6.
LIE, LIE DETECTION AND THE BRAIN

Giuseppe Sartori - Sara Agosta - Patrizia Pezzoli

One of the most common human behaviors is deception. Despite the wide use of deception in everyday life there seems not to be a uniquely recognized and accepted definition of deception. This problem is increased by the necessity of defining different types of lies (from an easy yes/no answer to a complicated constructed lie; e.g. Ganis, Kosslyn, Stose, Thompson, & Yurgelun-Todd, 2003).

St. Augustine defined deception as an «intentional negation of a subjective truth» (Augustine, 1949). Mitchell defined deception as «any phenomenon which fulfill these three criteria: i) an organism R register (or believes) something Y from some organism S, where S can be described as benefiting when (or desiring that) iia) R acts appropriately toward Y, because iib) Y means X; and iii) and it is untrue that X is the case» (Mitchell, 1986). Mitchell distinguishes between 4 levels of deception (Mitchell, 1986):

1. at the first level the organism «acts» deceiving because he/she cannot do otherwise;
2. at the second level the organism deceive «doing p given that q»;
3. at the third level deception is the result of an open program and this program can be modified by the result of the action of the organism;
4. at the fourth level there is an open program that is able to programming and reprogramming itself based upon the past and present actions.

From Byrne's (1996) point of view: «intelligence is an adaptation to deal with the complexity of living in semi-permanent groups of con-specifics, a situation that involves a complex tricky balance of competition and cooperation». Social interactions involve an element of deception, thus the possibility of deceptive, well-calculated communications and the necessity of detecting such machinations and manipulations provided a major impetus for the evolution of primate and human intelligence (Byrne, 1996). Byrne and Corp (2004) also showed that the use of deception within the primates is well predicted by the neocortical volume. This social function of intellect may be considered a primary context for his ontogenesis as well (LaFreniere, 1988).

Johnson and colleagues (Johnson, Barnhardt, & Zhu, 2003) highlighted the common substrate to all definitions: «regardless of the nature and extent of the cognitive/emotional processes that precede and accompany a decision to deceive, all deceptions require the execution of a response that is incompatible with the truth» (p. 219). This definition highlights the core problem related to deception: the «incompatibility» with the truth.

Given the wide use of deception in everyday life and the importance of deception from the ontogenetic and the phylogenetic point of view, deception detection is drawing the attention of the scientific community. Here it is important to underlie that, until now, no lie detector has been shown to be 100% effective. Follows a brief description of the techniques used to spot lies and liars.

6.1. Lie detection methodologies: beliefs about verbal and non verbal cues to deception

Commonly, we think it is possible to easily identify deception, we think that liars usually exhibit some signal that they are lying: they advert their gaze, move their hands and fingers, show nervousness, verbal and vocal uncertainty.

According to Zuccherman, De Paulo and Rosenthal (1981), three factors could influence the presence of cues to deception: (i) emotional reactions, due to experiencing negative emotions or excitement; (ii) cognitive effort, due to the cognitive demand of formulating a lie, suppressing the truth and remembering earlier statements; (iii) and the attempt of monitoring the interviewer's behavior. It seems that those behaviors that are the most difficult to control allow the identification of the lie (Ekman & Friesen, 1974). However, the previously described factors may lead to opposite behaviors. Arousal typically leads to an increase in eye blinks, whereas cognitive load to a decrease in it. The emotional and cognitive effort results in an increase in speech hesitations, errors and nervousness, but the attempt to control one's behavior and speech disturbances should make one sound flat.

Fabricating a convincing lie may be difficult and, as a result, verbal cues may occur. Some researchers have examined the extent to which truth tellers and liars can be correctly classified on the basis of individual verbal cues, resulting in successful classifications in 67 to 80% of the cases (Vrij, 2010). For example, consistently with the *motivational impairment effect* [1], in their study De Paulo and Kirkendol (1989) found that highly motivated liars give shorter answers than highly motivated truth tellers, whereas no difference emerged for not-motivated participants. Also, liars who had some time to prepare themselves tended to talk less than truth tellers who had some preparation time, whereas no difference was found with a short preparation time. In addition, people can not control their

[1] The *motivational impairment effect* (De Paulo & Kirkendol, 1989): the more liars are motivated in avoiding getting caught, the more likely is the presence of cue to lies.

speech if they don't notice changes in it. They can be aware of what they are conveying, but less aware of their exact wording.

The idea that liars show nonverbal cues associated with nervousness is prominent in the popular media and, strikingly, in police manuals (Vrij & Granhag, 2007) but in deception literature it is not possible to find a single behavior emerging as a diagnostic cue to deceit.

Unfortunately, once incorrect beliefs have been established they are difficult to reject. People perceive supporting evidence that in fact doesn't exist (Levine, Asada, & Park, 2006), tend to seek information than confirms their beliefs (the *confirmation bias*, Darley & Gross, 1983), and disregard examples that disconfirm them (the *belief perseverance*, Anderson, Lepper, & Ross, 1980).

The best way to counteract these beliefs is becoming more comfortable with uncertainty. Knowing that lies commonly occur in so many contexts, we should employ a *falsehood bias* (Feldman, 2010): maintaining the awareness that everything we are told could be a lie and searching for factual evidence if we care enough about a piece of information.

Analyzing tens of thousands individual performances, Charles Bond and Bella De Paulo (Bond & De Paulo, 2006) found that people can differentiate truth from lies only 47% of the time. Moreover, many studies investigated the idea that it is easier to do so with friends, family and romantic partners than with strangers. In most of the studies, indeed, accuracy rates between 49 and 59% were obtained (Vrij, 2010). But how reliable are professional lie catchers? Their performances with strangers resulted in an average total accuracy rate of 55,91% (Vrij, 2010), only slightly better than non-professionals.

Lie detection without using specialized «techniques» doesn't seem, therefore, to be reliable.

6.2. Lie detection «techniques»

Veracity assessment techniques used by professional lie catchers and scientists can be classified into three major categories: (i) techniques that examines behavioral cues to deception, (ii) techniques that are used to analyze speech content, and (iii) techniques that examine people's physiological responses or brain activity.

6.2.1. *The Behavior Analysis Interview*

Behavior Analysis Interview (BAI) (Inbau, Reid, Buckley, & Jayne, 2004) is believed to be one of the two most commonly taught questioning methods in the United States (Colwell, Miller, Lyons, & Miller, 2006) and can be useful for screening purposes in order to establish when it is worth further interrogating a suspect. This interview includes the presence of open-ended questions asking the description of the suspects' activities during a specific period of time and a series

of standardized questions. Truth tellers and liars are thought to respond differently to questions. Crossing legs, shifting about in the chair or performing anxiety-reducing behaviors are examples of non-verbal responses that guilty subjects resulted more likely to exhibit. Regarding verbal responses, suspects are thought to be more evasive about their activities, less immediate in their denial of having committed a crime and so on. A field study was conducted by Horvath *et al.* (1994) to empirically test the BAI protocol, resulting in evaluators achieving a total accuracy rate of 86%. Despite this impressive rate, the study has two important limits: a very small sample of highly trained and experienced administrators and evaluators and a poor definition of ground truth. Indeed, criteria to establish ground truth were confessions and a «systematic factual analysis» in which evaluators looked at factors such as biographical information, opportunity/access and motivation.

Nevertheless, the available laboratory and field studies where the ground truth was clearly established reveal that truth tellers display more signs of discomfort and appear less helpful than liars, as a result investigators may base their impressions on the outcome of the BAI interview submitting an innocent suspect to a persuasive interrogation and leading them to false confessions (Vrij, 2010).

6.2.2. *Statement Validity Assessment*

Statement Validity Assessment (SVA) has been designed to determine the credibility of child witnesses' testimonies in trials for sexual offences and is accepted as evidence in criminal courts in several West European countries and in some North American courts (Vrij, 2010). The four stages of this tool are: a case-file analysis, a semi-structured interview, the Criteria-Based Content Analysis (CBCA) and the Validity Checklist, and an evaluation of the CBCA outcome.

The CBCA, a list of 19 criteria, is the core phase of the SVA. It is based on the hypothesis that a statement based from memory of an actual experience differs in content and quality from a statement based on invention or fantasy (Steller, 1989). Each of the 19 criteria is thought to be more likely to occur in truthful than in deceptive statements. In an attempt to validate CBCA, two types of studies have been conducted: field studies, in which statements made by interviewees in actual cases of alleged sexual abuse were examined; and laboratory studies, in which statements of participants who lied or told the truth were assessed.

The accuracy of CBCA in real-life investigations is unknown since the ground truth has not been established in many field studies, while the known error rate in the laboratory studies reached 30%. Such outcomes do not meet the *Daubert* [2] guidelines for admitting expert scientific evidence in criminal courts.

[2] Daubert criteria for establishing the validity of a scientific methodology: (1) empirical testing (the theory or technique must be falsifiable, refutable, and testable); (2) subjected to peer review and publication; (3) known or potential error rate; (4) the existence and maintenance of standards and controls concerning its operation. Degree to which the theory and technique is generally accepted by a relevant scientific community.

The Validity Checklist research has concentrated on the impact of three issues on CBCA scores, demonstrating that total CBCA scores are age dependent, related to the interviewer's style and subject to countermeasures (coaching of the interviewee). In addition, research into the use of Validity Checklist in real-life cases are rare.

Because truths and lies can be detected above the level of chance with CBCA in a variety of setting, professional lie catchers could use SVA assessment in their investigations, if adequately trained. Despite this, allowing SVA as evidence in criminal courts, requires that problems and limitations associated with the assessment must be presented (Vrij, 2010).

6.2.3. *Reality Monitoring*

Reality Monitoring (RM) investigates the difference between memory characteristics of actually experienced events and imagined events, basing on the assumption that they differ in quality. Memories of real experiences are obtained through perceptual processes, thus are likely to contain sensory, contextual and affective information, whilst memories about imagined events are likely to contain cognitive operations (Johnson & Raye, 1981). To test people's memory for events, Johnson and colleagues developed a 39-item Memory Characteristics Questionnaire (MCQ).

From 1990 scientists have examined whether RM analyses could be used as a lie detection tool. A review of the literature revealed an average total accuracy rate of 68,80% (Vrij, 2010), demonstrating that RM can detect truths and lies above chance level. Moreover, it can be used in combination with CBCA. Research also showed restrictions and limitations in the use of RM as a lie detection tool. The restrictions are that it cannot be used with young children and probably cannot be employed when people talk about events that happened a long time ago, because differences between experienced and imagined events decrease as a function of time (Johnson, 1988). One limitation is that the RM criteria are poorly defined in deception research. Memory Characteristics Questionnaire may have potential to distinguish truth from false memories, but more research into this issue is needed.

6.2.4. *Scientific Content Analysis*

Scientific Content Analysis (SCAN) is being used worldwide by federal, law enforcement and military agencies, but, to date, little research has been carried out with it.

The underlying assumption is that a statement derived from memory of an actual event differs in content and quality from a statement based on imagined events (Smith, 2001). Written statements are used for SCAN analyses. Examinees are requested to write down their activities during a certain period of time in

enough detail either during the interview (Adams, 1996), or prior to the interview by filling out a questionnaire (Sapir, 1987, 2000). The investigator is not present when the examinee fills out his questionnaire and could then decide whether he is likely to be lying or could further discuss in a subsequent interview with him the elements that raised suspicion.

Only a few studies examining the SCAN technique have been published. Two of them found that many truth tellers and liars could be correctly classified with the method, but in both the ground truth could not be established. Other studies, mainly CBCA researches, revealed that some SCAN criteria did not differentiate between truth tellers and liars in the way predicted by SCAN (Vrij, 2010). As a result, SCAN can be seen as an interview guidance tool bringing structure to the interview, but there is no guarantee that its outcomes are a safeguard for innocent suspects, and research needs to demonstrate that there is overlap in different investigators' use of the method.

6.2.5. *The polygraph*

The polygraph is a scientific measuring device that can display, via ink pens on to charts or via computer's visual display unit, a direct and valid representation of various types of bodily activity (Bull, 1988). It records changes in electrodermal activity (EDA), blood pressure and respiration, etc.

Polygraph examiners use different questionnaires; they assume that truth tellers and liars respond differently to different types of questions. One of the psychological premises is that the heightened physiological responses displayed by examinees during «key-target» questions are the result of increased concern and anxiety.

The three concern-based polygraph tests that are currently used are: the Relevant-Irrelevant Test (RIT), the Control Question Test (CQT) and the Directed Lie Test (DLT).

The rationale behind the RIT is that the observed physiological responses are caused by anxiety (Raskin & Honts, 2002). Therefore, larger responses to the crime-relevant questions than to the crime-irrelevant questions are interpreted as signs of lying to the crime-relevant questions. The problem with this type of test is that the crime-irrelevant questions do not provide an adequate control for the emotional impact the crime-relevant questions can have on examinees (Iacono, 2000). There is agreement amongst proponents and critics of concern-based polygraph that the RIT should not be used (Honts, 1991; Lykken, 1998; Raskin & Honts, 2002).

In the Control Question Test an attempt is made to control for intrapersonal differences by introducing comparison questions (e.g. probable lie questions: Did you ever lie to your parents?) that are an adequate control for the emotional impact the crime-relevant questions may have on examinees.

The use of the CQT is controversial. There are five main points of criticism: the weak theoretical foundation; the lack of incorporation of psychological know-

ledge in the protocol; the lack of standardization in either conducting the test and scoring the charts; the vulnerability and illegality of using deceptive procedures and vulnerability to countermeasures (Vrij, 2010).

The DLT has been an attempt to standardize the CQT: probable lie questions were substituted by directed-lie questions that are standardized and can be asked in all situations. Guilty suspects are thought to be mostly concerned with the relevant questions, while innocent suspects are thought to be most concerned with the directed lie questions. However, this procedure does not address any of the other criticisms related to the CQT.

6.2.6. *Voice Stress Analysis*

The basic assumption of Voice Stress Analysis (VSA) is that liars experience more psychological stress than truth tellers. This would result in minor changes in the blood circulation, which subsequently influences various characteristics of the voice (Gamer, Rill, Vossel, & Godert, 2006). Therefore, Voice Stress Analysers use the microphones attached to computers to detect and display voice indices.

This tool has severe limitations: it may detect truths and lies inaccurately, there is no attempt to control for intrapersonal and interpersonal differences, and a CQT cannot be administered if VSA has to be carried out covertly.

6.2.7. *Thermal imaging*

Thermal imaging detects changes in temperature patterns (and thus blood flow) around the eyes via special cameras. The assumption behind this technique is that liars will show instantaneous warming around the eyes as part of a fight-or-flight response. One thermal imaging lie detection study in particular has attracted media attention (Pavlidis, Eberhardt, & Levine, 2002), because, according to its claims, thermal imaging seemed to have potential application in remote and rapid screening, such as airport screening. Unfortunately, not all potential terrorists would fail and all honest passengers would pass the test. No attempts were made to control for interpersonal and intrapersonal differences and the National Research Council (2003, p. 157) concluded against the use of facial thermography for lie detection.

6.2.8. *The orienting reflex approach*

The orienting reflex occurs when someone is confronted with a personally significant stimulus that attracts his/her attention. The Guilty Knowledge Test (GKT, also known as the Concealed Information Test) is a polygraph test based on the orienting response. In a typical GKT examination, examinees while undergoing the polygraph testing are shown a series of stimuli, including a salient one, related

to the crime. For each presentation the examinee is asked whether he or she recognizes a stimulus and is instructed to always answer «No». When the stimulus related to crime is shown the subject can easily recognize it. Thus, producing an orienting reflex (e.g. higher heart rate).

This tool has some criticism: lack of applicability, theoretical concerns, difficulty in formulating proper questions, leakage of GKT items and vulnerability to countermeasures. The known error rate in laboratory and field studies is acceptable for innocent examinees (respectively, less than 6% and between 2 to 6%), but high for guilty examinees (12 to 24% and 24 to 58%) (Vrij, 2010).

These error rates do not meet the *Daubert* guidelines for admitting expert scientific evidence in criminal courts.

6.2.9. *Event-related potentials: the P300 brain wave*

Event-related potentials are brain waves that are recorded via electroencephalograms (EEGs) (Rosenfeld, 2002). Several laboratory studies used P300 brain waves to detect deception because it occurs in response to personally significant stimuli, resulting in accuracy rates of 51 to 100% for guilty participants, and 72 to 100% for innocent participants (National Research Council, 2003). Unfortunately, using P300 instead of traditional GKT polygraph examinations does not solve any of the problems emerged.

6.2.10. *Functional Magnetic Resonance Imaging*

Activity in brain areas is associated with changes in blood flow and oxygen consumption that can be measured with a functional magnetic resonance imaging scanner.

Functional Magnetic Resonance Imaging (fMRI) lie detection publications (Vrij, 2010) are laboratory studies that provide detailed information about the structures and areas of the brain that were activated when lying. Despite some similarities in the findings, there were considerable differences, indicating that a pattern uniquely related to deception does not exist in the brain (Abe *et al.*, 2006). Moreover, telling spontaneous lies resulted in different brain activity than telling rehearsed lies, and the stakes of being caught in influencing brain structure and area activity (Ganis *et al.*, 2003).

In general terms, deception activates higher centers of the brain, suggesting that people find it somehow more difficult to lie than to tell the truth. Despite this, interpersonal and intrapersonal differences were found and research has not yet shown that the fMRI technique does produce more accurate results than traditional polygraph testing (Vrij, 2010).

6.3. A NEW METHOD FOR IDENTIFYING AUTOBIOGRAPHICAL EVENTS

As highlighted in the previous section, there is not a unique tool or technique that can help to spot liars and lies with 100% accuracy, for this reason there is a growing literature on new lie detection methods. A new technique uses implicit associations in order to identify a true memory.

The Implicit Association Test (IAT) (Greenwald *et al.*, 1998) is at present one of the most used instruments, in psychology, to measure automatic implicit associations. In accord to Greenwald (Greenwald *et al.*, 1998) the IAT measures the association strength between two concepts and a bipolar attribute. Participants have to classify stimuli, as fast as possible, in four different categories: two target concept categories (e.g. insects vs. flowers) and two attribute categories (pleasant vs. unpleasant) using two keys, one on the right and one on the left of the keyboard. In one block, two categories (one from the target concept and one from the attribute dimension) are mapped on the same response key (e.g. flowers and positive with the same key vs. insects and negative with the other key). In a reversed combined task participants have to classify the same four categories reversely paired (e.g. flowers and negative with a key vs. insects and positive with the other key), so that both target concept categories are paired with both attribute categories. The IAT effect is expressed as the difference between these two combined tasks: in the task where two associated concepts require the same motor response, reaction times (RTs) will be slower than in the task where the same two concepts require different motor responses. Thus, the IAT assumes that strong associated concept-attribute pairs (e.g. flowers and positive/congruent block) should be easier to categorize than weakly associated concept-attribute pairs (e.g. insects and positive/incongruent block). The IAT has been extensively studied in the social field to assess implicit beliefs, attitudes and prejudices, to measure self-esteem and self-concept (Nosek, Greenwald, & Banaji, 2007).

The use of the IAT (Greenwald *et al.*, 1998) could provide an important step forward for identifying lies when used in the forensic setting. For instance, Gray and colleagues elegantly illustrated how the IAT can be fruitfully applied in a forensic setting to psychopaths and pedophiles (Gray, Brown, MacCulloc, Smith, & Snowden, 2005; Gray, MacCulloch, Smith, Morris, & Snowden, 2003). They showed that it could correctly identify implicit beliefs in psychopathic murderers as well as pedophilic attitudes.

An adaptation of the IAT, which has the potential to be used in forensic setting is the Timed Antagonistic Response Alethiometer (TARA) (Gregg, 2007). By means of response incongruity, TARA may be used to classify the respondent as a truth-teller or a liar on the basis of a speeded classification task of sentences.

The autobiographical Implicit Association Test (aIAT) (Sartori, Agosta, Zogmaister, Ferrara, & Castiello, 2008) is a variant of the IAT (Greenwald, Mc Ghee, & Schwartz, 1998) that might be used to establish whether an autobiographical memory trace is encoded in the respondent's mind/brain. The aIAT is a reliable method, validated in both forensic and clinical settings (Sartori *et al.*, 2008; Sartori, Agosta, & Gnoato, 2007), which has the ability to reveal factual knowledge

regarding autobiographical events that are presented in a verbal format. More specifically, with the aIAT it is possible to evaluate which of two autobiographical events is true.

The aIAT differs, for example, from the standard race IAT as the evaluative dimension (Good/Bad) is substituted by a logical dimension (True/False) which is represented by items describing certainly true (e.g. I am sitting in front of a computer) and certainly false sentences (e.g. I am climbing a mountain). Furthermore stimuli are sentences describing events rather than single words or pictures.

The aIAT, as any IAT, includes stimuli belonging to four categories. Two of them are logical categories and are represented by sentences, which are always true (e.g. I am in front of a computer) or always false for the respondent (e.g. I am climbing a mountain). Two other categories are represented by alternative versions of an autobiographical event (e.g. I went to Paris for Christmas or I went to New York for Christmas) only one of the two being true. The true autobiographical event is identified because in a combined task it gives rise to faster RTs when it shares the same motor response with true sentences. The aIAT/IAT effect is expressed in terms of difference between the two double categorization blocks: the congruent block (pairing the two associated categories) and the incongruent block (pairing the non associated categories).

Used as a memory detection technique the aIAT has a number of unique features when compared to traditional psychophysiological techniques of lie detection (e.g. Ben-Shakhar, & Elaad, 2003) or more recent fMRI based lie detection strategies (e.g. Langleben, Loughead, Bilker, Ruparel, Childress, Busch, & Gur, 2005). For instance, it can be administered quickly (10-15 minutes), it is based on an unmanned analysis (no training for the user is necessary), it requires low-tech equipment (a standard PC is sufficient) and it can be administered remotely to many participants (e.g. via web).

6.3.1. *Description of the technique*

The autobiographical IAT consists of five separate blocks of categorization trials. In each trial, a sentence describing a potentially autobiographical event is presented at the center of a computer monitor. Subjects have to classify each stimulus as fast and accurately as possible by pressing one of two response keys. Reminder labels in the form of category names remain on the monitor for the entire duration of each block and an error signal appears after an incorrect response.

An example of IAT items is presented in Figure 1.

An example of aIAT method is now presented. The following experiment was designed to verify the applicability of aIAT in identifying which one of two cards the participant had previously chosen (Sartori *et al.*, 2008).

In block 1, certainly true and false sentences referring to the time of the test are presented. Subjects have to press the «A» key when a true sentence appears (e.g. I'm in front of a computer) and the «L» key when a false one does (e.g. I'm in front of a television). In the second block, sentences refer to the event under investigation.

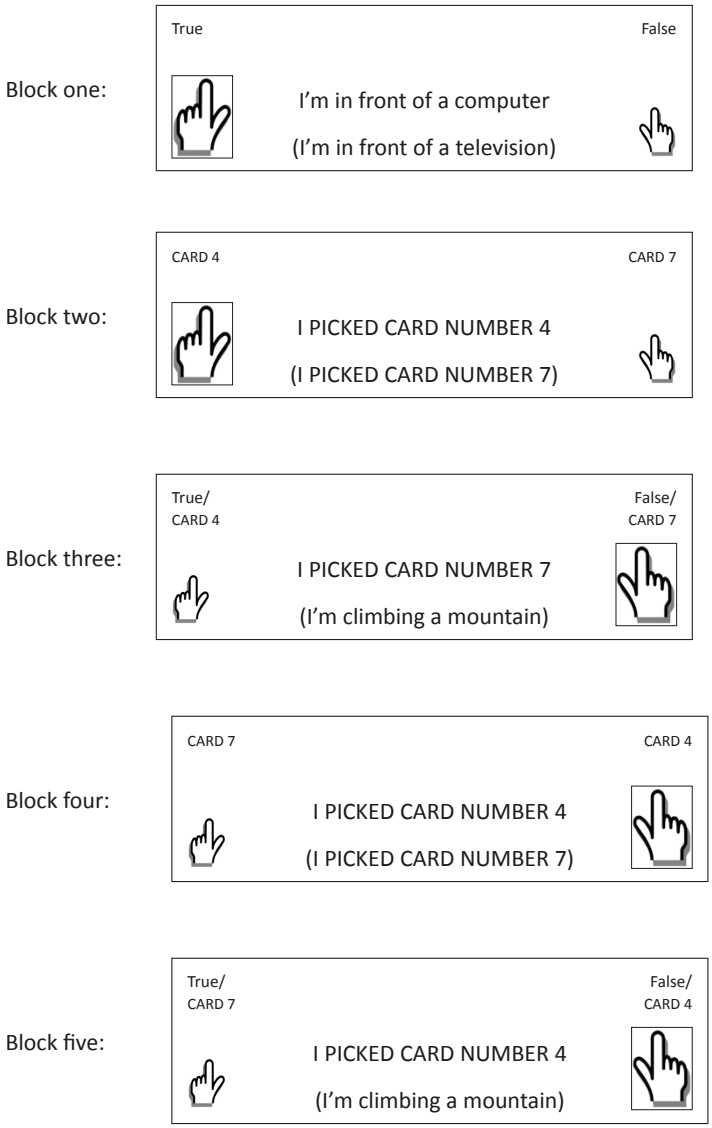

Figure 1.

The figure shows the structure of the aIAT. The aIAT is divided in 5 blocks; each one requires the classification of sentences (in the form of descriptions of autobiographical events) in two/four different categories using only two keys of the keyboard. Certainly true and false sentences, referring to the experiment, are mixed with autobiographical sentences referring to the event under investigation (e.g. having picked a card, either 4 or 7). In the two combined blocks (third and fifth) certainly true sentences are associated once with the true autobiographical event (e.g. CARD 4, for card 4 choosers and CARD 7 for those participants who choose card 7) and once with the false autobiographical event (CARD 7 for those who choose card 4 and CARD 4 for the group who choose card 7). The analysis of RTs revealed facilitation when certainly true sentences are associated with true autobiographical event sentences.

Back to the example, the «A» key corresponds to the category «CARD 4» and the «L» key to the category «CARD 7». Participants had to press the «A» key when a sentences describing having chosen card 4, in case a sentence describing having chosen card 7 appeared, they would have to press the «L» key (congruent block for those participants who actually choose card 4 and incongruent block for those subjects who choose card 7).

Third block is one of the two double-categorization blocks. True sentences and sentences describing having picked «CARD 4» were classified with the «A» key, whilst «L» key categorizes false sentences and sentences belonging to the category «CARD 7».

In block four, stimuli are the same as in second block, but response keys are reversed.

Fifth block is the second double-categorization block. Stimuli are the same as in third block but response keys are differently assigned: participants had to press the «A» key when true sentences and sentences referring to the category «CARD 7» appear, and they have to press the «L» key when false sentence and sentences referring to category «CARD 4» appear (congruent block card 7 choosers and incongruent block for card 4 choosers).

Reaction Times (RTs) in the congruent block are expected to be faster than reaction times in the incongruent block, this facilitation is due to the strict relation of the two associated categories (certainly true sentences and true autobiographical sentences).

6.3.2. *Applications*

The aIAT has investigative, clinical and forensic applications (Sartori, Agosta, & Gnoato, 2007). Indeed, experiments were conducted where aIAT examined drug abuse, driving under the effect of alcohol and mock crime (Sartori *et al.*, 2008). Moreover, it can be applied as a memory detection technique in court cases.

6.3.3. *Rules for a correct implementation of the test*

A recent study (Agosta, Mega, & Sartori, 2010) examined the effect of using negative sentences in the aIAT. It emerged that test accuracy is significantly reduced when using negative sentences or labels. Negative and false sentences are assumed to have higher saliency. Thus, the salience effect may be stronger than the association effect when negatives are used, leading to unreliable results and, consequently, to an enhanced classification of innocent subjects as guilty.

Another precaution must also be taken into account. A study conducted with trained participants (Agosta, Ghirardi, Zogmaister, Castiello, & Sartori, 2010), demonstrated that the IAT effect can be reduced when respondents are given the chance to practice in the classification task. Practice effect must therefore be prevented.

6.3.4. *Neural basis of the aIAT*

A study conducted by Agosta, Castiello, Rigoni, Lionetti and Sartori (2011), for the validation of the autobiographical IAT in investigating prior intentions [3], showed that P300 brain wave amplitude is reduced when the subject is performing the incongruent block.

Twenty-five participants were examined. Before attending the experiment, they answered a questionnaire aimed at investigating their prior intentions towards the upcoming night (sleeping in Padua or in Milan). An autobiographical IAT was created for all subjects and 16 of them, who showed a clear association between intention and true sentences, took part in the second phase of the study. Two components were analyzed in the event-related potentials analysis: a LPC (Late Positive Component, P300) is recorded on the parietal lobe with a latency of 300 milliseconds from the stimulus onset and corresponds to the deep elaboration of the information. This component presented decreased amplitude when sentences referring to the intention were paired with false ones (incongruent condition).

N400, a negative brain wave, was recorded 400 msec after the stimulus onset and has its amplitude peak on the parietal lobe. This brain wave is related to semantic congruency (Sartori *et al.*, 2005) and reflects the discrimination between true and false sentences, rather than between intentions and non-intentions.

6.4. Conclusions

In this chapter we have focused on deception and in particular on deception detection, describing the mechanisms and tools that have been studied and invented in order to identify liars and lies. An incredible amount of literature, on this topic, is growing and further researches are needed.

The debates over the use of lie-detection technologies in the courtroom are becoming more and more heated. In the future, lie detectors will become more accurate and correspondingly more intrusive.

If these lie detection technologies will be admitted in court, they will raise a number of questions of self-incrimination and privacy. In fact, prosecution and defense witnesses might have their credibility questioned if they refuse to take a lie detection test. Witnesses could also be compelled to have their brain scanned while undergoing a guilty knowledge test (GKT).

To the extreme point that lie detection and memory detection technologies could also pose a serious challenge to our freedom of thought: they open up the possibility of punishing people for what they think and not for what they do.

[3] Prior intention: mental representations that appear in the mind of the agent before the action (Searle, 1983).

Will it be possible to make specific prediction about people's behavior? And if this were possible, would it be ethical to use these technologies to make us safer? In this respect lie detection technologies could even jeopardize people for acts that they haven't committed, but predicting violent tendencies and marking someone to further surveillance might be appropriate in certain situations (Canli & Amin, 2002).

As the new lie-detection technologies grow and improve, lawyers, neuroscientists and experts should be prepared for facing the underling question we started to pose in this chapter.

References

Abe, N., Suzuki, M., Tsukiura, T., Mori, E., Yamaguchi, K., Itoh, M., & Fujii, T. (2006). Dissociable roles of prefrontal and anterior cingulated cortices in reception. *Cerebral Cortex*, *16*, 192-199.

Adams, S. H. (1996). Statement analysis: What do suspects' words really reveal? *FBI Law Enforcement Bulletin*, October, 12-20.

Agosta, S., Ghirardi, V., Zogmaister, C., Castiello, U., & Sartori, G. (2011). Detecting fakers of the autobiographical IAT. *Applied Cognitive Psychology*, *25*, 299-306.

Agosta, S., Mega, A., & Sartori, G. (2011). Detrimental effects of using negative sentences in the autobiographical aIAT. *Acta Psychologica*, *136*, 269-275.

Anderson, C. A., Lepper, M. R., & Ross, L. (1980). Perseverance of social theories: The role of explanation in the persistence of discredited information. *Journal of Personality and Social Psychology*, *39*, 1037-1049.

Augustine, S. (1948). De mendacio. In *Opuscules* (Vol. 2: *Problemes moraux*, pp. 244-245). Paris: de Brouwer.

Ben-Shakhar, G., & Elaad, E. (2003). The validity of psychophysiological detection of information with the Guilty Knowledge Test: A meta-analytic review. *Journal of Applied Psychology*, *88*, 131-151.

Bond, C. F. Jr., & De Paulo, B. M. (2006). Accuracy of deception judgements. *Personality and Social Psychology Review*, *10*, 214-234.

Bull, R. (1988). What is the lie detection test? In A. Gale (Ed.), *The polygraph test: Lies, truth and science* (pp. 10-19). London: Sage.

Byrne, R. W. (1996). Machiavellian intelligence. *Evolutionary Anthropology*, *10*, 172-179.

Byrne, R. W., & Corp, N. (2004). Neocortex size predicts deception rate in primates. *Proceedings of the Royal Society*, *271*, 1693-1699.

Collwell, L. H., Miller, H. A., Lyons, P. M., & Miller, R. S. (2006). The training of law enforcement officers in detecting deception: A survey of current practices and suggestions for improving accuracy. *Police Quarterly*, *9*, 275-290.

Darley, J. M., & Gross, P. H. (1983). A hypothesis-confirming bias in labeling effects. *Journal of Personality and Social Psychology*, *44*, 20-33.

Ekman, P., & Friesen, W. V. (1974). Detecting deception from the body or face. *Journal of Personality and Social Psychology*, *29*, 288-298.

Feldman, R. S. (2010). *Liar: The truth about lying*. London: Virgin Books.

Gamer, M., Rill, H. G., Vossel, G., & Godert, H. W. (2006). Psychophysiological and vocal measures in the detection of guilty knowledge. *International Journal of Primatology*, *2*, 237-248.

Ganis, G., Kosslyn, S. M., Stose, S., Thompson, W. L., & Yurgelun-Todd, D. A. (2003). Neural correlates of different types of deception: An fMRI investigation. *Cerebral Cortex*, *13*, 830-836.

Gray, N. S., Brown, A. S., Mac Culloch, M. G., Smith, J., & Snowden, R. J. (2005). An Implicit Test of the Associations between children and sex in pedophiles. *Journal of Abnormal Psychology*, *114*, 304.

Gray, N. S., Mac Culloch, M. G., Smith, J., Morris, M., & Snowden, R. J. (2003). Violence viewed by psychopathic murderers. *Nature*, *423*(29), 497-498.

Gregg, A. I. (2007). When vying reveals lying: The timed antagonistic response alethiometer. *Applied Cognitive Psychology*, *21*, 621-647.

Greenwald, A. G., McGhee, D. E., & Schwarz, J. L. K. (1998). Measuring individual differences in implicit cognition: The Implicit Association Test. *Journal of Personality and Social Psychology*, *74*, 1464-1480.

Greenwald, A. G., Nosek, B. A., & Banaji, M. R. (2003). Understanding and using the Implicit Association Test: I. An improved scoring algorithm. *Journal of Personality and Social Psychology*, *85*(2), 197-216.

Honts, C. R. (1991). The emperor's new clothes: The application of the polygraph tests in the American workplace. *Forensic Reports*, *4*, 91-116.

Horvath, F., Jayne, B., & Buckley, J. (1994). Differentiation of truthful and deceptive criminal suspects in behavioral analysis interviews. *Journal of Forensic Sciences*, *39*, 793-807.

Iacono, W. G. (2000). The detection of deception. In J. T. Cacioppo, L. G. Tassinary, & G. G. Berntson (Eds.), *Handbook of psychophysiology* (2nd ed., pp. 772-793). Cambridge, UK: Cambridge University Press.

Inbau, F. E., Reid, J. E., Buckley, J. P., & Jayne, B. C. (2004). *Criminal interrogation and confessions*. Sudbury, MA: Jones and Barnett Learning.

Johnson, M. K. (1988). Reality Monitoring: An experimental phenomenological approach. *Journal of Experimental Psychology: General*, *117*, 390-394.

Johnons, M. K., & Raye, C. L. (1981). Reality Monitoring. *Psychological Review*, *88*, 67-85.

Johnson, R. Jr., Barnhardt, J., & Zhu, J. (2003). The deceptive response: Effects of response conflict and strategic monitoring on the Late Positive Component and episodic memory-related brain activity. *Biological Psychology*, *64*, 217-253.

LaFreniere, J. P. (1988). The ontogeny of tactical deception in humans. In W. R. Byrne & A. Whiten (Eds.), *Machiavellian intelligence: Social expertise and the evolution of intellect in monkeys, apes, and humans* (pp. 238-252). New York: Clarendon Press - Oxford University Press.

Levine, T. R., Asada, K. J. K., & Park, H. S. (2006). The lying chicken and the gaze avoidant egg: Eye contact, deception and causal order. *Southern Journal of Communication*, *4*, 401-411.

Lykken, D. T. (1998). *A tremor in the blood: Uses and abuses of the lie detector*. New York: Plenum Press.

National Research Council (2003). *The polygraph and lie detection*. Committee to Review the Scientific Evidence on the Polygraph. Washington, DC: The National Academic Press.

Pavlidis, J., Eberhardt, N. L., & Levine, J. A. (2002). Seeing through the face of deception. *Nature*, *415*, 35.

Raskin, D. C., & Honts, C. R. (2002). The comparison question test. In M. Kleiner (Ed.), *Handbook of polygraph testing* (pp. 1-47). San Diego, CA: Academic Press.

Rosenfeld, J. P. (2002). Event-related potential in the detection of deception, malingering, and false memories. In M. Kleiner (Ed.), *Handbook of polygraph testing* (pp. 265-286). San Diego, CA: Academic Press.

Sapir, A. (1987/2000). *The LSI course on Scientific Contest Analysis (SCAN)*. Phoenix, AZ: Laboratory for Scientific Interrogation.

Sartori, G., Agosta, S., & Gnoato, F. (2007). *High accuracy detection of malingered whiplash syndrome*. Paper presented at the International Whiplash Trauma Congress, Miami (Florida).

Sartori, G., Agosta, S., Zogmaister, C., Ferrara, S. D., & Castiello, U. (2008). How to accurately detect autobiographical events. *Psychological Science*, *19*, 772-780.

Smith, N. (2001). *Reading between the lines: An evaluation of the Scientific Content Analysis technique (SCAN)*. Police research series Paper 135. London, UK, Home Office, Research, Development and Statistic Directorate.

Steller, M. (1989). Recent developments in statement analysis. In J. C. Yuille, *Credibility assessment* (pp. 135-154). Boston, MA: Kluwer.

Vrij, A. (2007). Deception: A social lubricant and a selfish act. In K. Fiedler (Ed.), *Frontiers of social psychology: Social Communication* (pp. 309-342). New York: Psychology Press.

Vrij, A., & Granhag, P. A. (2007). Interviewing to detect deception. In S. A. Christianson (Ed.), *Offenders' memories of violent crimes* (pp. 279-304). Chichester, UK: John Wiley & Sons.

Zuckerman, M., De Paulo, B. M., & Rosenthal, R. (1981). Verbal and nonverbal communication of deception. *Advances in Experimental Social Psychology*, *14*, 1-57.