1000_{ms}. Regardless of whether the response was correct or incorrect, responses falling between 3000_{ms} and 4000_{ms} were followed by an additional prompt with the BRASS logo (1000_{ms}) and "YOU MUST GO FASTER." and the (500_{ms}) ITI followed. Within all blocks the sequence of trials was randomized for each participant (see Appendix B).

The second block of trials trained a Truth/Lie discrimination task, in which quotations (in black text) appear in a light-grey stripe centered on the screen. Participants were instructed to indicate whether the statement, if said to them by another person, would be the truth or a lie. Truth/Lie statements were visually distinct in color to facilitate differentiating them from Yes/No questions in later dual-discrimination blocks (Nosek et al., 2007). Again responses were followed by a speed prompt after 3000_{ms} and counted as errors after 4000_{ms}.

The third block randomly intermixed Yes/No question trials with Truth/Lie discrimination trials and paired Yes and Lie response options on one button and No and Truth options on the other button. Thus, participants were required to respond to half of the questions under truth-congruent conditions (their response used the same button as they would press for a truthful statement) and the other half under truth-incongruent conditions. The stimuli were presented as they were in the earlier blocks, although participants were now required to respond within 3000_{ms} and speed prompts now followed latencies exceeding 2000_{ms}. Again trial sequences were randomized for each participant and correct responses would rely on the two buttons equally.

A fourth block of trials retrained the Truth/Lie discrimination task with the response options reversed. The fifth and final block repeated the dual-categorization task so that questions that were answered under truth-congruent conditions were now answered under truth-incongruent conditions (and vice-versa). After completing all five blocks (with a combined total of 356 trials) participants were thanked and excused.

Results

As with any reaction time procedure, a rule for data inclusion was established a priori. Participants whose response accuracy fell below 80% were excluded because such a high error rate indicates either a lack of effort or an inability to complete the task proficiently, thus making it difficult to interpret the latencies on correct trials. Of the 173 male and female undergraduates that participated data from thirteen (7.5%) were discarded for failing to achieve the 80% accuracy rate across all 356 trials and across the 220 trials within the two test blocks. The remaining 160 participants earned an average accuracy rate of 94%, and there was no difference in overall accuracy between those lying and those telling the truth.

In line with expectations, 55% reported some history of illegal drug use on the initial survey while the remaining 45% denied any use. By virtue of the instructions given to participants each was categorized into one of four conditions: they either (1) honestly admitted drug use, (2) honestly denied drug use, (3) dishonestly admitted drug use, or (4) dishonestly denied drug use. Assuming that the nature of an individual's claim and the distribution of the sample are known (i.e., 81 of 160 are lying) there was a 50.6% chance of correctly guessing whether he or she was instructed to lie or tell the truth.

Response latencies from the first block of practice trials in which participants responded to the Yes/No questions were subjected to an ANOVA to determine whether providing counter-factual responses led to greater overall response times. Contrary to what we might expect from studies that have found that lying takes longer to do (e.g., Gregg, 2007) there were no significant differences in the amount of time it took to respond to the drug-related questions among any of the four participant conditions, $F_{(3,156)} = .876$, $p > .05$.

Latencies from the two test blocks were converted to Z-scores based on each participant's individual average and standard deviation within each of the test blocks respectively. This effectively calibrates the analysis procedure for each participant's natural baseline reaction time and removes the variability from between-subject comparisons (Fazio, 1990) on specific questions. Further, transforming latencies by block ensures that the effect of any general practice or fatigue effects are accounted for. This was particularly important with the present design because the block in which a specific question occurred as a truth-congruent trial differs as a function of whether the individual was admitting or denying drug use. For example, when asked about having used an illegal drug, someone denying use would have answered "no" in the first test block as a truth-incongruent trial and in the second test block as a truth-congruent trial. However, when asked about abstaining from drug use, "yes" would have appeared as a truth-congruent trial in the first test block and as a truth-incongruent trial in the second. The opposite was true for someone admitting to drug use as the configuration of response options did not vary between subjects.

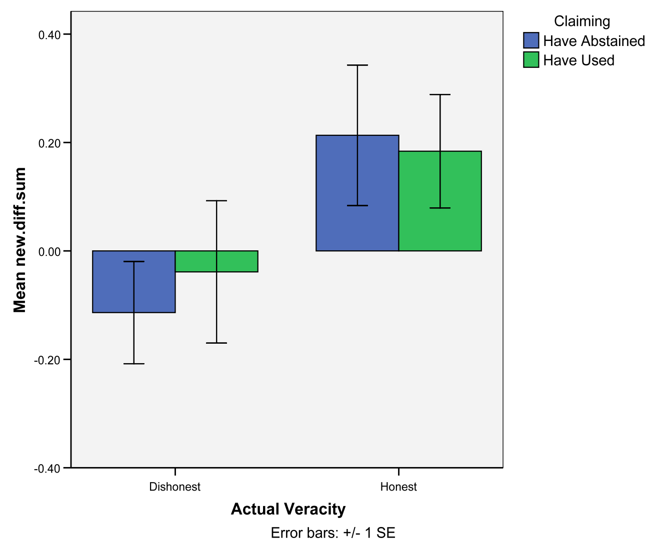
A participant's response profile consisted of four averages, one for each of the four drug-related questions under truth-congruent and truth-incongruent conditions. Much as in the traditional IAT, a difference score (Greenwald et al., 1998; 2003) for each of the four target questions was computed:

$$\text{Difference } (D_{Q1}) = \text{Truth-congruent } (Z_{Q1}) - \text{Truth-incongruent } (Z_{Q1})$$

A difference score greater than zero indicates that an individual took longer than average to answer that question under the truth-congruent condition as compared to the truth-incongruent condition. A negative score, on the other hand, indicates that the individual responded faster in the truth-congruent condition.

The difference scores on the four drug-related questions were summed together to form a single dependent variable reflective of any overall response bias in truth-congruent or –incongruent conditions. As depicted in Figure 1, participants responding honestly tended to exhibit a positive bias score (M = .188, SD = .712) while those responding dishonestly exhibited a negative bias score (M = -.147, SD = .687). An ANOVA confirmed a main effect for response veracity, $F_{(1,156)} = 5.80$, $p < .05$, and failed to detect either a main effect for the specific claim (used or abstained) or an interaction between the two, $F_{(1,156)} = .04$ and $F_{(1,156)} = .21$ respectively, *p*'s > .05. All four of the difference scores were greater for those responding honestly, though individual t-tests were only marginally significant. A subsequent analysis failed to find any significant covariants among training block latency averages or accuracy rates.

Fig 1. Bias Scores From Exp 1



Average bias scores of the four participant conditions were collapsed into two groups, one for those who were responding honestly and the other for those who were responding dishonestly. Using only the bias score a logistic regression correctly predicted response veracity 56.3% of the time, which is significantly greater than chance, $\chi^2_{(1)} = 8.99$, $p < .005$.

Discussion

The 6% gain in prediction accuracy may not seem overwhelmingly impressive, but Experiment 1 demonstrated that a dual-discrimination procedure can successfully detect some cognitive bias for truth-congruent (or –incongruent) responding. The positive bias score, typical of participants responding honestly, indicates more rapid reactions on truth-incongruent trials. Conversely, those lying tended to respond faster on truth-congruent trials than on truth-incongruent trials (as indicated by the negative bias score). It is important to note that this pattern was opposite from the general IAT finding that responses are facilitated by congruent (bias-consistent) response options. For example, on the typical IAT, someone categorizing images as animals or insects should be quick to press the "insect" button when that button is the same as that used to categorize valenced words as "bad" (e.g., "disease"). When the response options are bias-incongruent, however, with "insect" and "bad" on opposing buttons, response competition results between the desire to categorize the stimulus as an insect and the desire to categorize the stimulus as something bad (see Brendl, Markman, & Messner, 2001). The instantaneous (and uncontrolled) evaluation of the target stimulus leads to confusion, and therefore greater response latencies, when response options are incongruent.

Given the widely accepted response competition mechanism by which the IAT works, it had been hypothesized that honest responses would have been facilitated when the response option (e.g., "yes") was paired with "truth" and inhibited (via response competition) when paired with "lie." Someone responding dishonestly, however, should experience the opposite pattern of response competition. To understand why the present results were opposite to the typical IAT bias it is helpful to consider an example. Imagine a participant who is dishonestly denying any history of illegal drug use. When asked whether he or she has used an illegal drug (a yes-or-no trial) the correct response would be to press the "no" button, even though this particular response is a lie. Similarly, when presented with a statement claiming that a cow is smaller than a fly the correct response would be to press the "lie" button, even though there might be a tendency to respond to the statement as though it were a question (i.e., "no, a cow *is not* smaller than a fly"). If the participant is able to accurately and reliably distinguish question trials from statement trials then his or her dominant response (the one initially favored upon processing the target stimuli) is most likely to be correct, as was well established in the first two training blocks.

However, after completing the computer task many participants reported considerable confusion in keeping the two categories of stimuli separate to avoid errors caused by labeling their responses to yes-or-no questions as the "truth" or a "lie" and answering truth-or-lie statements with a "yes" or a "no." How might this confusion influence response latencies? If an inaccurate statement (a lie) is responded to as a question ("no") than the response option used will result in an error at least half of the time. Similarly, if a yes-or-no question is mistaken for a stimulus that can be categorized as representing either the "truth" or a "lie" as a function of the dominant response's actual veracity (e.g., it is a lie to say that I have never used an illegal drug), again that confusion would lead to response errors.

In the first block of test trials “yes” and “lie” were mapped to the left button while “no” and “truth” were mapped to the right. In our example, imagine that the participant, who is falsely denying a history of illegal drug use, is reacting towards the left response option following the presentation of “Have you completely abstained from illegal drug use?” One of two possibilities is likely: either (1) the stimulus was correctly processed and “yes” is the appropriate response (given their intent to deceive) or (2) the stimulus was incorrectly processed as representing a lie and that initial reaction towards the left response option is a result of “lie” being mapped to it.

As the question on which the participant is knowingly lying was asked in a truth-incongruent condition (the correct response is on the same button as “lie”), the latter is possible. The initial reaction towards the left could have been due to the association with the stimulus’ veracity. Given evidence of a possible miscategorization our participant may hesitate, if only for a moment, to confirm that the stimulus should in fact have been categorized as a yes-or-no question and that “yes” (rather than “lie”) is the appropriate answer. However, in the second of the two test blocks, when the same question is asked in a truth-congruent condition, the presence of the word “truth” on the initially favored response option would indicate that there was no miscategorization. Had the stimulus been mistakenly categorized as a “lie” then the initial reaction should have been towards the right, not the left. In the absence of any evidence that a miscategorization might have occurred the participant is free to commit to his or her initial response without further delay. As a result, participants who are lying take longer to respond when "lie" is present on the correct response option, earning the negative bias score.

For a participant who is truthfully answering the same question under the same conditions, the opposite pattern would emerge. "Lie" being present on the favored response option in the first block of test trials would be evidence that the stimulus was not mistakenly categorized as representing the truth. However, when asked again in the truth-congruent condition, there is now reason to second-guess the immediate reaction. With truth-congruent and –incongruent trials balanced across the two testing blocks and reaction times standardized by block, the overall bias score indicates whether a participant was generally delayed by the presence of "truth" or "lie" on the appropriate response option.

In sum, the present procedure is not a direct extension of implicit attitude measurement, and the results do not call into question the mechanism by which attitudes might be measured with the IAT. Instead, the data suggests that this novel application of a dual-discrimination task yielded differences in reaction times via its own mechanism. Any implicit benefit that congruent mapping might have in selecting the appropriate response button (as we see in an IAT) is overshadowed by the difficulty of the task and the inherent confusion created by the two categories of stimuli used. The bias score calculated indicates on which of the trials participants tended to hesitate and it is clear from the data that truthful participants are slower when their response to a yes-or-no question is asked in a truth-congruent condition while dishonest participants are slower responding in a truth-incongruent condition. The relative complexity of processing entire sentences (rather than individual words or images), combined with the difficulty of keeping separate factual claims from judgments of veracity, leads congruent response options to signal a potential error in the initial categorization of the stimulus. As a result, participants' awareness of the veracity of their answer, combined with the concern for making as few errors as possible, provided the analysis procedure with a means by which to distinguish genuine and deceitful responses to forced-choice questioning.

Had no significant differences been found between those lying and those telling the truth it would have made sense to abandon the present procedure in favor of some variation that might produce the predicted IAT response competition pattern. However, given that there is clearly some other mechanism underlying the present results it seemed imperative that subsequent study further explore the reliability of the obtained results.

Chapter III: Experiment 2

Introduction

Data from the first experiment suggests that a dual-discrimination procedure is capable of detecting a bias helpful in differentiating honest from dishonest reports of illegal drug use history. Although the results cannot be attributed to individual differences in actual drug use, it was nonetheless desirable to replicate the experiment with a different target question. Ideally the procedure would produce equally significant predictions, and more importantly, make its predictions based on the same pattern of differences observed in Experiment 1. Demonstrating reliability across questioning topics strengthens our conceptual understanding of how the procedure works to detect deception and testifies to its issue-independent nature.

An important feature of Experiment 1 is that the number of participants who reported some history of illegal drug use on the initial survey was roughly equal to those who had actually abstained. As a result of the subsequent assignment to give a particular response, each of the four participant conditions had approximately the same number of participants. Whereas this was a desirable feature for the first experiment, there are likely to be applications where the distribution of participants into the various conditions would be more skewed. For example, in a national security clearance context, everyone would presumably deny any impropriety. However, only a small percentage (if any) of the individuals screened would actually be guilty of something worth concealing. Thus, it would be informative to test the procedure with a topic on which we would expect to find a more skewed distribution in the actual history of the participants.

Methodology

Experiment 2 followed the same procedure as Experiment 1 but substituted illegal file downloading for drug use. Following the anonymous survey participants were randomly assigned to either admit to or deny some history of illegal file downloading, explicitly defined as obtaining any copyrighted media or software without paying the copyright owner for it. The four target questions asked whether the individual has engaged in (or abstained from) illegal downloading and whether the individual was responding honestly (or dishonestly) about his or her history of illegal file downloading. Again they were questioned orally by the experimenter and then instructed to complete the computerized deception detection procedure by responding as quickly and as accurately as possible. The number of trials and the sequence of the training and test blocks were the same as in Experiment 1.

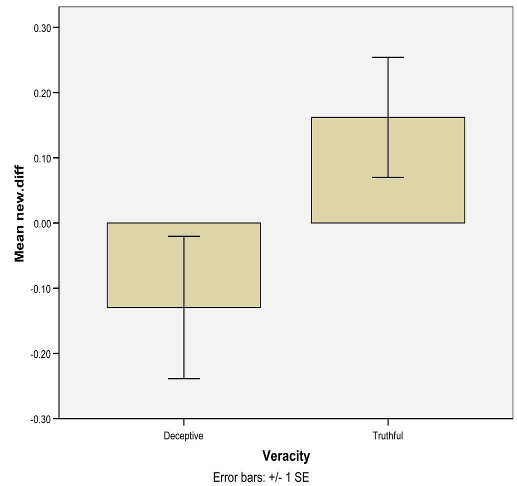
Results

Data were collected from 100 male and female undergrads participants who were instructed to either admit or deny ever having illegally downloaded files. Seven (7%) of those participants were ultimately excluded for having error rates over 20%, and of the remaining 93 all but five (94.6%) reported illegal downloading at least once in their lives. All five of the participants who had reported having never downloaded illegally happened to be randomly assigned to deny downloading, and thus no participants were instructed to dishonestly admit having downloaded illegally. However, there were still an equal number of participants responding honestly and dishonestly, so the chance of predicting the veracity of their answers remained at 50%.

Latencies were again transformed to Z-scores for each participant and by each block of trials to control for individual differences and order effects. A difference score for each of the four target questions was computed and then summed to compute the overall bias score.

Because there were an unequal number of participants in the four conditions, average bias scores were collapsed into two groups, one for those who were responding honestly and the other for those who were responding dishonestly (see Figure 2). As in Experiment 1, there were no differences in overall reaction time, $t_{(91)} = 1.37$, $p <$ .05) and participants who were responding honestly earned, on average, a positive bias score (M = .162, SD = .737) while those responding dishonestly averaged a negative bias score (M = -.130, SD = .749), $t_{(91)} = -2.04$, $p < .05$. The logistic regression correctly predicted the veracity of a participant's response 58.1% of the time, $\chi^2_{(1)} = 4.188$, $p < .05$. Again subsequent analyses failed to find any significant covariants in training block latencies or accuracy rates.

Fig 2. Bias Scores From



Discussion

Experiment 2 succeeded in replicating the earlier finding that participants responding honestly were generally faster on truth-incongruent trials while those responding deceptively were faster on truth-congruent trials. It is worth noting that, consistent with results from Experiment 1, providing counterfactual responses was not associated with greater overall latencies. The average gain of about 7% in accuracy across the two studies indicates there is room for future research to explore variations of the present design that might maximize predictions. However, from a theoretical standpoint the first two studies demonstrate conclusively that there are implicit associations between responses to forced-choice questioning and their veracity and that the influence of those associations can be measured with a dual-discrimination task. Before concern over the prediction accuracy drives empirical testing of the variants it is desirable to first identify some of the methodological constraints that govern the general effect.

It is also worth noting that nearly 95% of the participants admitted to having engaged in illegal activity. Aside from what this indicates about the prevalence of copyright infringement among college students, these results give further confidence that participants are responding honestly on the initial surveys used to assess the true state of affairs in Experiment 1 and 2. It would appear that the anonymous conditions in which the data were collected succeeded in making participants feel comfortable with honestly reporting illegal activity.

Chapter IV: Experiment 3

Introduction

The goal of Experiment 3 was to test a variant of the procedure from Experiment 1 in which truth-congruence was randomized on a trial-by-trial basis rather than by block. It is conceivable that someone well informed of the analysis procedure could selectively delay responses in such a way as to mimic the profile characteristics typical of an honest participant. As the average latencies calculated in Experiments 1 and 2 are based on trials within a single block the strategic pauses required are predictable and rehearsable even if the order of blocks is randomized.

Obviously the ability to be reliably categorized as honest would be the most desirable outcome for anyone attempting to countermeasure the procedure. However, if the configurations vary randomly between trials and are presented only a moment before the stimuli it would be considerably more difficult to appropriately delay specific responses based on the target stimulus and the specific configuration. Of course the additional task demand poses the risk of adding more variability in the latency data and delaying responses across the board, thereby obscuring relative differences between truth-congruent and –incongruent trials. Nonetheless it is worth exploring whether this variant can produce predictions similar to those generated in the first two experiments with the added benefit of being more difficult to countermeasure.

Methodology

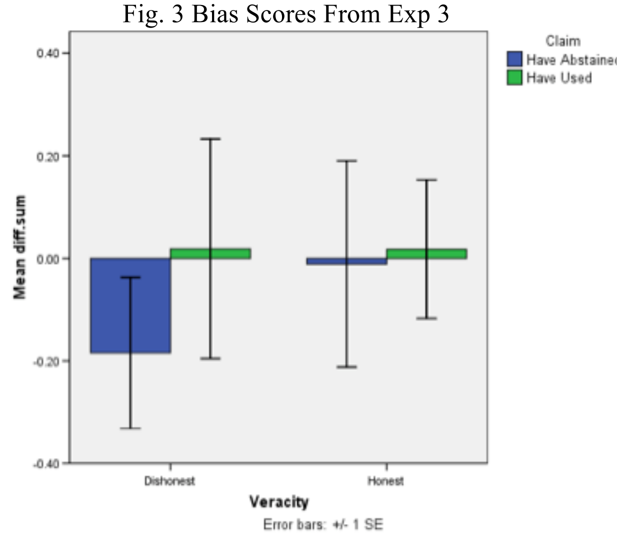
Generally speaking the procedure was a replication of Experiment 1 with three specific modifications. First, an additional training block followed the first two in order to establish the dual-discrimination task with fixed response option configurations before they varied between trials. Second, as all possible response option configurations occurred equally in each of the two testing blocks no re-mapping block was required in between them. Lastly, after each trial the response options disappeared from the screen for the 1500_{ms} ITI and then appeared, in another randomly determined configuration, 500ms before the target stimulus was presented. The order in which stimuli and screen configurations occurred was randomized for each participant and fully balanced in each of the two test blocks. Timing of the stimulus presentation, feedback, speed prompt and limit were the same as those in the first two experiments.

Results

Data were collected from 113 male and female undergraduate participants who, as in Experiment 1, were instructed to either admit to or deny illegal drug use. Twenty-four (21%) of those participants were ultimately excluded for having error rates over 20%, and the remaining 89 maintained an average accuracy rate of 92.4%.

Again responses were converted to Z-scores within each of the two test blocks and then combined to form the composite bias score between truth-congruent and –incongruent conditions. As depicted in Figure 3, participants responding honestly (M = .005, SD = .736) tended to exhibit a slightly more positive bias score than those responding dishonestly (M = -.108, SD = .844). However, given such large standard errors, an ANOVA found no effect for veracity, $F_{(1,85)} = .247$, $p > .05$. Collapsing bias scores into groups representing those lying and those telling the truth, a logistic regression was correct 53.9%, which is not significantly different than what chance might predict, $\chi^2_{(1)} = .458$, $p > .05$.

Fig. 3 Bias Scores From Exp 3



Discussion

Based on data from Experiment 3 it appears that the additional task demands created by randomly varying response options negates the procedure's ability to detect meaningful differences between truthful and deceitful participants. Indeed participants often commented on finding the procedure difficult and frustrating and the number of participants excluded for failing to achieve the minimum accuracy rate was triple of that in the first two experiments. Had the variant succeeded in producing significant predictions, the revised procedure might offer greater resistance to the selective manipulation of reaction times. However, given the inflated standard errors and a marked decrease in accuracy rates, the data suggests that a between-trial manipulations of response option configurations requires processing demands beyond what is appropriate for this type of reaction time paradigm. The remaining experiments will therefore maintain a between-block manipulation of response option configurations.

Chapter V: Experiment 4

Introduction

Perhaps the most simple and intuitive way to circumvent the detection procedure would be to delay all of one's reactions to a constant integer within the 3000ms response window and then answer correctly. Doing so would achieve the necessary accuracy rate while masking any differences in actual processing time as a function of truth-congruence. Further, even those without any detailed knowledge of the analysis procedure would be able to understand what the countermeasure strategy requires of them. However, given findings on the difficulty of manipulating response latencies in a dual-discrimination task, it is reasonable to hypothesize that participants will not be successful in reliably conforming their reaction times to sufficiently negate differences as a function of truth-congruence on their first exposure to the procedure. Successful predictions despite deliberate efforts to control latencies would expand on Experiments 1 and 2 to test the applied potential of the paradigm.

Methodology

Experiment 4 was an exact replication of Experiment 1 with the addition of instructions to avoid detection by holding all response times to a constant. After being surveyed about their actual history of illegal drug use but prior to beginning the computer task the researcher gave the following instructions:

> In previous studies we have told participants that their task is to convince me, and the lie detector, that they are telling the truth by responding to questions as quickly as they possibly can. However, I am going to give you information they did not have on how to defeat the test, and it is important that you listen carefully to how you can fool the computer and that you try your best to successfully use this strategy.
>
> The computer will not be able to determine if you are responding honestly or dishonestly if all your reaction times are the same. Therefore, rather than going as fast as you possibly can, your goal is take the same amount of time on every trial while still giving the correct answer. After the first set of practice trials the computer will require you to answer a question by pressing a button within 3 seconds. After 3 seconds the trial counts as an incorrect response.
>
> Your goal is to take the same amount of time on every trial without getting cut off by the computer. So, for example, if you take exactly 2 ½ seconds to respond on every single trial, you'll have beaten the test. Do your best to answer all of the questions correctly and in the same exact amount of time. Do you understand what you have to do to beat the test?

Following the computer task participants were given a survey on which they were asked to rate on a seven-point scale how easy (1) or difficult (7) they found it to regulate their latencies and whether they believe they were successful in defeating the detection procedure.

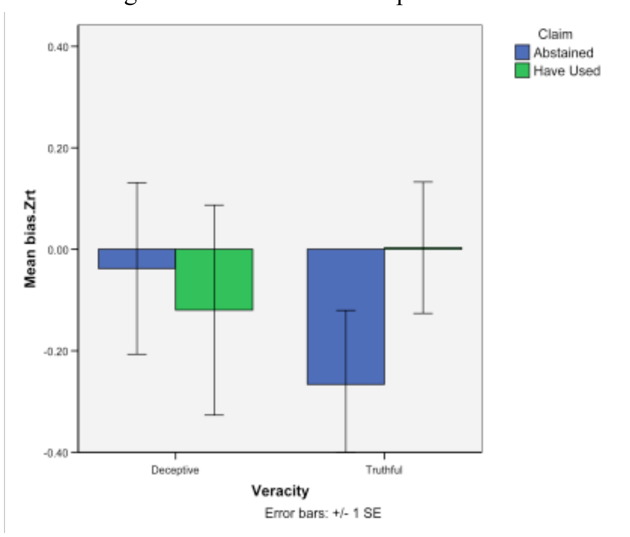
Results

Data were collected from 130 male and female undergraduate participants who, as in Experiment 1 and 3, were instructed to either admit to or deny illegal drug use. Ten

(7.7%) of those participants were excluded for having error rates over 20%, and the remaining 120 earned an average accuracy rate of 94% regardless of whether they were responding honestly or deceptively. With fifty-nine participants responding honestly and sixty-one deceptively, labeling all as deceptive would be correct 50.8% of the time.

Responses were again converted to Z-scores within each of the two test blocks and then combined to form the composite bias score between truth-congruent and –incongruent conditions. As depicted in Figure 4, those honestly denying any history of illegal drug use tended to earn a negative bias score (M = -.266, SD = .667), though none of four averages differed significantly from each other or from zero. An ANOVA confirmed there was no main effects for response veracity, $F_{(1,116)}$ = .095, p < .05, nor was there an effect of the specific claim (used or abstained) or an interaction between the two, $F_{(1,116)}$ = .229 and $F_{(1,116)}$ = 1.06 respectively, p's > .05.

Fig. 4 Bias Scores From Exp 4



Collapsing bias scores into groups representing those lying and those telling the truth, a logistic regression was correct 47.5% of the time, which is worse (though not significantly) than what chance might predict, $\chi^2_{(1)}$ = .022, p > .05. Honest (M = 5.05, SD = 1.33) and dishonest (M = 4.89, SD = 1.41) participants found it equally difficult to hold responses to a constant latency, $F_{(1,116)} = .825$ and there was no effect of claim nor an interaction between claim and veracity, $F_{(1,116)} = 1.22$ and $F_{(1,116)} = .001$ respectively, *p*’s > .05.

Discussion

Results from Experiment 4 indicate that providing participants with instructions to delay responses to a constant latency interfered with the procedures ability to detect any meaningful differences in reaction time profiles. This certainly calls into question the applicability of the present approach to deception detection in contexts where individuals might be motivated to avoid detection and informed of strategies for doing so. However, the ease with which the procedure might be countermeasured by attempts to delay responses does not negate the theoretical contribution of the earlier findings. Instead it calls for a variation of the procedure in which average latencies and the variability between trials and between subjects can be reduced. Such a variation may not only benefit the prediction accuracy or the procedure but may also, in turn, make it considerably more difficult to deliberately delay latencies.

Chapter VI: Experiment 5

Introduction

The final study was designed to explore another variation of the procedure in which target stimuli are presented in a more simple way. By reducing the trigger stimuli to a single word (rather than a complete sentence) participants should be able to respond more rapidly and with less variability than in Experiments 1 and 2. An overall reduction in variability may prove useful in increasing the accuracy of the predictions generated by the procedure. More importantly, this variant of the original is more similar in design to the IAT.

The earlier experiments used entire sentences because doing so seemed to guarantee that participants would have to process the full meaning of the stimulus in order to respond correctly. It was desirable that while responding to a question the implications of the given response (i.e., its veracity) be salient. However, by segmenting the stimuli into two successive presentations Experiment 5 aimed to test a more IAT-like design while maintaining the impact of having to respond to meaningful questions. Further, reducing the response window might increase the difficulty of defeating the procedure by delaying responses either selectively or across all trials. There would be less time available to pause before being cut off, and the shorter window would require even greater control over a smaller amount of time to reliably manipulate reaction times.

Methodology

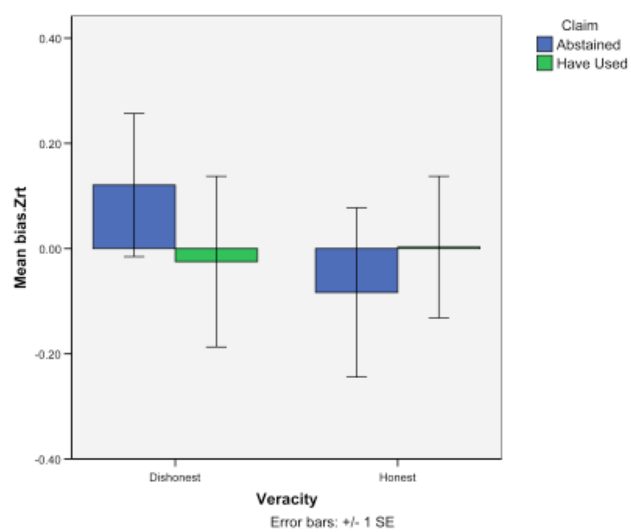
The procedure followed that of the first experiment with regards to the instructions given and the arrangement of the training and test blocks. The presentation sequence, however, was broken into two parts. Following the standard 1500 ITI, the first part of a yes-or-no question, or truth-or-lie statement, would appear on the screen for 1500ms. For example, the first line might read, "Have you abstained from:" on a yes-or-no question trial or "A cow is bigger than:" on a truth-or-lie statement trial. The target word that completes the question or statement (e.g., "drugs" or "water") would then appear on the second line and participants would have only 1500ms (rather than the 3000ms) to respond.

It was hypothesized was that the results would mirror those of the first two experiments in the direction of the bias score. Another possibility, however, is that making the procedure more similar to the IAT would, in turn, make the pattern of results more consistent with the typical effect of congruence in a dual-discrimination task. This would be the case if truthful participants earn negative bias scores by responding quickly on truth-congruent conditions and relatively slower on truth-incongruent trials.

Results

Data were collected from 128 male and female undergraduate participants who were instructed to either admit to or deny illegal drug use. Nine (7.0%) of those participants were excluded for having error rates over 20%, and the remaining 119 earned an average accuracy rate of 92% regardless of whether they were responding honestly or deceptively. With fifty-eight participants responding honestly and sixty-one deceptively, labeling all as deceptive would be correct 51.3% of the time.

Fig. 5 Bias Scores From Exp 5



Responses were again converted to Z-scores within each of the two test blocks and then combined to form the composite bias score between truth-congruent and –incongruent conditions. As depicted in Figure 5 there were no significant main effects for veracity, $F_{(1,115)} = .335$, $p > .05$, or claim $F_{(1,115)} = .040$, $p > .05$, nor was there an interaction between the two, $F_{(1,115)} = .607$, $p > .05$.

Collapsing bias scores into groups representing those lying and those telling the truth, a logistic regression was correct 50.4% of the time, which is not significantly different than what chance might predict, $\chi^2_{(1)} = .336$, $p > .05$.

Discussion

It appears that the IAT-like variant tested in Experiment 5 is not a viable substitute or replacement for the original design of the procedure. Modifying the procedure to utilize a single word as the trigger stimulus failed to produce any meaningful differences between participant conditions or predictions of response veracity. Perhaps the meaning of the sentence is lost in separating the stimulus into two parts and cognitive processing of the target word is limited to conditioned response strategies (e.g., if I see the words "drugs" next I'll press the left button, if I see the word "water" next I'll press the right button). It is also possible that the same concern over miscategorization errors that apparently led to the success of the original procedure in the first two experiments occurred but was sufficiently resolved in the 1500ms between the presentations of the first part of the sentence and the trigger stimulus. In anticipating the possible ways in which a yes-or-no question stimulus could be completed participants may have become aware of the potential confusion and confirmed the stimulus category (question or statement) prior to the target word appearing. However, a review of the reports completed by researchers did not turn up any comments made by participants in Experiment 5 that would indicate they found it any easier than those in the earlier studies. Regardless, it seems clear that future exploration of dual-categorization tasks in deception detection contexts should build upon the original design in which complete sentences are used as target stimuli.

Chapter VII: General Discussion

The present findings offer support for the idea that biographical information is cognitively represented such that what is known to be true or false is implicitly associated with one's general concepts of "truth" and "lie" respectively. Thus, the cognitive organization that enables one to selectively offer deceptive responses also provides a means by which to detect the deceptive intent. Taken together the project demonstrates that an existing dual-discrimination task such as the IAT can be adapted to assess the veracity of responses to forced-choice questioning. More notably the results from Experiments 1 and 2 provide consistent evidence that such an adaptation produces a pattern of bias scores opposite in direction to that of a traditional IAT. The most cogent account of the obtained results is that the judgments required to navigate the task create an inherent source of confusion, and therefore response apprehension, on veracity-congruent trials (truth-congruent for truthful respondents and truth-incongruent for deceptive respondents). The response apprehension pattern is expressed in the composite bias score, reflecting the relative speed with which participants react in truth-congruent and –incongruent response conditions.

It is impossible to study deception detection without considering the potential applied value of a novel theoretical and methodological approach. The marginal gain in prediction accuracy, combined with the procedure's failure to maintain those predictions in the face of deliberate latency manipulation in Experiment 4, casts serious doubt on whether this approach will ever be viable in an "applied" context.

However, the present procedure's limitations as a functional lie detector do not detract from its conceptual contribution to the science of deception detection. In addition to demonstrating that deception can be detected by the implicit association between one's representation of the concept "lie" and the actual lie itself, some of the methodological constraints of this approach have also been identified.

One important question addressed was whether manipulating the response conditions between-trials would intensify the underlying response apprehension (and thereby polarizing bias scores) or negate its effect by introducing additional variance to the latencies. Based on Experiment 3 it is evident that such a dynamic cognitive task, combined with the complexity of the stimuli, is not reasonable for a reaction time measurement procedure. With triple the error rates and double the variance, any differences that might have existed between response conditions would have been obscured out by the noise. Any future variation of the procedure should clearly maintain the between-block manipulation of truth-congruence and focus on reducing variance in the latency profiles. However, results from Experiment 5 suggest that simply reducing the trigger stimulus to a single word, as in a traditional IAT, is not the appropriate way to minimize error variance.

It may be that the future application of this new development is not as a stand-alone detection system, but rather as a technique to integrate with existing technologies. For example, physiological data traditionally collected during a polygraph, or perhaps even facial cues (Ekman et al., 1998), may provide evidence (beyond a relative delay in reaction time) of stress when responding under veracity-congruent conditions. Further, the cognitive demands of the procedure may interfere with self-presentation efforts to conceal some of these physiological and nonverbal indicators, thereby providing a multiplicative effect on existing measures. Eye gaze (e.g., Yarbus, 1967) during the task may offer an additional indication of deceptive responding if the present account for the obtained pattern is correct. Response apprehension, triggered by veracity-congruent trials, should be marked by greater back and forth movement between the stimulus and a response option before the corresponding button is pressed. As research continues to develop our understanding of the underlying process involved, advancements to the methodology may one day redeem the applied value of a dual-discrimination task to the field of deception detection.

Appendix A

Question orally asked by the researcher prior to the testing procedure and the appropriate answers to those questions.

	Denying Drug Use	Admitting Drug Use
Is it your intention to answer all of my questions honestly?	"Yes"	
Have you ever in your life drunk water?	"Yes"	
Have you completely abstained from drinking water?	"No"	
Have you ever used a drug that is currently illegal in the United States?	"No"	"Yes"
Have you completely abstained from illegal drug use?	"Yes"	"No"
Are you telling the truth about your history of illegal drug use?	"Yes"	
Are you lying about your history of illegal drug use?	"No"	

Appendix B

Experiment 1 Trial Sequence

Block	Purpose	Trail Stimuli	Left	Right
1	Train Yes/No discrimination	12 Have you ever used an illegal drug? 12 Have you abstained from illegal drug use? 12 Are you telling the truth about your drug use? 12 Are you being dishonest about your drug use? 4 Have you ever drunk water? 4 Have you abstained from water?	YES	NO
2	Train Lie/Truth discrimination	12 True statements – for example: • "There are 26 letters in the English alphabet." • "You are on a college campus right now." • "A fly is smaller than a cow." 12 False statements – for example: • "There are 62 letters in the English alphabet." • "You are on a bus right now." • "A cow is smaller than a fly."	LIE	TRUTH
3	Test Yes/No by truth-congruence	15 Have you ever used an illegal drug? 15 Have you abstained from illegal drug use? 15 Are you being honest about your drug use? 15 Are you being dishonest about your drug use? 5 Have you ever drunk water? 5 Have you abstained from water? 20 True statements 20 False statements	YES LIE	NO TRUTH
4	Reverse Lie/Truth discrimination	12 True statements 12 False statements	TRUTH	LIE
5	Retest YES/NO by truth-congruence	15 Have you ever used an illegal drug? 15 Have you abstained from illegal drug use? 15 Are you being honest about your drug use? 15 Are you being dishonest about your drug use? 5 Have you ever drunk water? 5 Have you abstained from water? 20 True statements 20 False statements	YES TRUTH	NO LIE

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