Universidade de Aveiro Departamento de Educação e Psicologia
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BEATRIZ MORAIS MELO DE OLIVEIRA

ESTUDO DA EFICÁCIA DE NOVAS TÉCNICAS DE DETEÇÃO DO ENGANO

STUDY OF THE EFFICACY OF NEW TOOLS FOR DETECTING DECEIT

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Tese apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Doutor em Psicologia, realizada sob a orientação científica da Doutora Isabel Maria Barbas dos Santos, Professora Auxiliar do Departamento de Educação e Psicologia da Universidade de Aveiro, e coorientação do Doutor Aldert Vrij, Professor de Psicologia Social Aplicada do Departamento de Psicologia da Universidade de Portsmouth, Reino Unido, e do Professor Carlos Fernandes da Silva, Professor Catedrático do Departamento de Educação e Psicologia da Universidade de Aveiro

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Para a minha família.

o júri

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palavras-chave

Deteção da mentira, carga cognitiva, pistas do discurso, codificação verbal, viés de observação, estereótipos de mentira, ansiedade social.

resumo

Várias teorias e técnicas têm sido desenvolvidas e testadas para melhorar a deteção do engano. Iniciamos esta tese com uma revisão geral da literatura existente sobre deteção de mentiras, onde são abordadas as razões pelas quais as pessoas mentem, bem como possíveis explicações para a dificuldade destes processos. De seguida discutimos técnicas multidisciplinares de deteção de mentiras baseadas em pistas verbais, não-verbais e psicofisiológicas. Terminamos o Capítulo 1 com uma revisão mais ampla sobre técnicas de deteção de mentiras baseadas numa abordagem cognitiva, uma vez que mentir é geralmente mais exigente cognitivamente do que dizer a verdade. Investigadores têm desenvolvido ferramentas de deteção de mentiras que ampliem as diferenças entre mentirosos e inocentes, manipulando o seu estado mental. Uma vez que os mentirosos já estão numa posição vulnerável devido a estarem a mentir, uma tarefa que aumente sua carga mental pode resultar em mais pistas de esforço cognitivo nos mentirosos do que nos inocentes. Estas teorias foram o ponto de partida para os estudos empíricos descritos nos Capítulos 2, 3 e 4, que visaram superar alguns dos problemas que dificultam a deteção de mentiras. O Capítulo 2 descreve um estudo em que uma Tarefa de Stroop Emocional Computadorizada (TSEC) foi usada como tarefa secundária para impor carga cognitiva. A TSEC teve por base os reflexos orientados que os culpados parecem experimentar perante informações críticas que reconhecem. Diferenças entre mentirosos e inocentes emergiram em algumas pistas de discurso, independentemente da condição (entrevista de recolha de informação ou entrevista de recolha de informação e TSEC). Os resultados também sugerem que a TSEC impôs níveis semelhantes de carga cognitiva em mentirosos e inocentes. É sugerido que os investigadores tenham cuidado com o método usado para aumentar a carga cognitiva, pois este pode afetar todos os entrevistados. O Capítulo 3 consiste num estudo com elementos da Guarda Nacional Republicana (GNR) cuja tarefa foi avaliar a veracidade de depoimentos do estudo do Capítulo 2. Neste estudo, analisámos a taxa de acerto dos elementos da GNR na discriminação de mentirosos e inocentes em ambas as condições de entrevista, bem como aquilo em que se basearam para julgar. Os resultados sugerem que os observadores tendem a fazer julgamentos de veracidade baseados em estados emocionais, como nervosismo, o que pode explicar a baixa taxa de acerto obtida. O estudo do Capítulo 4 analisou os efeitos da ansiedade social como diferença interpessoal nas pistas exibidas durante entrevistas de deteção de mentiras. Os entrevistados, com diferentes níveis de ansiedade social, mentiram ou não, e os resultados mostraram diferenças, sugerindo que os profissionais devem avaliar a ansiedade social antes de realizar estas entrevistas. Finalmente, no Capítulo 5 revemos os estudos, salientando as suas principais conclusões e impacto na prática. Discutimos ainda algumas limitações dos estudos de deteção de mentiras, apresentando sugestões para melhorá-los, bem como linhas de investigação promissoras para o futuro.

keywords

Lie detection, cognitive load, speech cues, verbal coding, observation bias, lying stereotypes, social anxiety.

abstract

Detecting deceit is still a difficult task, despite researchers' efforts to improve lie detection techniques. Several theories and techniques have been developed and tested. We begin this thesis with a general literature review of lie detection research, where the reasons to why people lie are outlined, as well as possible explanations to the difficulty of the lie detection processes. Then, we discuss multidisciplinary lie detection techniques based on verbal, non-verbal and psychophysiological cues. We end Chapter 1 with a more extensive review on cognitive-based lie detection techniques since multiple research suggests that lying is mentally more taxing than telling the truth. Scholars have been working on lie detection tools that can magnify the differences between liars and truth tellers by manipulating their mental state. Because liars are already in a vulnerable position due to lying, a request that increases their mental load may result in more cues of cognitive effort in liars than in truth tellers. These theories were the starting point for the empirical studies described in Chapters 2, 3 and 4, which aimed to overcome some of the problems than hamper lie detection. Chapter 2 describes a study where a Computerised Emotional Stroop Task (CEST) was used as a secondary task to impose cognitive load. The CEST was based on the orienting reflexes that guilty suspects seem to experience towards recognised information. Differences between liars and truth tellers emerged concerning some speech cues regardless of the condition (information-gathering interview or information-gathering interview and CEST). Results also suggested that the CEST imposed similar levels of cognitive load both in liars and truth tellers. Thus, researchers should be careful with the method used to increase cognitive load as it may affect all the interviewees. Chapter 3 consists of a study that involved elements from a Portuguese security force (GNR) whose task was to judge the veracity of statements collected during the study described in Chapter 2. In this study, we aimed to analyse the accuracy rate of the elements of GNR in discriminating liars and truth tellers during both interviewing conditions and to analyse the cues they rely on to make a judgment. Results suggested that observers tended to make veracity judgments based on emotional states such as nervousness, which can explain the low accuracy rate obtained. The study on Chapter 4 analysed the effects of social anxiety as an interpersonal difference in the cues elicited by lie detection processes. Interviewees with different levels of social anxiety lied or told the truth, and the results showed differences between liars and truth tellers socially and non-socially anxious. The main conclusion was that professionals should assess social anxiety before conducting lie detection interviews. Finally, in Chapter 5 we summarise the current studies and present their main conclusions and practical utilities. We discuss some common limitations on lie detection research and what can be done to improve it, also presenting a research line for future studies in the area.

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Chapter 1. Introduction and literature review

"There is a sense in which all liars are candidates for experience guilt and shame, as they all have done something that could be considered wrong: They have intentionally misled someone. Truth tellers have not. It is important to note, however, that liars do not always feel badly about their lies, and truth tellers do not always feel good about their honesty." (DePaulo et al., 2003, p. 81)

1.1. What is lying?

The importance of lie detection was established many years ago. Trying to detect lies has been inevitable in many forensic settings, and several researchers have been focusing on developing techniques that can improve it.

Information is truthful when it objectively describes an event or a situation. "Objective" is the product of an intersubjective agreement concerning the characteristics or properties of the object and not the cognoscente subject (Hessen, 1987). The opposite of true is false and not lie. While lying implies the intention of deceiving, one can unintentionally give information that is untrue due to ignorance or memory errors, which constitutes a falsity but not a lie. Lying is "a successful or unsuccessful attempt, without forewarning, to create in another a belief which the communicator considers to be untrue'' (Vrij, 2008a, p. 15). Misremembering is not the same as lying (Vrij, Granhag, & Porter, 2010), and to study and outline either verbal, para-verbal, non-verbal or psychophysiological cues associated to lie detection the intention to deceive must be present.

Lying is a part of our daily life, especially the so-called "white lies" (e.g. saying that we liked a gift that we did not like), which are harmless. Research suggests that in average people try to deceive someone twice a day (DePaulo et al., 1996). However, recent studies suggest that the majority of lies are told by a small group of people. Some people report little or no lying at all, meaning that there are a lot of individual differences concerning the prevalence of lying (Halevy, Shalvi, & Verschuere, 2014; Levine, Serota, Carey, & Messer, 2013).

1.2. Why do people lie?

Several reasons motivate people to lie. Some authors even suggest that lying has a survival value (King & Ford, 1988, cit. in Halevy et al., 2014). DePaulo and Kashy's (1998) results concerning everyday lies suggest that when people lie, they do it about their feelings and opinions, their actions and whereabouts, their knowledge, achievements, failures, explanations for their behaviours, facts and personal possessions. Men and

women lie with the same frequency (DePaulo et al., 1996). Concerning age, research has shown that, at least at age four, children can deliberately communicate information that they know is not true (Newton, Reddy, & Bull, 2000; Wilson, Smith, & Ross, 2003).

Vrij (2008a) describes three main types of lies. *Self-oriented lies* are told to obtain or to avoid losing something (material or not), to avoid embarrassment, or to give a positive image to others. *Lies oriented to others* have the goal to protect others, to obtain material benefits, to prevent material losses or punishments, or to protect others from psychological damage. *Social lies* are usually told to avoid awkwardness or being rude.

Individual differences can also be related in several ways to reasons that potentiate lying. For example, the attachment styles characterised by avoidance and anxiety can explain an individual's relationship with lying (Vrij, 2008a). Avoidance is marked by a lack of confidence in others, fear of and avoiding intimacy due to expectations that people will not be supportive or available. Those who score high in anxiety experience a negative modulation of themselves, low self-esteem, jealousy, fear of abandonment, high need and dependence of other people's approval. Thus, people who score low in these two dimensions may have less intention to lie in a relationship. Individuals who score high in anxiety and low in avoidance can have difficulties in addressing an issue, and those who score high in both dimensions have more probability to lie in a relationship. On the other hand, socially anxious individuals seem to persist less in a lie (Vrij & Winkel, 1992). Also, extroverts tend to lie more than introverts and people with good self-awareness may mould their behaviour into something they believe would be beneficial. Psychopaths use deceit to exploit others (Seto, Khattar, Lalumire, & Quinset, 1987, cit. in Vrij, 2008a), and they lie better, more persistently and more flagrantly than most people (Porter & Woodworth, 2007, cit. in Vrij, 2008a). Machiavellians with social skills see others in a cynic way and admit that they will lie, cheat and manipulate others to obtain what they want (Kashy & DePaulo, 1996).

1.3. Detecting lies: Why is it so difficult?

Besides the inexistence of a cue as clear as Pinocchio's nose, according to Vrij, Granhag, and colleagues (2010) there are countless problems that can impair the lie detection process, such as 1) the typically subtle differences between truth tellers and liars (e.g. DePaulo et al., 2003); 2) countermeasures, i.e., the intentional attempt to appear credible in order to avoid being caught (e.g. Buller & Burgoon, 1996; Caso, Vrij, Mann, & De Leo, 2006; Leary & Kowalski, 1990); 3) the embedded lies, i.e., saying truthful information but out of context, like intentionally describing truthfully what the interviewee has done on Monday when asked about his activities on Tuesday (e.g. Hartwig, Granhag, & Strömwall, 2007; Strömwall, Granhag, & Landström, 2007); 4) the absence of adequate feedback (Park, Levine, McCornack, Morisson, & Ferrara, 2002), which prevents lie detectors to learn from their errors (e.g. Vrij, Granhag, et al., 2010); and 5) the existence of good liars – people who do not find it cognitively difficult to lie; people who do not experience guilt, fear or delight; people who can mask signs of cognitive load and emotions; people with good appearance or facial characteristics related to trustworthiness and people who have insight into another's person's thought process (Vrij, Granhag, et al., 2010).

People in general, in their daily lives, do not always try to find the truth, a phenomenon known as the *ostrich effect* (Vrij, 2008a). Fabrication can be more tolerable or pleasant for those who listen and not knowing how to respond to certain truths can also lead people to ignore some potential red flags.

When it comes to professional lie detectors, there are common errors worth highlighting (Vrij, Granhag, et al., 2010): examining the wrong cues; the *Othello error*, which describes failure in considering that truth tellers can be as nervous or more than liars and therefore display signs of nervousness; overemphasis on nonverbal cues; the use of heuristics; neglect of interpersonal and intrapersonal variations; existing interviewing techniques; and overconfidence in lie detection skills. Some of these errors will be described in more detail in the following paragraphs.

Research has consistently shown that both laypeople and professionals tend to expect liars to exhibit signs like gaze aversion and grooming gestures (Strömwall,

Granhag, & Hartwig, 2004; Taylor & Hick, 2007; The Global Deception Team, 2006; Vrij, 2008a; Vrij, Akehurst, & Knight, 2006). Nonetheless, despite research showing that those are not reliable cues to deception (DePaulo et al., 2003; Sporer & Schwandt, 2007), their use is still encouraged internationally (Johnson, 2006). The most extensive lie detection meta-analysis to date (DePaulo et al., 2003) reveals that most of the nonverbal and verbal cues analysed in lie detection studies are not related to deception. From the 158 cues examined in that meta-analysis, 118 (75%) were not reliable cues to lie detection. The lying/ gaze aversion association may have become popular because of the "lying is bad" stereotype (The Global Deception Research Team, 2006). If people avert eye contact when they feel ashamed, they are expected to do the same when they lie (DePaulo et al., 2003). Also, if “lying is bad”, liars should feel nervous about not getting caught. However, this is not always the case.

In a study in which police officers viewed video fragments of real-life suspects telling truths and lies (Mann, Vrij, & Bull, 2004), the results showed an inverse relation between the use of lie cues promoted in the manual *Criminal interrogation and confessions* (Inbau, Reid, Buckley, & Jayne, 2001) and the accuracy in discriminating truths and lies. Kassin and Fong (1999) had already suggested that college students trained in the behavioural cues advocated in Inbau et al.'s (2001) manual performed worse than non-trained colleagues. According to Vrij & Granhag (2007), it is common that police manuals recommend investigators to notice signs of nervousness during a lie detection process. Yet, examining such wrong cues, namely interpreting signs of nervousness as signs of deceit, can lead to the occurrence of the *Othello error*.

The overemphasis on non-verbal cues is frequent too. People are used to relying on other people's behaviour to make inferences based on personality traits, masculinity/ femininity, sexual orientation, status (Vrij, 2008a). Observers tend to focus on speech mainly when they have some knowledge about it (e.g. when they have some evidence), comparing statements from different occasions and different people. When investigators are expecting to hear lies, which according to Moston, Stephenson, and Williamson (1992) happens in 73% of the cases, or at least very frequently (Kassin, 2005), they tend to overlook the speech and focus on behavioural cues that confirm their suspicion (Millar

& Millar, 1998). Also, the training of many police forces advocates for the non-verbal cues (Ekman, 1985/2001; Inbau et al., 2001). Finally, while there are a lot of cues associated with lying, stereotypes of truth-telling are not common, and people usually respond to the presence of something and not to its absence (Vrij, 2008a).

Another problem concerning the lie detection process consists in the use of heuristics, or general decision rules, that are often biased and can originate errors in the process of decision making (Burgoon, Blair, & Strom, 2008). Some heuristics are worth highlighting. There is *the availability heuristic*, which states that because people find more truthful than deceptive messages on a daily-bases, they will assume that most of the messages they receive are true. *The anchoring heuristic* refers to the tendency to make insufficient adjustments from an initial inaccurate idea (the anchor), ending up with a final incorrect judgement towards that "anchor" (Elaad, 2003). For example, when lie detectors are anchored to beliefs about the veracity status of the interviewees, they may not make an adequate adjustment if evidence that contradicts their beliefs emerges. There is also *the relational truth-bias heuristic*, which states that the more intimate a relationship is, the more a person believes the other is being truthful (Anderson, Ansfield, & DePaulo, 1999; Stiff, Kim, & Ramesh, 1992). *The representativeness heuristic* (Stiff et al., 1989) describes the predisposition to classify a particular reaction as an example of a more extent category (e.g. nervous behaviours as signs of deceit). The tendency to judge consecutive consistent statements as truthful and consecutive inconsistent statements as deceptive is known as the *consistency heuristic* (Granhag & Strömwall, 2000). The predisposition to judge reactions that appear strange according to the conversation norms (e.g. keeping the eyes closed, staring) as being deceptive is *the expectancy violation heuristic* (Vrij, 2004). There is also a tendency to judge people with attractive, symmetrical and/ or baby faces as being honest and people with certain facial characteristics suggesting anger or unkindness as less credible (Porter, England, Juodis, ten Brinke, & Wilson, 2008), which is *the facial appearance heuristic* (Vrij, 2004). *The primacy heuristic* (Burgoon et al., 2008; Stiff et al., 1989; Vrij, Granhag, et al., 2010) refers to the preference that is given to visual information when making veracity judgments, as opposed to audio information, and *the single cue heuristic* (Vrij, Granhag, et al., 2010) is

the belief that there is a cue like the Pinocchio's nose that occurs for all liars in all circumstances (e.g. liars look away from their interlocutor). Also, when observers have a strong opinion about something, it is recurrent to try to find reasons to support their vision, ignoring all other cues that might point in a different direction (being it a lie or a truth), which is the *confirmation bias*, (Darley & Gross, 1983; Strömwall et al., 2004).

Intra and interpersonal differences are also significant aspects to consider in the process of lie detection. There are obviously considerable differences when we compare the behaviour and the speech of different individuals (DePaulo & Friedman, 1998). Some people make more movements and are more eloquent than others, and some have a bigger tendency to blush or sweat. Lack of social skills, social anxiety or even introversion can also put some interviewees at risk if investigators do not take into consideration the interpersonal differences that exist. Similarly, the intercultural differences play a role that should not be ignored, not only for police officers and investigators but also for professionals of immigration services. Behaviours that are common in a particular culture can appear suspicious to members of other culture. For example, looking in the eye is considered polite and a sign of honesty in many occidental cultures, but for several Aboriginal cultures from Canada (Porter & ten Brinke, 2009) people looking directly in the eye is considered rude, hostile, intrusive. Similarly, Black Americans display more gaze aversion than White Americans (Johnson, 2006), and people from Turkey and Morocco living in the Netherlands show more gaze aversion than Dutch people (Vrij, Dragt, & Koppelaar, 1992). However, it is important to note that these differences are not exclusive in situations when we consider different people because the same individual can behave differently depending on the context (Vrij, 2008a). For example, people react in different ways when they are accused of an offence, like when they are being interrogated, comparing to when they are not feeling challenged, like during the small talk conversation before the actual interrogation that lie detectors sometimes carry out to set a behavioural baseline (Vrij, 2006). When comparing people's reactions in high-stakes and low-stakes interviews, differences can also emerge (Porter & ten Brinke, 2010; Vrij, 1995). Similar variations are possible when using different interviewers (Vrij &

Winkel, 1991) and talking about distinct topics (Kleinke, 1986, cit. in Vrij, Granhag, et al., 2010; Matarazzo, Wiens, Jackson, & Manaugh, 1970).

1.4. Multidisciplinary lie detection techniques

The scientific study of deceit began when researchers started to study physiological variables such as heart rate, skin conductance and respiration (Andreassi, 2007). The technological development of equipment like the polygraph has allowed the recording and analysis of these measures more rigorously. There are also lie detection techniques that involve electroencephalography (e.g. Lefebvre, Marchand, Smith, & Connolly, 2009; Matsuda, Nittono, & Allen, 2013) and Magnetic Resonance Imaging (MRI) (e.g. Christ, Essen, Watson, Brubaker, & Mcdermott, 2009; Spence et al., 2001).

Lykken (1974) developed the Guilty Knowledge Test, also known as Concealed Information Test (CIT) in more current research. At the same time, the Control Question Technique (CQT) was developed by Podlesny and Raskin (1977, cit. in Andreassi, 2007). These techniques originated a controversial dispute during the 1980's.

The CQT is the standard lie detection test that is based on the premise that the anxiety caused by lying rises physiological responses to some questions. This anxiety-based technique assumes that liars are more nervous than truth tellers and thus display physiological or non-verbal signs of anxiety/ nervousness, like increased heart-rate or shifting movements (Vrij, 2014). The test involves the comparison of crime-relevant questions (e.g. "Did you rob a bank last Monday?"), arousing control questions (e.g. "Have you ever stolen something?") and neutral questions (e.g. "Is today Wednesday?"). When physiological activity to crime-relevant responses is larger than neutral's, the suspect is considered to be lying (Verschuere, Crombez, & Koster, 2004). The CQT paired with the polygraph has been widely used by polygraph interviewers (Bashore & Rapp, 1993; Vrij, 2008a). However, flaws in its assumptions and interpretation have originated much criticism against the CQT (Gombos, 2006). For example, some limitations of the CQT are its unreliability, with false positive rates as high as 33% and false negative rates at 25% (Kleinmuntz & Szuko, 1982, cit. in Gombos, 2006) and the possible use of

countermeasures, like using mental and physical distraction techniques to beat the detection (Waid, Orne & Orne, 1981, cit. in Gombos, 2006).

On the other hand, the CIT is an information test, a psychophysiological method that tests whether a suspect has some relevant crime-related knowledge, i.e., guilty knowledge (Lykken, 1959). This test is based on the orienting reflex theory which states that these reflexes occur when people are confronted with personally significant stimuli (Pavlov, 1927). Orienting reflexes origin physiological responses (e.g. Nakayama, 2002) that can be measured by central and peripheral measures (e.g. electroencephalogram (EEG), electrocardiogram (ECG)). The classical CIT uses a series of multiple-choice questions, where one of the items is crime-related. The examinee is usually asked to answer "no" to all of the questions (Ben-Shakhar, Bar-Hillel, & Kremnitzer, 2002). If the specific details of a crime remain confidential, the only people that have knowledge of them will be the police officers and the perpetrator. Supposing that a murder occurred and the murder weapon was a kitchen knife, a classic CIT (e.g. Lykken, 1959) would present several edged weapons (kitchen knife, penknife, axe, etc.), each following the question "Was this the murder weapon?" According to the orienting reflex theory, an innocent person will have the same physiological responses when answering to all the items because he/she does not have knowledge about the murder weapon and, therefore, does not have an orienting reflex towards any item. However, a guilty examinee will probably respond differently to the critical item (i.e., the recognised murder weapon), comparing to the non-critical items. The CIT consists of several questions, typically at least five (e.g. Ben-Shakhar et al., 2002; Verschuere, Crombez, De Clercq, & Koster, 2004). If the examinee repeatedly responds more strongly to the critical items, the interpretation is that he/she probably has some knowledge about the crime (Verschuere, Crombez, De Clercq, et al., 2004).

It is agreed that the CIT relies on firm scientific grounds and suitable control questions (e.g. Lykken, 1974) and it is officially used in forensic investigations in Japan (e.g. Yamamura & Miyata, 1990). Original results (Lykken, 1959) were replicated numerous times (see Ben-Shakhar & Elaad, 2003) and findings suggest an accuracy rate around 90%. The CIT is a cognitive approach to psychophysiological detection since it

relies on what the suspect knows, and not on what he feels (Ben-Shakhar & Furedy, 1990). However, the use of these technologies is difficult to implement in most lie detection contexts. In many forensic settings, observation is still the leading technique.

Regarding the use of verbal and non-verbal cues, traditionally, lie detection techniques focused on the different emotions that liars and truth tellers would experience. The first manuals about lie detection techniques were based on the idea that liars are more concerned and worried than truth tellers (Vrij & Granhag, 2007; Vrij, Granhag, et al., 2010). In this emotional approach, the use of facial expressions, particularly the micro-expressions (Ekman, 1985/ 2001), was prevalent. This approach claimed that "deceptive emotional information is betrayed (leaked) by micro-expressions, which are fleeting but complete facial expressions that are thought to reveal the felt emotion during emotional concealment and are suppressed within 1/5th to 1/25th of a second" (Vrij, Granhag, et al., 2010, p. 104).

The first detailed investigation of facial expressions associated with genuine and deceptive emotions was carried out by Porter and ten Brinke (2008). In their study participants viewed emotional (happy, sad, frightening, disgusting) and neutral images from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999; Lang, Greenwald, Bradley, & Hamm, 1993) while being judged by "blind" observers. In some cases, they should respond genuinely (express their true emotions), and in other cases, they should try to mask their genuine emotion by replacing it with another emotion (masking condition) or by creating an emotional expression in a neutral state (simulating condition). Their results showed that emotional expressions inconsistent with the intended occurred more frequently in the masked condition than in the genuine or simulated conditions. However, there were no differences in the inconsistent expressions between genuine neutral expressions and neutralised expressions of felt emotions. Also, they lasted longer (more than a second) than the traditional micro-expression as defined by Ekman (1985/ 2001). On the other hand, micro-expressions were more subtle than predicted and were manifested only in the upper or lower face. The authors only found a small number of partial micro-expressions, and although some were indicative of the masked emotion, they also occurred during genuine expressions. Another interesting

finding was that while masking an emotion seemed to increase the eye blinking, neutralising it may lead to lower blink rate, both comparing to the genuine emotion condition. A decrease of eye blink rate appears to be a sign of cognitive load (e.g. Leal & Vrij, 2010), which suggests that participants experienced mental effort while trying to neutralise the emotion. Despite some interesting results, lie detectors should always proceed cautiously when they identify a possible incongruence between the individual's nonverbal behaviour and speech content. Before making a judgment, alternative explanations should be considered to avoid false positives. One of Porter and ten Brinke's (2008) major conclusions was that techniques that rely on identification of full-face micro-expression may lead to errors.

Nevertheless, the biggest limitation concerning the emotional approach is that there are not emotions exclusive from liars (e.g. DePaulo et al., 2003). As addressed previously, a truth teller may display signs of emotions and be as nervous or even more nervous than a liar.

Concerning the analysis of verbal cues, the Statement Validity Assessment (SVA) is probably the most frequently used tool to date (Vrij, 2008a). This method is based on truth verification and has been used as evidence in criminal court in several European countries (e.g. Sweden, Germany, Austria, Netherlands, Switzerland) (Köhnken, 2004, cit. in Vrij, 2008b). This method was developed to evaluate children's statements concerning sexual abuse (witnesses or alleged victims). The SVA starts with a semi-structured interview in which the child describes the allegation without any influence of the interviewer. Distinctive interview techniques have been developed to obtain as much truthful information as possible during a free recall (e.g. Memon & Bull, 1999, cit. in Vrij, 2005; Milne & Bull, 1999, cit. in Vrij, 2005), such as the use of appropriate prompts (e.g. "What happened next?") or questions (e.g. "You just mentioned a man. What did he look like?").

Statements resulting from memory recall of an actual experience are different in content and quality from statements based on invention or fantasy – *Undeutsch hypothesis* (Steller, 1989, cit. in Vrij, 2005). This hypothesis was the base for the Criteria-Based Content Analysis (CBCA, the core component of SVA) and received theoretical

support by Kohnken (1989, 1996, 1999, cit. in Vrij, 2005), who suggested that cognitive and motivational factors influence CBCA scores. The CBCA contains 19 different criteria, and CBCA-trained evaluators judge the strength of presence of each of these criteria in the transcript of the interview. The criteria assess general characteristics (e.g. logical structure, the quantity of detail), specific contents (e.g. contextual embedding, reproduction of conversation), motivation-related contents (e.g. spontaneous corrections, admitting lack of memory), and offence specific elements (details characteristic of the offence). The presence of each criterion supports the hypothesis that the statements are based on genuine personal experience, i.e., truthful declarations will have more of the elements measured by CBCA than will false ones. Despite some positive outcomes, an extensive meta-analysis by Vrij (2005) warns that SVA evaluations are not accurate enough to be used as expert scientific evidence. Also, children (and adults) who learn how this technique works can produce statements that sound plausible (e.g. Caso et al., 2006; Vrij, Akehurst, Soukara, & Bull, 2004; Vrij, Kneller, & Mann, 2000).

Reality Monitoring (RM) is another tool to assess veracity through verbal analysis, popular in scientific research, where trained coders also judge the strength of presence of the RM criteria in the transcribed statements (for reviews see Masip, Sporer, Garrido, & Herrero, 2005; Vrij, 2005, 2008a). The central base of RM theory is that memories of experienced events are different in quality from memories of imagined events (Johnson & Raye, 1981). According to Vrij (2008b), real experiences originate memories that emerge through perceptual processes, being “clear, sharp and vivid” (p. 1328). They are likely to contain perceptual information (details of sound, smell, taste, touch or visual details) and contextual information, spatial details (details about where the incident took place and details about how objects and people were positioned in relation to each other, e.g. "She was sitting behind the desk"), and temporal details about time order of the incidents (e.g. "First she closed the door, and then she sat down) and their duration. On the other hand, statements of imagined events emerge from an internal source, and besides usually being vaguer and less concrete, they are likely to contain cognitive operations, such as thoughts and reasoning (e.g. "I must have had my coat on, as it was snowing that night). Several

RM criteria received consistent support, particularly “spatial details” and “temporal details” (Vrij, 2008a).

Recent research has been focusing on the cognitive load that lying originates (Vrij, Granhag, Mann, & Leal, 2011a; Vrij, Fisher, Mann, & Leal, 2006). Though emotions and cognitive load, the two most studied indicators of deception, may be displayed by truth tellers and liars, it is possible to elicit and enhance cues of cognitive load more in liars by developing techniques that manipulate the mental states of truth tellers and liars. This would result in magnifying the differences between liars and truth tellers. The same process has not yet been developed concerning the emotional approach, and it is doubtful it can be done (National Research Council, 2003). On the next topic, we will discuss the specificities of the cognitive load approach.

1.5. Cognitive-based lie detection techniques

The cognitive load approach (Vrij, 2014; Vrij, Fisher, & Blank, 2017; Vrij, Granhag, et al., 2011a) proposes that lying is cognitively more demanding than telling the truth. Liars have to fabricate the lie and simultaneously try to be plausible and pay attention to what someone already knows or can find out (Vrij, 2008a). They also need to control and monitor their behaviour to appear honest to interviewers (DePaulo & Kirkendol, 1989) and monitor the reactions of the interviewers to examine whether their lies are believed (Buller & Burgoon, 1996; Schweitzer, Brodt, & Croson, 2002). Liars must remind themselves to role-play and to lie (DePaulo et al., 2003), suppressing the truth while lying (Spence et al., 2001) and activating the lie (Gilbert, 1991; Walczyk, Roper, Seemann, & Humphrey, 2003).

There is multiple research suggesting that lying is mentally more taxing than truth telling, reported by interviewees either when they had to provide a long and elaborative response (e.g. Hartwig, Granhag, Strömwall, & Kronkvist, 2006; Vrij, Fisher, et al., 2006) or when only short responses were required (Caso et al., 2006; Vrij, Mann, & Fisher, 2006). Similarly, in fMRI deception research, where participants can only press a “yes” or a “no” button, a review has showed that there is higher brain activity when people are lying

comparing to when they are telling the truth, namely in prefrontal regions associated with executive processes such as working memory, inhibitory control, and task switching (Christ et al., 2009). Research involving police officers as observers and real-life suspects as interviewees also showed that liars were assessed as thinking harder than truth tellers and providing more signs of cognitive load (e.g. increased pauses and decreased blinking) (Mann, Vrij, & Bull, 2002; Vrij & Mann, 2003). However, truth tellers can also experience some interviews as mentally taxing, like when they need to recall an event that was not distinctive or that occurred a long time ago, and that variable should be taken into account when making veracity judgments.

Recent research has been focusing on exploring this additional cognitive load experienced by liars. If the cognitive load is increased during an interview, this should have a superior negative impact in liars because they would have less attentional resources available, resulting in a worse performance (Vrij, Granhag, et al., 2011a; Vrij, Fisher, et al., 2006). Liars and truth tellers may differ in their verbal and nonverbal behaviours in consequence of this increased cognitive demand – liars may display a higher number of verbal and nonverbal cues associated with cognitive load, such as fewer details, more pauses and more speech hesitations (Vrij, Fisher, Mann, & Leal, 2008).

We will focus now on the different types of techniques that have been used in research to elevate the cognitive load during interrogatories, in an attempt to distinguish between liars and truth tellers regarding elicited cues.

1.5.1. Interviewing styles: Information-gathering interview vs. Accusatory interview

The two most popular interviewing styles in lie detection processes are the information-gathering interview and the accusatory interview (Meissner, Redlich, Bhatt, & Brandon, 2012). The information-gathering interview does not confront the suspect with an accusation; it asks an open question (e.g. "Describe in as much detail as possible where you were yesterday morning between 9h and 10h") (Vrij, Mann, et al., 2006). This interviewing style is based on building rapport, explaining the allegation and the

transgression, emphasising the importance of honesty and truth gathering, requesting the suspects' version of the event, and allowing them to provide all the information they consider necessary with an uninterrupted recall (Meissner et al., 2012). The information-gathering interview encourages suspects to talk, which may offer more information about the alleged event to the investigators (Bull, 2010; Fisher, 2010). It is also an assurance for not obtaining a false confession since it does not accuse the suspects of any offence (Gudjonsson, 2003) and may also be seen as more ethical (Williamson, 1993).

An accusatory interview is based on confrontation and psychological manipulation, using guilty-presumptive questions and confronting the suspect with an accusation (Meissner et al., 2012), which will exert more pressure on both liars and truth tellers than an information-gathering interview (Vrij, Mann, et al., 2006). Despite what is being claimed in Inbau et al.'s (2001) police manual, an accusatory interview does not make the interviewees more likely to talk. According to Moston, Stephenson & Williamson's (1993) systematic analysis of the information-gathering interview, only 5% of the suspects did not speak, and Baldwin (1993) found that 80% of the interviewees were willing to cooperate with the interviewers.

The information-gathering interview was also found to be more cognitively demanding than the accusatory. The accusatory interview may lead to short answers (Vrij, Mann, et al., 2006), which can originate a higher number of diagnostic cues produced in the information-gathering interview, compared to the accusatory (Meissner et al., 2012).

1.5.2. Imposing cognitive load

Researchers have been focusing on developing techniques that manipulate the mental state of liars and truth tellers, by testing interviewing methods that can enhance cues of mental effort more in liars than in truth tellers. One way of doing so is by imposing cognitive load.

Increasing mental effort can be achieved by several methods, such as asking the participants to recall an event in reverse order. The reverse order technique is part of the Cognitive Interview (Fisher & Geiselman, 1992), which is an interview technique that

results in more detailed and accurate information of a specific event recalled by truth tellers (Fisher, 2010). It also elicits more information than standard police interview protocols (see Memon, Meissner, & Fraser, 2010, for a meta-analysis). Asking participants to recall an event in reverse order was found to be particularly debilitating for liars, who provided much more cues to deceit in the reverse order condition than liars in the control condition. Also, the accuracy rate of the observers' judgments improved in the reverse order condition, comparing to the control condition (Vrij, Mann, et al., 2008). The cues that were elicited more in liars during the reverse order condition were mainly signs of cognitive load: fewer auditory details and contextual embedding details and more cognitive operations. Liars made more speech hesitations, spoke with a slower speech rate and made more speech errors than truth tellers, which are also cues of mental effort. Liars also showed to be more nervous than truth tellers in the reverse order condition by showing several signs of nervousness: leg and foot movements and blinked more (Vrij, Mann, et al., 2008). Another study (Vrij, Leal, Mann, & Fisher, 2011) where interviewees were requested to recall their stories in reverse order also had interesting outcomes. Liars provided fewer details than truth tellers during both the reverse and the chronological order. However, significantly more participants in the reverse order condition (87% vs. 71%) included fewer details when lying. The effect size was also larger between liars and truth tellers' number of details in the reverse order condition (d = 0.72 vs. d = 0.38). According to Cohen (1988), effect sizes of 0.8 are considered very large. Also, Vrij, Leal, Mann, and Fisher (2011) showed that more contradictions emerged between the reverse order condition and the chronological order condition during liars' statements, comparing to truth tellers recalls. In the reverse order condition, the accuracy rate of the observers improved as well.

A study carried out by Vrij, Mann, Leal, and Fisher (2010) showed that when participants were asked to look the interviewer in the eye, liars provided more cues to deceit (fewer spatial details and told the event in a more chronological order) than truth tellers, comparing to the control condition. Observers' ability to detect deceit also improved in the eye contact condition. Both truth tellers and liars showed more signs of nervousness during the experimental condition (more eyeblinks and more hand/ finger

movements), which suggests that participants in general interpreted that instruction as anxiety-provoking.

Another technique that can be used to impose cognitive load is to ask interviewees to perform a secondary unrelated task during the interview, like conducting a computer driving simulation task (Vrij, 2014). Liars may find harder to attend this request because besides dividing their attention between two tasks, they also have to lie, which has been shown to be mentally taxing and an enhancer of cognitive load cues. Recent studies have shown that this is an area worth exploring. Liars' reaction time in a stimulus-response experiment was longer when participants were asked to squeeze a handgrip as long as possible while answering to an interview (Debey, Verschuere, & Crombez, 2012), and during conditions that contained interfering tasks like pressing a key once or twice in a recognition test (CIT), depending on whether the answers were written in bold or italics (Visu-petra, Varga, Miclea, & Visu-petra, 2013).

1.5.3. Asking unanticipated questions

In the possibility of being interrogated, liars tend to prepare themselves for possible questions, rehearsing their story (Granhag, Andersson, Strömwall, & Hartwig, 2004; Hartwig et al., 2007). Liars seem to provide fewer cues to deceit when they have the opportunity to prepare the lies, providing a similar speech to truth tellers (DePaulo et al., 2003). However, the advantage is limited to the ability to predict what kind of questions will be asked. When facing an unanticipated question, eventually liars will have no alternative than to formulate an unplanned lie, if they do not want to raise suspicion by answering "I don't know/ I don't remember" too often (Vrij, 2014). This is mentally taxing.

According to Lancaster, Vrij, Hope, and Waller (2013), liars give significantly fewer details than truth tellers when answering to unanticipated questions (e.g. “Please describe exactly how you arranged the four objects you placed on the table at the centre of the room”) comparing to anticipated questions (e.g. “Tell me in as much detail as you

can what you did in the room"), which in their study allowed an accurate identification of 78% of the truth tellers and 83% of the liars.

This technique can also be beneficial when interviewing pairs of suspects individually, by taking advantage of possible questions that they may not have anticipated or by using a method that is unusual (e.g. spatial questions, drawings). Vrij and colleagues (2009) asked pairs of truth tellers to have lunch together and pairs of liars to pretend they had lunch together. Results showed that, concerning the level of correspondence between the reports of the two elements of each pair, 60% of pairs of truth tellers vs. 80% of pairs of liars were identified based on spatial questions, 60% vs. 55% were identified based on temporal questions, and 80% vs. 75% were identified based on their drawings. Open expected questions did not result in statistically significant differences concerning correspondence in answers for pairs of truth tellers and pairs of liars, meaning that the correspondence for pairs of truth tellers and pairs of liars were similar. Questions concerning temporal and spatial details, and drawings, were rated as less expected than open questions. Since these first promising results using drawings, other studies have been carried out also with consistent results (e.g. Leins, Fisher, Vrij, Leal, & Mann, 2011; Vrij, Leal, et al., 2010; Vrij, Mann, Leal, & Fisher, 2012).

The expected and unexpected questions need to be related to the core elements of the investigation. Many questions can be unexpected, but in order to facilitate the process of discriminating liars and truth tellers, they must address the topic under investigation (Lancaster et al., 2013). Drawings, spatial and temporal questions, perspective shifts and the format in which the questions are phrased are examples of what constitutes surprising elements.

1.5.4. Strategic use of evidence

As mentioned earlier, guilty suspects usually have unique knowledge concerning some particular aspects of the crime (e.g. murder weapon). This will result in entering the interrogation with a different mental state than innocent suspects (Granhag & Hartwig, 2008). Guilty suspects tend to have a strategy when facing a police interview (Hartwig et

al., 2007), and their primary goal is to keep their knowledge private, while innocent suspects just want to “tell it all”, be understood and believed. Thus, liars tend to use different strategies like avoidance and denial (Granhag & Hartwig, 2008). If they are allowed, guilty interviewees will avoid referring information that can be incriminating. Only when they do not have the opportunity to avoid will they deny that knowledge (Hartwig, Granhag, Strömwall, & Vrij, 2005; Hartwig et al., 2006; Strömwall, Hartwig, & Granhag, 2006).

The Strategic Use of Evidence (SUE) technique aims to access possible concealed (incriminating) information. It consists of open questions, such as "What did you do yesterday in the morning?", followed by specific questions, such as "Did you stopped by any coffee shop?", without revealing possible evidence the investigators may have about it, like closed-circuit TV images of the street where the coffee shop that was robbed is located. While truth tellers who may have forgotten to mention about going to that coffee shop will probably mention that at this point, liars are more likely to continue not mentioning their presence at the coffee shop spontaneously, avoiding it and, if being directly asked, denying it, which will contradict the evidence (Vrij, Granhag et al., 2011a). For example, in Hartwig and colleagues (2006), liars interviewed by trained interviewers with the SUE technique were more inconsistent with the evidence than liars interviewed by non-trained interviewers, allowing an accuracy rate of around 85% vs. 56% in discriminating truth tellers and liars in total. Also, guilty suspects reported having experienced more cognitive load during the SUE, comparing to innocent suspects.

Thus, when applying the SUE technique, the interviewer must withhold incriminating information from the suspects and ask for a free recall. Then, the interviewer asks several specific questions that involve the incriminating evidence without disclosing it. Finally, the interviewer reveals the evidence and asks for explanations in any contradictions between their statements and the evidence (Vrij, Granhag, et al., 2010).

1.5.5. Devil's Advocate approach

The Devil's Advocate approach was developed to detect lies concerning the suspects' opinions (Leal, Vrij, Mann, & Fisher, 2010), which can be very relevant particularly in security settings. This approach consists of two questions. After the opinion is expressed (e.g. "I am against nuclear bombs"), the investigator asks an opinion eliciting question: "What do you think led to you having that opinion about this topic?". That is followed by the second question "Playing the Devil's Advocate, is there anything you can say against/ in favour of this topic?". The interviewer asks "against" or "in favour" depending on the opinion expressed – if the suspect had expressed a positive attitude, interviewer would use "against", and vice-versa.

Thus, this technique requests truth tellers to give reasons that support their true opinion in the opinion eliciting question and to provide reasons against their opinion in the Devil's Advocate answer. If someone is lying, the opposite process will occur.

People usually have more knowledge concerning their beliefs and are more likely to effortlessly generate reasons that support their opinions than that contradict them (see Ajzen, 2001). Also, as referred earlier, people frequently search for information that confirms their views – *confirmation bias* (Darley & Gross, 1983; Strömwall et al., 2004). In consequence, a truth teller's answer to the opinion eliciting question contains more words than his/her answer to the Devil's Advocate question (Leal et al., 2010). Also in this study, while truth tellers' opinion eliciting answers were judged as more immediate, plausible and emotional than the Devil's Advocate answers, no differences were found when comparing the liars' replies between those two types of questions. This means that truth tellers showed noticeable differences between the two questions, contrarily to liars. Thus, when applying this technique, deceit is identified by the absence of differences between the two types of question. The authors suggest that liars may have tried to disguise their true opinion, but could not restrain themselves enough in the Devil's Advocate question, or intentionally decided to provide similar answers as a strategy. The results showed that 86% of truth tellers and 71% of liars were accurately classified and a total of 79% participants were correctly identified based on their speech content (Leal et al., 2010).

1.6. Overview of the current work

The next three chapters will describe different studies that were carried out with the purpose of developing cognitive-based lie detection techniques that sought to overcome some of the problems that make lie detection so difficult.

The first study, reported in Chapter 2, involved developing a lie detection method that would improve the assessment of verbal cues of deceit. We aimed to develop a method that would elicit more cues of cognitive load in liars than in truth tellers by imposing cognitive load through the use of a secondary task. That secondary task was developed based on the orienting reflex theory that underlies the CIT. We also developed a coding guide for speech variables.

In the second experiment, described in Chapter 3, we aimed to understand how cues of cognitive load and nervousness were interpreted by professionals of Portuguese police forces and how those interpretations influenced their accuracy judgments. We also sought to compare these variables in standard and mentally taxing interviews.

The third study, which is the focus of Chapter 4, looked at social anxiety as an individual difference that should be taken into consideration when interviewing suspects and selecting the best interviewing style to use – information-gathering or accusatory. The coding guide developed in the first study was used to analyse the speech cues produced in this experiment.

Finally, Chapter 5 summarises the empirical studies included in the present thesis, their main conclusions and their practical implications. This chapter also presents a discussion of the problems and limitations that are common to most lie detection studies, suggesting ways to improve lie detection and research lines for future studies.

Chapter 2. Detecting deceit: A new coding method and challenges of the cognitive load approach

2.1. Introduction

Detecting deception is a difficult task. Over the last years, the use of the cognitive load approach has been suggested as a way to improve lie detection (Vrij, 2014; Vrij et al., 2017; Vrij, Granhag, et al., 2011a). This approach proposes that, in interview settings, lying requires greater mental effort than telling the truth, as liars are required to perform several activities simultaneously that can be considered mentally taxing: fabricating the lie and thereby trying to be plausible and paying attention to what someone already knows or can find out (Vrij, 2008a); controlling and monitoring their behaviour to appear honest to interviewers (DePaulo & Kirkendol, 1989); monitoring the reactions of the interviewers in order to examine whether their lies are believed (Buller & Burgoon, 1996; Schweitzer et al., 2002); reminding themselves to role-play and to lie (DePaulo et al., 2003); suppressing the truth while lying (Spence et al., 2001); and activating the lie (Gilbert, 1991; Walczyk et al., 2003).

An interviewer can exploit this additional cognitive load experienced by liars. If the cognitive load is increased during an interview, for example by asking interviewees to carry out a second task, this should have a greater detrimental effect in liars because they would have less attentional resources available, resulting in a worse performance both on the primary and on the secondary tasks (Vrij, Fisher, et al., 2006; Vrij, Granhag, et al., 2011a). As a result of this increased cognitive demand, liars and truth tellers may differ in their verbal and nonverbal behaviours, as liars may display a higher number of verbal and nonverbal cues associated with cognitive load, such as fewer details, more pauses and more speech hesitations (Vrij, Fisher, et al., 2008) than truth tellers.

2.1.1. The Stroop Task

The classic Stroop is a task that manipulates the stimulus-response compatibility (Verschuere & Houwer, 2011) and is sensitive to conflict-related responses. In a Stroop Task participants are shown a list of words and are asked to ignore the meaning/content of the words and name the colour in which the words are printed instead (Phelps, 2009). Despite the apparent lack of effort required to do this task, when the words asked to

ignore are the name of colours, and when those words are not compatible with the ink they are printed in (e.g. the word "blue" written in red ink), the task becomes difficult. It takes longer to name the ink in the incompatible trials because of the conflict between the response elicited by the stimulus (reading the word "blue") and the required response (saying the word "red"). Carter and van Veen (2007) suggested that naming the colour of the ink for coloured words in comparison to other words originates a significant activation of the anterior cingulate cortex, a region that, together with the inferior frontal gyrus, is known for responding to conflict or interference, and is also activated when people lie (e.g. Kozel, Padgett, & George, 2004).

Struggle in naming the ink colour of words is not exclusive for colour words. For example, patients are often slower to name the colour of a word associated with worries relevant to their psychopathology (a paradigm which is known as "emotional Stroop", Williams, Mathews, & MacLeod, 1996), as there is more performance interference on physically threatening material such as "cancer" and "blood" for participants with health worries (Mathews & Macleod, 1985). Similarly, rape victims showed greater disruption during rape theme words (Cassiday, McNally, & Zeitlin, 1992; Foa, Feske, Murdock, Kozak, & McCarthy, 1991) and individuals with spider phobia struggled with spider words (Watts, McKenna, Sharrock, & Trezise, 1986). Emotional variations of the Stroop task result in activation of the anterior cingulate as well (Whalen et al., 1998).

Research suggests that lying results in a cognitive conflict between truth telling and lying since individuals have to suppress the truth and create a lie (Phelps, 2009). There is evidence that the involvement of the anterior cingulate cortex and inferior frontal gyrus in the neural circuitry of conflict can also be exploited in lie detection studies (e.g. Kozel et al., 2004). Gronau, Ben-Shakhar, and Cohen (2005) modified the Stroop task for concealed information detection. Participants were presented with critical and control words written in one of four colours. In a first experiment, the critical words were mock-crime related (e.g. valuables presented in a stolen envelope) and in a second experiment they were autobiographical (e.g. participants' first name). Amongst other measurements, skin conductance responses (SCR) were recorded and the results showed that, in both

experiments, the SCR highly differentiated between the critical and control words, with critical words eliciting larger SCR than non-critical words.

Several authors have proposed an information-view on orienting (see Verschuere, Crombez, & Koster, 2004) suggesting that the core function of the orienting response is to enhance information processing, which is achieved by directing the senses to the stimulus and also by allocating attention towards it. The information processing view on orienting to guilty knowledge advocates that guilty knowledge elicits an "orienting reflex" signal and consequently demands attentional resources (Verschuere, Crombez, & Koster, 2004). An emotional Stroop would work similarly to a guilty knowledge's orienting reflex since the Stroop's critical words would probably evoke an orienting reflex.

Thus, we think that it is worth exploring how the Stroop task, as a means of adding extra cognitive load during an information-gathering interview, can introduce a demand for more attentional resources. Additionally, answering to an information-gathering interview while performing an emotional Stroop task will most likely result in increased cognitive effort due to the extra attentional resources required, and liars should be affected more than truth tellers when additional cognitive load is introduced during an interview.

To our knowledge no study exists that combines an emotional Stroop task with the quality of speech during an information-gathering interview – the available studies are mostly focused on variables such as reaction times (RT) and SCR (e.g. Engelhardt, Merckelbach, & van den Hout, 2003; Gronau et al., 2005), disregarding the speech analyses. In the present experiment, the Stroop tasks will be used as a method to enhance the cognitive load experienced during an information gathering interview. An adapted and computerised emotional Stroop task was used to not interfere with the oral fluency of the participants. This task is expected to cause more interference in liars, who have guilty knowledge about the critical items and are already experiencing more cognitive load than truth tellers, suffering an extra increase in cognitive load imposed by this task.

We expected that the speech of liars would show a larger decline in details in general and an increase in pauses and speech hesitations than the speech of truth tellers,

especially when the information-gathering interview and the emotional Stroop task are performed simultaneously (Hypothesis 1). We also expected that, during this dual task, compared to truth tellers, liars would display slower response times and lower hit rates in the Stroop task, particularly for the critical items (Hypothesis 2).

2.2. Method

2.2.1. Participants

A total of 134 participants took part in the experiment, but ten participants were excluded for methodological reasons (e.g. disclosing the lie, or holding the PC mouse incorrectly after being instructed to hold it in a specific position). Thus, our final sample consisted of 124 participants (75 females, 49 males). Ages ranged from 18 to 37 years (M=22.74; SD=3.86). Participants were randomly allocated to six conditions: Liar or truth teller and performing 1) the Computerized Emotional Stroop Task (CEST) only (n = 41; 21 truth tellers, 20 liars); 2) the Information-gathering interview only (n = 41; 19 truth tellers, 22 liars); 3) the CEST and information-gathering interview simultaneously (n = 42; 22 truth tellers, 20 liars).

2.2.2. Materials

For this experiment, we needed three rooms: two experimental rooms (A and B) and one interviewing room. The experimental room A was a typical seminar room with a computer, a projector, tables, chairs, a water disposal machine and windows with blinds. There were also other objects placed in that room by the experimenter: three empty bottles of water, three full bottles of water, one plastic bag, one misplaced centre piece and three name tags. The room was disorganised as part of the experiment. The experimental room B was a smaller room with a few tables, chairs and two windows, and a computer specifically placed for the experiment. On the left of the computer was a red wallet and on the right of the computer was an exemplar of the Bible. There was a little monkey toy in front of the computer screen and a coat on the back of the chair that was

in front of the computer. On another table was an iPod connected to two sound columns playing classical music. The rooms used for the experiment were always the same and the objects were always displayed in the same positions. The classical music playing was always the same too.

The CEST was programmed and run in E-PRIME. The camera used to record the interviews was a Panasonic SDR-H80 strategically placed in the same position for all the participants. The informed consent form and the pre and post-task questionnaires that all participants completed were presented on paper sheets.

2.2.3. Procedure

The truth tellers' task consisted of preparing a room (experimental room A) for a mock seminar, based on Shaw, Vrij, Mann, Leal, and Hillman (2014). Participants were given an instruction sheet with precise details about how to prepare the room (e.g. arranging the chairs). After completing the eight basic organisational tasks, innocents were briefed before being taken to the interview room. They were told that someone had accessed and stolen some sensitive information from a University's computer in room B about an exam that would take place soon. The experimenter added that despite them knowing that the participant had not been there, someone suspected him/her, and they would be interviewed about it to determine whether they have made a copy of the exam. The experimenter also told them that if they managed to successfully convince the expert that they were telling the truth, they would be considered for a raffle prize of a music concert ticket valued 50 euros or 50 euros in vouchers from a local media store.

The main task for liars was to illegally copy some encrypted information from the computer in experimental room B about an exam that would take place soon. They were told that, if anyone asked them, their alibi should be that they were preparing room A for a seminar. The experimenter added that someone else would prepare the room on their behalf and that, therefore, the room would actually be prepared in case someone checked it. After receiving this information, each participant viewed room A and prepared the alibi. The same instruction sheet provided to truth tellers was given to liars and they were asked to imagine completing that task. After a few minutes, the experimenter

escorted the participants to the "critical" room (room B) and told them that they had to enter that room and make a copy of a file called "SECRET." In order to log in the computer, they had to enter a username and a code provided to them by the experimenter, as well as a USB stick.

After the liars stole the required information, they were told that they would be questioned about the fact that someone had accessed and stolen some sensitive information about an exam from the University's computer in room B. The experimenter assured the participants that the interviewer did not know what they had been doing, but that they would be questioned about it to determine whether they knew anything about that incident. Before they entered the interviewing room, the experimenter reiterated that their task was to conceal (1) having been in room B and (2) having been involved in that theft. Instead, they had to say that they had been preparing room A. Participants were also informed that they would be considered for a raffle prize of a music concert ticket valued 50 euros or 50 euros in vouchers from a local media store if the interviewer believed them.

The critical items for the emotional Stroop tasks (conflict words) were chosen on the basis of several distinctive but realistic features contained in room B (liars' scenario only): Classical music playing: ("classical"); a little monkey toy in front of the computer ("monkey"); a picture of a horse on the computer's desktop ("horse"); a coat on the chair in front of the computer ("coat"); the name of the stolen file ("secret"); a book on the desk ("Bible"); and a wallet next to the computer ("wallet"). The words "lie", "illegal" and "code" were also added to the conflict words list.

2.2.3.1 Pre-task questionnaire

The questions of the pre-interview questionnaire were adapted to each condition. All participants answered socio-demographic questions (age, course, schooling, profession); self-perceived lying ability and self-perceived ability to detect lies – answers were given on a Likert scale ranging from 1 (not good at all) to 7 (very good). Specific colour blind tests and experience with computers (Likert 1-7) were also assessed in the two conditions that included the Stroop Task.

2.2.3.2. Computerised Emotional Stroop Task

The Computerized Emotional Stroop (CEST) task consisted of reading the words displayed on the screen and pressing, as fast and accurately as possible, the corresponding mouse button – left or right – previously associated with one of two colours – blue or red. For example, if the word "classical" was written in red ink, participants should press the right button of the mouse, pre-determined as associated with the colour "red"; if the word "classical" was written in blue ink, participants should press the left button of the mouse, pre-determined as associated with the colour "blue". Response mapping was counterbalanced across participants, meaning that the same word (e.g. classical) sometimes appeared written in blue and others in red. Also, some participants were instructed to press the left button of the mouse if the word was written in blue, and others were instructed to press the left button of the mouse if the word was written in red. A variable duration (1-5 seconds) fixation cross appeared during the inter-stimulus interval. Before the beginning of the experimental trials, participants executed six training trials (words unrelated to the experimental situation) that allowed their adjustment to the response keys.

The CEST consisted of 20 words presented twice: 10 conflict words (mock crime related) and 10 non-conflict words (not crime related), which appeared randomly. The words were selected using three criteria: 1) words with the same number of syllables; 2) same number of concrete and abstract conflict and non-conflict words; 3) the category of the target words was different from the non-target words (e.g. because "Bible" is a target word, we did not present any non-target word in the same category, such as "Koran").

After the CEST, participants performed a memory test which contained the words presented during the CEST and 20 extra words not previously seen. The 20 extra words were chosen with the following criteria in mind: 1) same number of syllables as the words presented in the CEST; 2) same number of concrete and abstract words as presented in the CEST; 3) one word from the same category of each of the words that appeared during the CEST (e.g. Bible – Koran; Monkey – Dolphin; Classical – Gothic, etc.). Participants were warned about this recognition test before performing the CEST, which intended to ensure that participants actually read the words that appeared in the CEST task.

Instructions were given before the beginning of the task(s).

CEST only:

The interviewer (who was in each condition blind to whether the participants were lying or telling the truth) told the participants that they were going to perform a task on the computer and that they must remain looking at the computer screen during the whole task. They were informed that when the experiment started, the presentation of various words would begin within intervals of few seconds, and their task was to choose between the left and right button of the mouse, depending on the colour of the word. The instructions varied concerning the mouse button attribution, as mentioned before. Participants were also instructed to work as quickly as possible without impairing the accuracy for speed and to read the words before clicking the mouse button because after this test they were going to complete a memory test about the presented words. Participants were also instructed to hold the mouse with both hands and to use the thumbs to click it.

Information-gathering interview only:

The interviewer instructed the participants to face the computer and remain looking at it. Then she asked them to describe in as much detail as possible their activities in the 15 minutes before. Participants were asked to look at the computer during the interview.

CEST and Information-gathering interview combined:

The participants were asked to perform a task – the CEST – while answering one question about their activities in the past 15 minutes. The instructions given were the same as in the other two conditions.

2.2.3.3. Post-task questionnaire

Motivation level to perform the task (CEST, interview and CEST & interview) was assessed with the following question: “How motivated were you to perform this task?”. The difficulty of the task was assessed with three questions: “How demanding was it for

you to perform this task?"; "How much did you need to think in order to perform this task?"; and "How mentally difficult was it for you to perform this task?". We also assessed if the participant considered himself successful at the required task: "Do you consider that you were able to fool the expert?" The answers were given on 7-point Likert scales ranging from 1 (not at all) to 7 (very much). Participants in the CEST & Interview condition also answered one additional question that ranged from 1 (CEST) to 7 (interview): "To what did you pay more attention?" Participants were debriefed after completing the questionnaire.

2.2.4. Coding of the interviews

Three independent coders, blind to the veracity status of the interviews and hypotheses, coded the number and type of details of the interviews: list-related action details (details of actions that participants said that they actually executed and that were on the list that truth tellers had to execute, e.g. "I turned on the computer"); list-related intention details (details that participants enumerated from the list that truth tellers had to execute, while not actually saying they did it, e.g. "I had to turn on the computer"); extra-list details (details that participants mentioned that were not on the list that truth tellers had to execute, e.g. "There were three bottles of water"); and total details (sum of all the details). The same coders counted corrections (e.g. "Then I turned on the computer… No… First I connected the projector and then I turned on the computer"); repetition of words (e.g. "I turned… turned on the computer); number of pauses (pauses of 2 seconds or more); speech hesitations (e.g. "hum…", "err…", "aaaaand"); self-reminders (e.g. "Oh, before I turned on the computer I connected the projector").

The three coders coded all the participants and the statistical analysis were performed using the average count of the three coders. To assess the reliability of the three coders' judgments, we calculated the Cronbach's alpha for each dependent variable. The results showed excellent inter-rater agreements, see Table 1. Concerning the CEST, we considered the response time (RT) and the hit rate.

Table 1. Inter-rater reliability between the coders

	Cronbach's alpha
List-related action details	.90
List-related intention details	.90
Extra list details	.94
Total details	.94
Correct themselves	.80
Repetitions	.79
Pauses	.84
Speech hesitations	.94
Self-Reminders	.90

2.3. Results

2.3.3. Pre-task questionnaire

A 3 (Interview Condition – CEST, interview, CEST & interview) X 2 (Veracity – Truth tellers and Liars) ANOVA was performed to compare the participants' self-perceived computer skills, ability to lie and ability to detect lies. No statistically significant effects emerged (all *F's* < 2.93, all *p's* > .057).

2.3.4. Post-task questionnaire

Regarding the mental effort experienced to perform the task, a 3 (Interview Condition) X 2 (Veracity) ANOVA showed a significant main effect of Interview Condition, $F(2,118) = 14.93$, $p < .001$, $\eta^2_p = .202$. Participants who answered the interview while performing the CEST reported the highest levels of mental effort. Participants in this group reported having experienced significantly more cognitive load ($M = 4.63$, $SD = 1.12$) than participants who just performed the CEST ($M = 3.52$, $SD = 1.26$), $t(81) = 4.27$, $p < .001$, 95% CI [0.59, 1.63], $d = 0.94$, or just performed the interview ($M = 3.28$, $SD = 1.27$),

t(81) = 5.13, *p* <.001, 95% CI [0.83, 1.87], *d* = 1.14. The results for the participants who just performed the interview and the participants who just performed the CEST did not differ significantly from each other, *t*(80) = 0.84, *p* = .401, 95% CI [-0.32, 0.80], *d* = 0.19. The Veracity main effect, *F*(1,118) = 1.97, *p* = .163, η^2_p = .016, and the Veracity X Interview Condition interaction effect were not significant, *F*(2,118) = 1.51, *p* = .226, η^2_p = .025.

When asked if they had convinced the interviewer of their innocence, a 3 (Interview Condition) x 2 (Veracity) ANOVA revealed that while no statistically significant effect for Interview Condition emerged, *F*(2,118) = 2.39, *p* = .096, η^2_p = .039, a main effect of Veracity indicated that truth tellers assessed their behaviour as more convincing (*M* = 4.84, *SD* = 1.39) than liars (*M* = 4.16, *SD* =1.33), *F*(1,118) = 8.31, *p*= .005, η^2_p = .066. The Veracity X Interview Condition interaction was not significant, *F*(2,118) = 0.27, *p* = .766, η^2_p = .004.

Regarding the question "To what did you pay more attention?", a one-sample t-test considering the value 4 as having paid equal attention to both tasks, showed that participants who performed both CEST and interview reported having paid more attention to the interview than to the CEST (*M* = 4.83, *SD* = 1.41), *t*(41) = 3.82, *p* <.001, 95% CI [0.39, 1.27], *d* = 1.18. However, Veracity did not have a statistically significant effect on the focus of attention during the task, *t*(40) = 0.72, *p* = .943, 95% CI [-0.94, 0.88], d = 0.02.

2.3.5. Memory Test

Results from the memory test showed a main effect for Interview Condition, *F*(1,79) = 46.74, *p* < .001, η^2_p = .372. Participants who only performed the CEST correctly remembered more words (*M* = 16, *SD* = 3.85) than participants who performed the CEST & interview (*M* = 9.43, *SD* = 4.73). The Veracity main effect, *F*(1,79) = .05, *p* = .825, η^2_p = .001, and the Veracity X Interview Condition interaction effect, F(1,79) = .01, p = .905, η^2_p = .000, were not significant.

2.3.6. CEST

CEST data for RT and hits were analysed with a 2 (Interview Condition – CEST, CEST & interview) x 2 (Veracity – Truth tellers and liars) x 2 (Item – Baseline, Target) mixed design ANOVA. Interview Condition and Veracity were between-subject factors and Item was a within-subject factor. Considering the within-subject factors statistical effects, there was only a main effect of Item on hits (Greenhouse-Geisser corrected: $F(1,79) = 4.24$, $p = .043$, $\eta^2_p = .051$). Participants had more hits for baseline words ($M = 18.52$, $SD = 1.70$) than for target words ($M = 18.14$, $SD = 1.88$).

Considering the between-subject factors, there was a main effect of Interview Condition on hits, $F(1,79) = 23.97$, $p < .001$, $\eta^2_p = .233$. Participants who just performed the CEST had more hits ($M = 19.10$, $SD = 1.16$) than participants who performed the CEST and the interview simultaneously ($M = 17.58$, $SD = 1.63$). Also, a trend was found for Interview Condition on RT, $F(1,79) = 3.60$, $p = .062$, $\eta^2_p = .044$) suggesting that participants who performed the CEST and the interview took more time to respond ($M = 594.97$, $SD = 76.87$) than participants who only performed the CEST ($M = 560.18$, $SD = 88.17$). No further statistically significant effects emerged, all $F's < 1.77$, all $p's > .19$. Hypothesis 2 was not supported.

2.3.7. Verbal Coding

For the details (list-related action details, list-related intention details, extra-list details, total details) we used the exact numbers. For each variable other than details, we calculated the proportion between the number of counts in that variable and the total number of words in the whole speech of each participant. For example, if participants were assessed as giving "x" speech hesitations and their speech during the interview contained "y" words, we calculated the proportion $\frac{x}{y}$ and considered that value for the statistical analysis. This follows common procedure in deception research (Vrij, 2008a).

We performed a 2 (Interview Condition – interview vs. CEST & interview) x 2 (Veracity) ANOVA for each speech variable. The ANOVAs showed significant main effects for Veracity on list-related action details, $F(1,79) = 8.38$, $p = .005$, $\eta^2_p = .096$, and list-

related intention details, $F(1,79) = 6.69$, $p = .012$, $\eta^2_p = .078$). Liars gave more list-related action details ($M = 10.33$, $SD = 3.79$) than truth tellers ($M = 7.61$, $SD = 4.50$), while truth tellers gave more list-related intention details ($M = 4.64$, $SD = 4.75$) than liars ($M = 2.27$, $SD = 3.32$).

The ANOVAs further showed significant main effects of Interview Condition on extra-list details, $F(1,79) = 4.31$, $p = .041$, $\eta^2_p = .052$, and total details, $F(1,79) = 4.66$, $p = .034$, $\eta^2_p = .056$. Both liars and truth tellers who performed only the information-gathering interview gave more extra-list details ($M = 15.92$, $SD = 10.51$) and total details ($M = 28.81$, $SD = 12.49$) than participants that performed the CEST & interview ($M = 12.06$, $SD = 7.52$; $M = 23.90$, $SD = 8.90$). All other statistical effects were not significant, all F's < 2.78, all p's > .099. Hypothesis 1 was not supported.

Concerning the other speech variables, Hypothesis 1 was also not supported. The ANOVA showed a main effect of Veracity for speech hesitations, $F(1,79) = 4.59$, $p = .035$, $\eta^2_p = .06$. Truth tellers were rated as hesitating more ($M = .09$, $SD = .03$) than liars ($M = .07$, $SD = .04$). A main effect for Interview Condition emerged for pauses, $F(1,79) = 15.17$, $p < .001$, $\eta^2_p = .16$. Participants who performed the CEST & interview were rated as pausing more ($M = .02$, $SD = .02$) than participants who only performed on the interview ($M = .01$, $SD = .01$). There was also a significant interaction between Interview Condition and Veracity on pauses, $F(1,79) = 4.89$, $p = .030$, $\eta^2_p = .06$). While the truth tellers who only performed the interview were assessed as pausing more ($M = .010$, $SD = .012$) than liars ($M = .004$, $SD = .006$), liars who performed the CEST & interview were rated as pausing more ($M = .024$, $SD = .024$) than truth tellers ($M = .016$, $SD = .011$). All other statistical effects were not significant, all F's < 2.01, all p's > .160.

2.4. Discussion

In this experiment we tested a new interview technique based on the manipulation of cognitive load. Differences between liars and truth tellers emerged regarding the list-related action details (e.g. I turned on the computer), list-related intention details (e.g. I had to turn on the computer) and hesitations. While liars gave more list-related action details, truth tellers gave more list-related intention details. This

can be explained by the fact that liars typically do not take their credibility for granted (DePaulo et al., 2003; Gilovich, Savitsky, & Medvec, 1998; Kassin, 2005; Kassin & Gudjonsson, 2004; Kassin & Norwick, 2004; Vrij, Mann, et al., 2006). Liars, therefore, wanted to be as assertive as possible (e.g. "I did this", "I did that"), without mentioning that they were following a list of instructions. Truth tellers did not show having problems in mentioning that they were following a list of instructions, where they "had to do this or that". The results concerning speech hesitations also support these findings: truth tellers hesitated significantly more than liars. The need to show certainty and security in what they were saying was patent in the liars' results: they said what they immediately remembered and trying not to hesitate, while truth tellers were not afraid to take their time to think.

Results showed that the secondary task increased mental effort in both truth tellers and liars, and both groups displayed signs of cognitive load. That is, both liars and truth tellers paused significantly more in the CEST & interview condition than in the interview only condition and regarding the hit rates, both liars and truth tellers were significantly more accurate when performing just the CEST compared to when performing the CEST & interview combined. Thus, the addition of the CEST to the interview did not improve the ability to discriminate between liars and truth tellers, it just made the task harder for both groups. The self-reports support this conclusion: Regardless of Veracity, participants who performed the dual task reported having experienced more cognitive load than participants who just performed the CEST or just the interview. Lying has been shown to be cognitively more demanding than telling the truth and recent research has suggested that an effective way to discriminate between liars and truth tellers would be to raise the cognitive load experienced by truth tellers and liars. Our study thus suggests that one needs to be careful with the amount of cognitive load that is imposed: Excessively increasing the cognitive load can lead to a task that is too difficult for liars as well as truth tellers, equalizing the amount of effort needed by liars and truth tellers, and not being helpful to discriminate between them.

Chapter 3. Stereotypical cues of lying: Does truth tellers' nervousness increase judgements of deception?

3.1. Introduction

Over the last years, research has shown that people are poor lie detectors, performing at a chance level (Bond & DePaulo, 2006; Memon, Vrij, & Bull, 2003; Vrij, 2008a). Classic lie detection studies are characterised by showing video clips from liars and truth tellers to professional lie detectors (e.g. police officers) and asking them to identify if the individual is lying or telling the truth (Vrij, 2004). Three main findings stood out in a meta-analysis from Vrij & Mann (2005) examining ten lie detection studies with professional lie catchers: 1) the accuracy scores for detecting truths and detecting lies combined (total accuracy rate) was 55%, which was analogous to the total accuracy rate (57%) found in laypeople; 2) despite professionals appearing to have accuracy problems concerning lie detection, they frequently feel more confident in their ability to detect truths and lies comparing to laypeople; and 3) some groups of professional lie detectors are better than others. Nevertheless, Mann and colleagues' (2004) study with authentic high stake liars showed that the analysed police officers, not identified as belonging to a group superior in lie detection, were able to identify truths and lies above the level of chance – 66% accuracy in detecting lies and 63% accuracy in detecting truths. In this study, accuracy was negatively correlated with popular stereotypes cues of nervousness.

Lie detection is a difficult process. Research has shown that there is not even one cue that lie detectors can rely upon consistently, i.e., there are not verbal or nonverbal cues exclusively related to deception (DePaulo et al., 2003; Sporer & Schwandt, 2006, 2007; Vrij, 2005). For example, from the 158 cues analysed in the meticulous DePaulo and colleagues' (2003) meta-analysis, 118 cues (75%) did not show any association with deception, including cues that people typically associate with lying (e.g. gaze aversion, postural shifts, self-references).

The focus on nonverbal cues is common in the majority of the classical lie detection techniques, specifically when investigators do not have facts to compare the verbal information with, or when speech content is not distinctive (Vrij, Granhag, et al., 2010). This preference may be a consequence of training. Training manuals (e.g. Inbau et al., 2001; Ekman, 1985/ 2001) have encouraged nonverbal analysis to the detriment of analysis of speech cues (Bond & DePaulo, 2006; Vrij & Granhag, 2007). However, over the

past years, speech-related deception detection research has been developed (e.g. Vrij, 2008b; Vrij, Granhag, et al., 2010) and meta-analyses of verbal and nonverbal cues of deception suggest that many speech-related cues are more reliable to detect deceit than nonverbal ones (DePaulo et al., 2003; Vrij, 2008b). Also, focusing on behavioural cues may encourage a lie detection bias, i.e., the tendency to judge someone as a liar (Bond & DePaulo, 2006).

The cognitive load approach (Vrij, 2014; Vrij et al., 2017; Vrij, Granhag, et al., 2011a) is based on the premise that, generally, lying is cognitively more demanding than telling the truth (see Vrij, Fisher, et al., 2008). Some of the factors that contribute to increase liars' cognitive load are: the formulation of the lie and the effort to be plausible and consistent (Vrij, Fisher, et al., 2008), the need to monitor their own behaviour (DePaulo & Kirkendol, 1989) and the interviewer's reaction (Buller & Burgoon, 1996; Schweitzer et al., 2002), and the suppression of the truth (Spence et al., 2001). Thus, during a typical interview, liars will experience a higher level of mental effort compared to truth tellers, which can originate some cognitive load-related cues, such as pauses, speech hesitations and fewer details (Vrij, Fisher, et al., 2008). Since liars are already more vulnerable than truth tellers because they are lying, a way to enhance these differences between liars and truth tellers is to manipulate the interviewees' mental state by using interview methods that increase the experienced cognitive load.

In the present study, we aimed to investigate how those variables can influence the veracity judgments and accuracy rate of Portuguese professionals from *Guarda Nacional Republicana* (GNR – Republican National Guard) in discriminating liars and truth tellers based on videos from recorded interviews. We used two types of interviews: an information-gathering interview and an information-gathering interview with a secondary task performed simultaneously, which was a technique used to increase the mental effort of the interviewees. Hence, we expected that the accuracy rate would be higher when participants saw the dual task videos (Hypothesis 1). We also hypothesised that our participants would have an accuracy rate similar to what has been found in recent lie detection literature for the information-gathering interview – i.e., around chance level (Hypothesis 2). Finally, we predicted that the use of stereotypic cues related to

nervousness would be positively correlated to judgements of deception, regardless of being correct or not (Hypothesis 3).

3.2. Method

3.2.1. Participants

A total of 160 officers from GNR (142 males, 17 females, 1 unknown), ages from 26 to 53 (*M*=39.28, *SD*=6.21) participated in this experiment. One participant was excluded due to technical reasons.

The experiment was conducted in the headquarters of the GNR in different cities, after superior authorization was given. All participants signed the informed consent form.

3.2.2. Materials

For this experiment, 79 videos with a duration of 1 to 2 minutes were used. Thirty-nine of the videos contained participants answering to an information-gathering interview and forty contained participants answering to an information-gathering interview while performing a secondary task. These videos were previously recorded as part of another study (for more details, see Chapter 2). In each condition (information-gathering interview – IGI / information-gathering interview with secondary task – IGI-ST), some participants were telling the truth (18 in IGI / 22 in IGI-ST), and the remaining were lying (21 in IGI / 18 in IGI-ST). The videos were shown on a 13.3'' Toshiba laptop. The questionnaire and the informed consent form were completed on paper. The questionnaire (see Appendix) aimed to evaluate four different dimensions: cognitive load, nervousness, task difficulty and attempt to control the behaviour. Participants had to answer questions concerning what they have perceived from the interviewees' answers. Examples: "What is the level of cognitive load that the interviewee seem to be experiencing during the interview?"; "Did the interviewee appear to attempt to control his/her behaviour?"; "Do you consider that the interviewee was nervous?"; "How did the interviewee's task seem?". Each dimension was evaluated through three different questions on a Likert scale from 1 (very low/none/not at all…) to 7 (very high/very

much/very…). Finally, they were also asked to answer to how much did they consider the interviewee was telling the truth, also on a Likert scale from 1 (nothing) to 7 (very) – veracity scale.

3.2.3. Procedure

Each video was shown twice, to different GNR officers, except one video, that was shown four times (again to different officers). Thus, each GNR officer saw one video, and each video was seen individually by two officers, except one, who was seen by four officers. As a result, if we do not include the participant that was eliminated, there were 79 GNR officers seeing videos from truth tellers, and 80 officers seeing videos from liars.

The participants knew that they were participating in a lie detection study. Before the experiment begun, they were told that the experiment consisted of visualising one short video and answering an anonymous questionnaire about it. They were briefed about the specificities of the interview that they were going to visualise: the interviewees from the videos were instructed to remain looking at the computer in front of them during the interview – there was no eye contact with the camera, but that was not an individual choice from each interviewee. This instruction was given to the interviewees because half of them performed a secondary task while answering to the interview that required looking at a computer screen. Therefore, all the interviewees were asked to look at the screen during the interview, even if no secondary task was required. No further information was disclosed, so that all the observers assessed the video with the same knowledge.

After visualising the video, participants were required to answer all questions from the questionnaire. There were several versions of the questionnaire, so that questions could be presented in different order among the participants. Participants were not allowed to see the videos more than once (which they knew from the beginning), but they were given access to the questions before watching the videos so they knew what to pay attention to. They could have as much time as they wanted to answer the questions. In the end, participants were debriefed.

3.3. Results

We created a new dependent variable by transforming the variable veracity scale into a dichotomous variable, veracity scale – dichotomous, having considered that interviewees classified with 1, 2, or 3 in the scale were assessed as being lying, whereas interviewees classified with 5, 6, or 7 in the scale were assessed as telling the truth. Answers with the value "4" (18.87% of the responses) counted as "fails" for the analysis of the accuracy rate, as that value was precisely in the middle of the scale and was considered equivalent to "do not know" answer.

Concerning the different interview conditions, the accuracy rate was 40.5% when the observers saw interviewees from the information-gathering interview (IGI) and 41.3% when they saw interviewees from the information-gathering interview performed simultaneously to a secondary task (IGI-ST) (see Table 2). The accuracy rate did not differ between the two interview conditions ($X^2(1) = .009$, $p = .526$). Therefore, Hypothesis 1 was not supported. Overall, the accuracy rate was 39.2% for discriminating truth tellers and 42.5% for the identification of liars (see Table 3). The accuracy rate was similar when assessing truth tellers and liars ($X^2(1) = .175$, $p = .399$) and below of what has been reported in previous studies. Thus, Hypothesis 2 was also not supported.

Table 2. Condition * Accuracy rate cross tabulation

			Accuracy rate		
			Hit	Fail	Total
Condition	Information-gathering interview	Count	32	47	79
		Expected Count	32.3	46.7	79.0
		% within Condition	40.5%	59.5%	100,0%
	Information-gathering interview with secondary task	Count	33	47	80
		Expected Count	32.7	47.3	80.0
		% within Condition	41.3%	58.8%	100.0%
Total		Count	65	94	159
		Expected Count	65.0	94.0	159.0
		% within Condition	40.9%	59.1%	100.0%

Table 3. Group * Accuracy rate cross tabulation

			Accuracy rate		Total
			Hit	Fail	
Group	Truth tellers	Count	31	48	79
		Expected count	32.3	46.7	79.0
		% within Group	39.2%	60.8%	100.0%
	Liars	Count	34	46	80
		Expected count	32.7	47.3	80.0
		% within Group	42.5%	57.5%	100.0%
Total		Count	65	94	159
		Expected count	65.0	94.0	159.0
		% within Group	40.9%	59.1%	100.0%

The results for the four domains assessed by the questionnaire were analysed with four 2 (Condition – IGI vs. IGI-ST) x 2 (Veracity status – Liars vs. Truth tellers) ANOVAs. Regarding cognitive load, there was a main effect of Condition, $F(1, 155) = 4.02$, $p = .047$, $\eta^2_p = .025$. Participants who performed the dual task were assessed as experiencing more mental effort ($M = 4.75$, $SD = 1.30$) than participants who just answered to an information-gathering interview ($M = 4.32$, $SD = 1.39$). All other effects, from all analyses, were not statistically significant, all F's < 2.08, all p's > .151.

In order to examine in more detail how correctly and incorrectly classified truth tellers and liars were assessed by the observers, further independent samples t tests were carried out. For these statistical analyses, we used the veracity scale – dichotomic and answers with the value "4" from the variable veracity scale were discarded, for the same reason mentioned above. These analyses revealed that the truth tellers wrongly assessed as liars were rated as more nervous ($M = 5.21$, $SD = 1.38$) than truth tellers correctly assessed ($M = 4.16$, $SD = 1.59$), $t(66) = -2.93$, $p = .005$, 95% CI [-1.77, -.34], $d = 0.72$. Likewise, truth tellers who were incorrectly assessed as liars were rated as attempting to control their behaviour more ($M = 5.08$, $SD = 1.39$) than truth tellers who were accurately assessed ($M = 4.01$, $SD = 1.62$), $t(66) = -2.93$, $p = .005$, 95% CI [-1.80, -.34], $d = 0.73$. The independent samples t-test also showed that liars who were correctly identified were tendentiously regarded as attempting to control their behaviour more ($M = 4.88$, $SD = 1.50$) than liars who were mistakenly assessed as truth tellers ($M = 4.04$, $SD = 1.85$), $t(59) = -1.97$, $p = .053$, 95% CI [-1.70, -.04], $d = 0.51$.

A Pearson correlation was carried out between the variables cognitive load, nervousness, task difficulty and attempt to control the behaviour, and the veracity scale (this time not dichotomised). A significant correlation emerged between the variable nervousness and the veracity scale ($r = -.311$, $p < .001$): the more the observers rated the interviewees as nervous, the lower they rated them on the veracity scale, i.e., the more they considered the interviewees as not being truthful. Also, the variable attempt to control the behaviour and the veracity scale were also significantly correlated ($r = -.387$, $p < .001$): the more the observers perceived the interviewees as attempting to control their behaviour, the more they gave them lower ratings on the veracity scale, hence,

identifying them as being less truthful. No further correlations emerged. These results including the full sample of observers confirm the previous *t*-tests analyses and provide further support for Hypothesis 3.

3.4. Discussion

In this experiment, we intended to study the ability to discriminate liars and truth tellers of a Portuguese sample of officers from GNR. Also, we aimed to understand which factors might influence those judgments. We used two types of interview, an information-gathering interview and an information-gathering interview with increased cognitive load. Our results suggest that the type of interview did not influence the accuracy rate. Although observers rated the interviewees from the dual task condition as experiencing more cognitive load than participants from the interviewing-gathering condition, statistically significant differences on veracity assessments did not emerge. Moreover, ratings on the experienced cognitive load were not correlated to the participants' judgments on the veracity scale. We can hypothesise that these professionals might not have enough knowledge about the recent lie detection techniques concerning the cognitive load approach and therefore do not use it. Alternatively, maybe the dual task was mentally challenging for both liars and truth tellers, leading both to exhibit cognitive load cues, which was detrimental to the performance of the observers. However, if that were the case, we would expect a bias towards judging interviewees as liars, leading to higher accuracy rates in classifying liars and lower accuracy rates in classifying truth tellers, which was not the case, as performance was similar for both.

Finally, the results suggest that when the observers wrongly classified truth tellers as liars, they previously assessed them as being significantly more nervous than the truth tellers who were correctly classified. Also, the truth tellers misidentified as liars were also rated as attempting to control their behaviour significantly more comparing to the truth tellers that were properly identified. Concerning the liars, the interviewees who were correctly identified were rated as attempting to control their behaviour more than the

lying interviewees that were misidentified as truth tellers. In line with this, there was also a significant correlation between the variables nervousness and attempt to control the behaviour, and the veracity scale. The more the observers rated the interviewees as nervous and attempting to control the behaviour, the lower they rated them on the veracity scale, i.e., the more they assessed them as liars. Thus, the use of anxiety cues seems to be positively correlated to judgements of deception, providing support to what has been identified in the literature as *Othello error* (Vrij, Granhag, et al., 2010). Research has consistently shown that both laypeople and professionals have a tendency to expect liars will exhibit signs like gaze aversion and grooming gestures (Strömwall et al., 2004; Taylor & Hick, 2007; The Global Deception Research Team, 2006; Vrij, 2008a; Vrij, Akehurst, et al., 2006). Nonetheless, despite research showing that those are not reliable cues to deception (DePaulo et al., 2003; Sporer & Schwandt, 2007), their use is still incentivised (Johnson, 2006).

Our results do suggest that observers associate nervousness and attempting to control the behaviour to lying. The analysed police officers in Mann and colleagues (2004) were able to identify truths and lies above the level of chance (66% accuracy in detecting lies and 63% accuracy in detecting truths), being that accuracy was negatively correlated with popular stereotypes cues of nervousness. However, the perceived nervousness and behaviour control occurred in situations of both lying and truth telling. Given that these cues were not exclusive from liars, they do not appear as reliable cues to discriminate liars and truth tellers. Yet, our results suggest that these beliefs persist in the security force in analysis. The US National Research Council (2003) has already published a report claiming that there is not compelling evidence that liars would experience more fear or anxiety than truth tellers. Our results concerning the practitioners' beliefs are in line with previous studies (Strömwall et al., 2004; Vrij, Akehurst, et al., 2006; Vrij, Semin, & Bull, 1996), providing further strength to the claim for a change in direction concerning the lie detection protocols (Vrij, 2014; Vrij & Granhag, 2012).

Chapter 4. The influence of social anxiety in lie detection interviews

4.1. Introduction

Anxiety can be distracting, disturbing and debilitating, and can cause performance to decline (Vytal, Cornwell, Letkiewicz, Arkin, & Grillon, 2013). Moriya and Tanno (2008) suggested that trait social anxiety is strongly associated with an impaired attentional control. Also, the fear of being negatively evaluated by others shapes someone's cognitive, emotional and physiological functioning (Baldwin & Main, 2001). Therefore, socially anxious individuals might show covert safety behaviours such as thinking carefully about what they are going to say next in order to reduce the risks of negative evaluation by others (Pinto-Gouveia, Cunha, & Salvador, 2003). Intrapersonal and interpersonal differences are often neglected in lie detection (Vrij, 2004; Vrij, Granhag, et al., 2010), which could lead to misidentifying liars and truth tellers. It is therefore important to examine social anxiety because it could influence lie detection.

When interviewing suspects, the two most popular interviewing styles are the information-gathering interview and the accusatory interview (Meissner et al., 2012). Information-gathering is based on building rapport, explaining the allegation and the transgression, emphasising the importance of honesty and truth gathering, requesting the suspects' version of the event, and allowing suspects to provide all the information they consider important without being interrupted (Meissner et al., 2012). The information-gathering interview encourages suspects to talk, which may offer more information about the alleged event to the investigators (Bull, 2010; Fisher, 2010). An accusatory interview is based on confrontation and psychological manipulation, using guilty-presumptive questions and confronting the suspect with an accusation (Meissner et al., 2012), which will exert more pressure on suspects than an information-gathering interview style (Vrij, Mann, et al., 2006). However, it can also be less cognitively demanding (Vrij, Mann, et al., 2006). In accusatory interviews, the respondents' replies are likely to be simple and short refutations of the accusations (e.g. ‘‘I didn't do it'', ‘‘I am innocent''), whereas in information-gathering interviews respondents are encouraged to provide detailed and extensive statements about their activities.

In an experiment in which the two interview styles were compared, suspects experienced more discomfort during accusatory interviews but found an information-

gathering interview cognitively more demanding (Vrij, Mann, et al., 2006). In addition, individual differences emerged. Participants who considered themselves as being shyer, felt most anxious in the two most anxiety-provoking settings (the accusatory interviews or when lying) and experienced more cognitive load in the potentially most challenging interview conditions: the information-gathering interview or when lying (Vrij, Mann, et al., 2006).

Speech hesitations are typically considered suspicious (Vrij, 2008a), but they may differ between truth tellers and liars as a function of social anxiety. Liars are expected to experience more cognitive effort than truth tellers because lying is cognitively more difficult than telling the truth (Vrij, Fisher, et al., 2006). That would mean that liars would hesitate more than truth tellers (Sporer & Schwandt, 2006) and also that liars would provide fewer details than truth tellers (e.g. Vrij, Fisher, et al., 2008) since those seem to be signs of mental effort. Socially anxious participants would also experience more mental effort, because they usually think carefully about what they say in order to create a positive impression, thus possibly hesitating more than non-socially anxious participants. However, non-socially anxious truth tellers may not be afraid to take their time to think when answering to the interviews, hence hesitating more than non-socially anxious liars, since non-socially anxious truth tellers do not have the pressure to appear credible or the fear of being negatively evaluated.

Also pauses are considered suspicious (Vrij, 2008a) but they too may differ between truth tellers and liars as a function of social anxiety, in a similar way to speech hesitations.

Thus, we expected that socially anxious participants would hesitate and pause more than participants with low social anxiety (Hypothesis 1). Since the information-gathering interview seems to be cognitively more difficult, we expected that this effect would occur especially during the information gathering interview (Hypothesis 2). We also anticipated that liars would hesitate and pause more than truth tellers in general (Hypothesis 3), especially during the information-gathering interview (Hypothesis 4). We predicted that while liars with high anxiety might hesitate and pause more than truth

tellers with high anxiety, truth tellers with low anxiety would hesitate and pause more than liars with low anxiety (Hypothesis 5).

Research consistently suggests that information-gathering interview allows obtaining more information, hence more details. We expected that participants, in general, would provide fewer details during the adapted accusatory interview than during the information-gathering interview (Hypothesis 6) and that truth tellers would provide more details than liars regardless of the interviewing style (Hypothesis 7). Due to the increased cognitive load that socially anxious participants experience, we also predicted that socially anxious participants would give fewer details than non-socially anxious participants (Hypothesis 8), especially in the accusatory interview (Hypothesis 9).

4.2. Method

4.2.1. Participants

A total of 251 participants completed a social anxiety questionnaire (Social Interaction and Performance Anxiety and Avoidance Scale (SIPAAS), Pinto-Gouveia et al., 2003). Considering the results (see below), 80 participants were asked to join the second phase of this experiment, but nine were excluded due to methodological reasons (e.g. did not understand the task, the camera was not in the right position). Our final sample consisted of 71 participants, primarily females (61 females), with ages from 18 to 47 (M = 24.21, SD = 5.77). The participants, part of a non-clinical sample, were randomly allocated to one of four conditions: liars with high (n = 19) or low social anxiety levels (n = 17) or truth tellers with high (n = 17) or low social anxiety levels (n = 18).

4.2.2. Materials

We used an online questionnaire via *Qualtrics Survey Software*, that consisted on the Anxiety/Discomfort subscale of SIPAAS, α = .95, (Pinto-Gouveia et al., 2003). This Likert subscale from 1 (none) to 4 (severe) consisted of 44 items and assessed the anxiety levels concerning several social interactions that are representative of a set of situations often dreaded by people with social anxiety disorder (Pinto-Gouveia et al., 2003).

For the second part of the experiment, we used three rooms: one experimental room and two interviewing rooms, one for each interviewer. The experimental room was a small room with a window, blinds, a desk, two chairs, one of which had wheels, a white board with colourful markers, and a cabinet. There was also a plastic bag and three empty bottles of water and an empty envelope. Inside the cabinet, there was a telephone, a stapler, a hole puncher and a box of clips. Each interviewing room had two chairs, one laptop with a built-in camera and a video camera placed at the same position for all the participants, at about 1,5 meters of distance and filming from the waist up. The informed consent form that all participants completed were presented on paper sheets.

4.2.3. Procedure

We started by advertising a study that consisted of completing an adapted and online version of the SIPAAS and invited people to answer it. We informed the participants that they might be contacted later for a second phase of the experiment and, if they agreed, they were asked to give us their email address.

Participants were selected based on their results on the SIPAAS. According to Pinto-Gouveia and colleagues (2003), in non-clinical samples socially anxious participants scored at 103.18 on average and non-socially anxious students averagely scored at 91.36. Participants who scored lower on the social anxiety questionnaire up to the 50th percentile (≤96) were allocated to the low social anxiety group. Participants who scored higher than the 60th percentile (≥102) were allocated to the high social anxiety group. Then, participants were randomly attributed to a truth-telling or lying condition.

Participants selected for the second phase of the study arrived at the Psychology and Education Department and were brought to the experimental room, which was a Professor's office. In the truth-telling condition, the office door was unlocked, and the experimenter gave an instruction sheet with eight tasks that the participants should complete (e.g. close the blinds, collect the garbage). The participants were asked to wait for the experimenter when they finished their tasks. The experimenter arrived five minutes later and led the participant to one of the interview rooms.

In the lying condition, participants were given an envelope with instructions. The instructions informed them to wait for the experimenter if the office door was locked, which was the case in this condition. Three minutes later the experimenter returned and gave the participants the same list of instructions that was given to truth tellers. However, in this case participants should only read the instructions and imagine that they had to execute them but not actually perform the task. They had two minutes to do so, and then they were escorted to the interview room.

Before both liars and truth tellers arrived at the interview room, the experimenter informed them that they were going to be asked about their activities by two interviewers in two different rooms in order to determine if they had been preparing the office or not. They were informed that the interviewers did not know if the participants were lying or telling the truth and that their job was to convince them that they were telling the truth. If they managed to do it successfully, they would be considered for a raffle prize of 30 euros in vouchers from a local media store. Also, the experimenter told the participants that the interviews would be watched by a group of observers through the computer camera, using *Skype*. The observers would decide whether they were telling the truth or not. In reality no one was watching, but the camera was on.

Two different interview styles were used: an information-gathering interview and an accusatory interview. There were two interviewers in two different rooms who were responsible for asking the questions and who were blind to the participants' condition. The interviewers and the order of the interviews were counterbalanced. Both interviewers carried out both types of interview, and each interviewer performed only one of the interview styles for each participant. The participants were conducted between rooms by the experimenter.

For the information-gathering interview, interviewers asked the participants to describe in as much detail as possible their activities in the previous minutes, since they arrived at the department. For the second type of interview, we did not use the classical accusatory interview, but an adapted version. In this experiment, interviewers started by saying that they knew the interviewees did not prepare the office and ask them to describe what they had been doing since they arrived at the department. We asked the

participants in the accusatory interview to describe where they had been so that we could compare the speeches between the information-gathering interview and the accusatory interview. Our purpose with the accusatory style was mainly to elicit anxiety.

4.2.4. Coding of the interviews

We asked three independent coders to code the total number of details of the interviews. The same coders counted the number of pauses (pauses of 2 seconds or more) and speech hesitations (e.g. "hum…", "err…", "aaaaand").

The three coders did not know the veracity status, the interview condition of the participants, or any hypothesis of the experiment. Each coder coded all interviews, and we used their average score to perform the statistical analysis. The Cronbach's alpha calculated for each dependent variable allowed us to assess the reliability of their judgments and the results showed excellent inter-rater agreements (see Table 4).

Table 4. Inter-rater reliability between the coders

	Cronbach's alpha (Accusatory interview)	Cronbach's alpha (Information-gathering interview)
Total details	.97	.98
Pauses	.74	.75
Speech hesitations	.96	.94

4.3. Results

Following common procedures in deception research (Vrij, 2008a), we analysed the frequency of occurrence for total details. For pauses and hesitations, we calculated the proportion between the frequency of occurrence of that variable and the total number of words given by the participant in the entire interview.

A 2 (Veracity – liar vs. truth teller) x 2 (Anxiety level – low anxiety vs. high anxiety) x 2 (Interview style – accusatory vs. information-gathering) mixed designed ANOVA was

performed. Interview style was a within-subjects factor, whereas Veracity and Interview style were between-subjects factors.

Regarding speech hesitations, a significant main effect emerged for Anxiety level, $F(1, 67) = 4.11$, $p = .047$, $\eta^2_p = .06$. Participants with lower anxiety ($M = .07$, $SD = .03$) hesitated less than participants with higher levels of anxiety ($M = .08$, $SD = .04$). There was also a significant Anxiety level x Veracity interaction effect, $F(1, 67) = 11.34$, $p = .001$, $\eta^2_p = .15$. Truth tellers with low anxiety hesitated significantly more ($M = .08$, $SD = .03$, 95% CI [.07, .09]) than liars with low anxiety ($M = .05$, $SD = .03$, 95% CI [.04, .07]), $F(1, 33) = 8.88$, $p = .005$, $\eta^2_p = .212$, and liars with high anxiety tended to hesitate more ($M = .10$, $SD = .05$, 95% CI [.08, .11]) than truth tellers with high anxiety ($M = .07$, $SD = .03$, 95% CI [.05, .09]), $F(1, 34) = 3.89$, $p = .057$, $\eta^2_p = .103$. Concerning pauses, no statistically significant differences emerged (all F's < 1.86, all p's > .177). Hypothesis 1 and 5 were supported for hesitations, but not for pauses. Hypothesis 2, 3 and 4 were not supported for hesitations nor pauses.

Regarding the total number of details, participants provided less details in the accusatory interview ($M = 38.88$, $SD = 16.58$) than in information-gathering interview ($M = 41.69$, $SD = 17,42$), $F(1, 67) = 5.38$, $p = .023$, $\eta^2_p = .074$. Also, truth tellers gave more details ($M = 45.50$, $SD = 18.55$) than liars ($M = 35.22$, $SD = 13.78$), $F(1, 67) = 7.76$, $p = .007$, $\eta^2_p = .104$. Hypothesis 6 and 7 were supported. All other statistical effects were not significant, all F's < .526, all p's > .471. Hypothesis 8 and 9 were not supported.

4.4. Discussion

Our findings showed that participants with higher social anxiety hesitated more than participants with lower social anxiety, showing signs of thinking harder (Sporer & Schwandt, 2006). Also, when comparing truth tellers and liars with high social anxiety, liars hesitated more than truth tellers, which may be the result of the extra cognitive load experienced by socially anxious liars. However, when comparing truth tellers and liars with low social anxiety, truth tellers hesitated significantly more than liars, maybe because they were more willing to try to remember every detail and did not worry about

making a convincing impression, while liars may have been afraid to hesitate out of fear that this would negatively affect their credibility. These findings suggest that when investigators rely on hesitations to detect deceit, they should take into account the level of social anxiety of the interviewee.

Concerning pauses, no differences occurred. This is surprising as we expected pauses to reveal the same pattern of results as hesitations, but that was not the case. Thus, what caused the difference in results for hesitations and pauses? Our answer to this question is necessarily speculative. Perhaps participants were generally motivated to avoid making pauses in order to appear credible. When answering a question, they may have decided (perhaps after a hesitation) to provide all the information they wanted to convey at once rather than starting with an answer, then pause for what to say more, and then to continue with that answer. If this is the case, it may suggest that pauses in speech are more under voluntary control than hesitations. This would require additional investigation in future studies.

Regarding total details, during the information-gathering interview participants gave significantly more details than during the accusatory interview. This is in line with previous research that suggests that information-gathering interviews provide more details (e.g. Vrij, Mann, et al., 2006). In our experiment the two interviews contained the same request, to describe in much detail as possible the participants' activities since they met the experimenter. However, the adapted accusatory interview included an accusation, the interviewer started by saying that she 'knew' the interviewees did not prepare the office. Thus, our data suggest that being accused interfered with the amount of details that both liars and truth tellers provided: one accusation was enough to obtain fewer details from the interviewees. Finally, truth tellers provided more details than liars in both types of interview, which is in line with previous studies (e.g. Vrij, Fisher, et al., 2008) that suggest that, due to the mental effort increased by lying, liars provide less details than truth tellers.

Some limitations of the current study are worth mentioning, although they apply to most deception studies: the sample mainly consisted of university students, the participants were asked to lie or tell the truth (they could not choose), and the stakes in

the experiment were low. The important question is how such factors could have influenced the results. Perhaps the fact that the participants could not choose to lie is the most important factor, as socially anxious individuals may opt to lie less frequently than their counterparts (Kashy & DePaulo, 1996). Research suggests that they usually persist less in a lie (Vrij & Holland, 1998). However, even socially anxious individuals cannot avoid lying all the time, so this may be representative of real life situations.

Our data suggest that professionals should start assessing social anxiety before conducting lie detection interviews, particularly when relying on cues such as hesitations. For that, they could use the SIPAAS, which is easily administrated and coded. Social anxiety seems to have the power to influence the interviewee's response to frequently used interrogation techniques.

Chapter 5. General discussion and conclusions

5.1. Summary of main findings and limitations

The studies carried out as a part of this thesis aimed to study the efficacy of new tools to detect deceit, particularly cognitive-based lie detection techniques, and the influence of some interpersonal variables when using some of those techniques. We based our work on recent relevant research on lie detection and its specificities. Our goal was to contribute to overcoming some of the problems that hamper lie detection. The studies were thoroughly and ethically executed with the collaboration of multiple staff from the Department of Education and Psychology from the University of Aveiro.

In the study described in Chapter 2, a new coding system was developed, that was especially designed to analyse the interviewees' speech under different levels of cognitive load. The main aim was to study the differences between liars and truth tellers after an information-gathering interview and after an information-gathering interview performed simultaneously with a secondary task: The Computerised Emotional Stroop Task (CEST). The CEST was developed based on the principles of the Concealed Information Test (also known as Guilty Knowledge Test). Guilty knowledge elicits an "orienting reflex" signal and demands attentional resources accordingly (Verschuere, Crombez, & Koster, 2004). We hypothesised that an emotional Stroop would work similarly to a guilty knowledge's orienting reflex as the Stroop's critical words would probably evoke an orienting reflex.

Results of this study showed that liars and truth tellers differed in the number of list-related action and intention details, and speech hesitations. However, the most relevant outcome from the study described in Chapter 2 is the data obtained concerning the secondary task. The information-gathering interview performed simultaneously with the CEST increased mental effort for both truth tellers and liars, as both groups displayed signs of cognitive load. The results draw attention to a potential problem when trying to elicit cues of deceit more in liars than in truth tellers by imposing cognitive load. If the way of manipulating mental effort is not carefully chosen and tested, it can result in an interview that is mentally taxing for both liars and truth tellers, which can be counter-productive. In this sense, the secondary task selected for this study (CEST) appears not to have allowed an effective manipulation of cognitive load in a way that would benefit lie detecting.

Our motivation to develop the study described in Chapter 3 was that people in general, both lay people and professionals, are poor lie detectors. The focus on emotionally-based cues is still common in classical lie detection techniques and that can contribute to a chance level accuracy outcome, even among security forces. Thus, our primary goal was to study the accuracy rate of professionals from a Portuguese security force in discriminating liars and truth tellers and to analyse the cues they rely on to make a judgment. Each participant saw one video from a truth teller or a liar, performing an information-gathering interview or an information-gathering interview performed simultaneously with a secondary task. All the participants were assessed as thinking harder during the dual task interview and the type of interview did not influence the accuracy rate. This result is in line with the findings of the study described in Chapter 2, suggesting that the CEST may have been too mentally taxing for both truth tellers and liars. More importantly, our results suggest a significant correlation between the variables nervousness and attempt to control the behaviour, and the veracity scale. The more the observers rated the interviewees as nervous and attempting to control the behaviour, the lower they rated them on the veracity scale, i.e., the more they judged them as liars, regardless of the participants' veracity status. Our research provides strength to the claim for a change in direction concerning the lie detection protocols, namely concerning practitioners' beliefs. It would be interesting to carry out more research with this population, such as trying to find out which specific cues were used to make the judgment that the interviewees were nervous and/ or lying. It would also be interesting to develop and test training protocols with the elements of the security force in analysis.

The study in Chapter 4 provides helpful information concerning social anxiety as a relevant variable concerning individual differences in lie detection research. Individual differences are often neglected in lie detection protocols. Social anxiety, for example, can deter performance due to increased use of mental resources. The main goal of this study was to analyse the speech of socially anxious and non-socially anxious liars and truth tellers during the two most frequently used interview approaches: the information-gathering interview and an adapted version of the accusatory interview. Results showed that participants provided significantly more details during the information-gathering

interview compared to the adapted accusatory interview, indicating that a mere accusation affects interviewees' speech, regardless of their veracity status. Also, truth tellers gave more details than liars. Finally, non-socially anxious participants hesitated less than socially anxious participants in general, and while socially anxious liars hesitated more than socially anxious truth tellers, non-socially anxious liars hesitated less than non-socially anxious truth tellers. The results of this study suggest that social anxiety should be considered when developing lie detection protocols because this characteristic seems to influence an interviewee's responses to frequently used interview approaches.

These studies share some of the limitations that, unfortunately, are common in lie detection research, and which will be mentioned in the more detail in the following section of this Chapter. Namely, participants were mostly university students or people from the university community (Chapters 2 and 4), including the interviewees from the videos shown to professionals from police forces (Chapter 3). The studies were performed in low-stakes scenarios, despite our best effort to overcome that obstacle by using external incentives such as monetary prizes or academic credits and trying to attract participants internally motivated to the task by advertising the experiment as "Can you fool a lie detector?". As we will discuss, these limitations are not easy to overcome in most of the studies.

5.2. Common limitations of lie detection research

With a similar purpose to ours when developing this thesis, many researchers have been working on improving lie detection techniques. Nonetheless, detecting lies remains a difficult task, for a number of different reasons. The most recent meta-analysis to date that directly compared studies using a cognitive approach and studies using a standard approach showed an accuracy rate of 67% for truth detection, 67% for lie detection, and 71% accuracy rate for truth and lie detection combined, in cognitive-based lie detection studies – the total accuracy rate differs from the average of the truth and lie accuracy rates because it was calculated based on all 14 studies reviewed. The studies that used a standard approach, i.e., that did not involve cognitive lie detection manipulations, revealed a lower accuracy rate (57% for truth detection, 47% for lie

detection and 56% for truth and lie detection combined) (Vrij et al., 2017). Despite the promising results of the cognitive-based approach, the results show that there is still work to do.

Some limitations are transversal to most lie detection studies. In laboratory studies, it is possible to control several variables, such as using the same interviewer through the whole experience and controlling exactly what participants have done (liars and truth tellers). Moreover, in laboratory studies, it is common to use monetary incentives (e.g. Leal & Vrij, 2008) or attribution of academic credits in university contexts (e.g. Caso et al., 2006). Also, the way experimenters choose to advertise the experiment can appeal to volunteers, motivating them to perform well by facing it as a challenge (e.g. "Can you fool a lie detector?"). However, despite trying to motivate participants to perform well (whether lying or truth telling), in a real context (forensic or not) there are more relevant gains and losses, like being convicted of a crime (e.g. Mann et al., 2002), or the spouse finding out about a betrayal. It is also frequent that volunteers in laboratory studies are university students. On the other hand, in natural settings, with real high-stakes interviews, there are several variables difficult to control that should be highlighted: the interviewers change and the number of interviewers that are present in an interrogatory change as well (Mann et al., 2002). It is also difficult to know exactly what is true or not. The available studies in high-stakes contexts are also scarce (Vrij, Granhag, et al., 2010). Thus, it would be beneficial for both researchers and professionals to push the development of studies in these settings, namely by working together on setting up experiments that can be fitted in the forensic context (e.g. police interviews).

5.3. How can lie detectors improve?

In order to improve lie detection abilities, some facts should be taken into consideration when researchers have the goal to develop the most efficient lie detection tools and consequently train the most accurate lie detectors.

Researchers and professionals should *avoid using wrong cues* and try to use cues that research has shown to be linked to deception. Also, research suggests that accuracy in lie detection significantly improves when speech is taken into consideration (Mann et

al., 2004), and thus professionals should *avoid focusing on non-verbal cues only*. Both of these improvements could be achieved by developing training protocols destined to professionals.

Some researchers have tried to train people to detect lies (see reviews Frank & Feeley, 2003; Vrij, 2008a). Observers were exposed to short videotapes or audiotapes containing interviewees lying or telling the truth. The training protocols varied between asking the participants to pay attention to some specific cues while ignoring others, giving information about the relation between specific behaviours and lying, and providing feedback after each decision. Then the performance of the trained participants was compared to the performance of untrained or uninformed participants (controls) (Vrij, Granhag, et al., 2010). Despite the improvement in accuracy that resulted from these training protocols, the difference was typically small (on average, 53.4% for control observers and 57.66% for trained observers). That could be due to limitations inherent to the training protocols, which were usually brief (no more than 15 minutes). More extensive protocols revealed promising results: a study involving two days of training resulted in an increase from 40.4% to 76.6% on the accuracy rate (Porter et al., 2000), and a three-hour training also revealed successful results from 51.2% to 60.7% accuracy rate (Porter, Juodis, Klein, & Wilson, 2010). It is, however, important to note that all of these studies referred to low-stakes truths and lies. Also, the particular cues taught to the observers do not necessarily occur for all liars, which is a common limitation in lie detection protocols that should always be acknowledged.

A more recent study from Shaw, Porter, and ten Brinke (2013), based on an updated approach of Porter and ten Brinke's (2010) research, revealed great success in their training approach. This study analysed the effectiveness of a comprehensive deception detection training program directed to forensic psychiatrists, forensic psychologists, and several legal professionals. Porter and ten Brinke (2010) advocate for a holistic assessment strategy, that should include training on how to avoid the most common errors of deception detection (see Vrij, 2008a; Vrij et al., 2010) and training on verbal and non-verbal cues associated with deception. Despite the fact that attending to multiple verbal and non-verbal cues can help to discriminate liars from truth tellers,

nonverbal cues can only assist professionals who are informed about the specificities of using them in lie detection (Porter & ten Brinke, 2010). According to Frank and Freely (2003), it is important that the training is understandable and transmissible to professionals that may be unfamiliar with the literature on deception. The training should cover several relevant deception situations, especially high-stakes lies, and have an impact on professionals' judgments post-training. They also think it is important to assess the ability pre- and post-measures in order to test the effectiveness of each lie detection training protocol.

Besides updating Porter and ten Brinke's (2010) study, Shaw and colleagues (2013) followed Frank and Freely's recommendations. Their training had a duration of 6,5 hours and involved content such as how to avoid the major pitfalls in detecting deception, how liars behave, and an integrated approach to detecting high-stakes lies. The training included video demonstrations, and transcripts were used and reviewed. The participants included several professionals from the legal system (e.g. forensic psychologists/ psychiatrists, correctional service workers, lawyers), and during the training they practised detecting deception and were given feedback. The videos were collected from real-life settings over a number of years before the study and randomly selected from the database of Shaw and colleagues' (2013) team. They contained publicly pleading for the safe return of a missing relative (see Mann et al., 2002) being that in half of the videos the pleader is the killer of the missing person. In that experiment, researchers were able to establish what was true (e.g. the person is found safe, DNA evidence establishes the guilt or innocence of the pleader), which allowed the implementation of a study with truly high-stakes lies.

The results suggest that the practice originated a substantial improvement in the ability to detect high-stakes lies, 81% accuracy vs. chance level. The authors outlined some limitations such as the small sample sizes and the few pleader videos. They also recommended further research. However, their results suggest that professionals can indeed learn how to improve their judgements on discriminating liars and truth tellers in extremely high-stakes lies.

Inter and intrapersonal differences should be considered in lie detection processes too. Besides acknowledging the differences between different people with distinct personalities and diverse cultures, as reviewed in Chapter 1 and reinforced by the results of our study described in Chapter 4, lie detectors should also be aware of intrapersonal differences, i.e., behavioural differences that can emerge in the same person, depending on the context. The lie detector should compare the interviewee's behavioural patterns when the suspect is truthful (e.g. when discussing unchallenging topics) with the suspect's target behaviour (e.g. when discussing the wrongdoing, not knowing if lying or not). However, it must be done carefully. Sometimes police officers compare the suspect's behaviour obtained during a "small talk" before the interrogation (baseline response) to the suspect's behaviour during the interview. However, engaging in small talk and being interrogated are two different situations. The same person can react differently in formal settings, such as during an interview selection, and in informal settings, like being at home with the family. Also, interviewees can react differently when they are accused of a crime comparing to when they are simply being interviewed – context overshadowing effect (Vrij, 2006). People can also respond differently in high-stakes and low-stakes situations (Porter & ten Brinke, 2010; Vrij, 1995) and when interviewed by different people (Vrij & Winkel, 1991). Another fact that is frequently ignored by professionals is that people's behaviour may vary during the same interview (Buller & Burgoon, 1996; Burgoon & White, 1999; White & Burgoon, 2001), or when comparing several interviews that occurred on different occasions (Granhag & Strömwall, 2002). Different topics (embarrassing vs. neutral, important vs. not important) can also elicit different reactions (Kleinke, 1986, cit. in Vrij, Granhag, et al., 2010; Matarazzo, Wiens, Jackson, & Manaugh, 1970). Thus, when using the comparable truth approach, i.e., when using as a baseline a known truthful response to make a comparison with the target's response (e.g. discussing the offence), professionals need to pay attention to the interview settings and compare similar topics and within short periods of time. Differences may be subtle, and the absence of differences may not necessarily represent a truthful statement.

One of the biggest challenges that lie detectors face is that both truth tellers and liars can display the same emotions, especially in high-stakes situations. Research has

consistently suggested that liars usually have to think harder than truth tellers (Vrij et al., 2017). The manipulation of the liars and truth tellers' mental state in order to enhance cues of cognitive load more in liars than in truth tellers is one of the main directions in lie detection research. However, the interviewees may be older, have some cognitive impairment, or the episode they are being questioned about may have happened a long time ago, and consequently, the interviewees may exhibit some signs of mental load. These variables should be considered when interviewing suspects since the use of cognitive-based techniques may be hampered and originate potential errors. As a guideline, justified by all the variance that can occur when trying to detect lies and that was more deeply approached in Chapter 1 (specifically in section 1.3. Detecting lies: Why is it so difficult?), professionals should always *consider alternative explanations when interpreting cues of emotions and cognitive load* (Vrij, Granhag, et al., 2010).

5.4. Future lines of research

In light of the recent well-known international terrorist attacks, one of the most relevant research lines in lie detection must be the development of techniques that can be used in intelligence settings, where the investigators are frequently interested in someone's future activities (e.g. intentions). Investigators are also interested in developing techniques that can lead to obtaining information from the interviewees without them noticing they are being interviewed, like when agents are working under cover. Also, many crimes, such as terrorist acts, are often planned and executed by groups. While the primary goal of a traditional police interview is to solve crimes, or obtain confessions from suspects, intelligence interviews are focused on gathering information.

Although extensive research has been devoted to developing methods that focused on discovering the truth about past activities, recent research is directing its focus to identify truths and lies about *people's intentions*. According to Granhag (2010), the societal value of detecting planned but not-yet-committed crimes is clear, such as a potential terrorist going through customs/security, or an informant discussing future activities (Vrij, Leal, Mann, & Granhag, 2011). However, the number of studies concerning

lying about intentions is still limited. To our knowledge, the first study ever conducted aiming to detect lies about intentions was carried out by Vrij, Granhag, Mann, and Leal (2011b) and took place in a British international airport. Participants had to lie or tell the truth about their trip and were interviewed in the airport departure hall. The interviews contained nine questions and were transcribed and coded for number of details, plausibility of the answers, contradictions and spontaneous corrections. The results suggested that liars' answers were assessed as less plausible and contained more contradictions and fewer spontaneous corrections than truth teller's answers. The technique allowed the identification of 72% of the truth tellers and 74% of the liars. In another study about intentions (Vrij, Leal, Mann, & Granhag, 2011), truth tellers and liars left a building to collect a package from a specific location with the mission of delivering it to another place. They were interviewed about their intentions before leaving the building and about their activities after finishing the assignment. Results showed that, concerning the details, despite liars having given fewer details than truth tellers concerning the recall of past activities, no differences emerged between the truthful and deceptive responses concerning their intentions. The authors hypothesised that maybe details do not work similarly concerning past activities and intentions because when talking about past activities, truth tellers are talking about something they have actually experienced. Talking about something that interviewees have not experienced yet may restrict the amount of details, which may explain why both truth tellers and liars struggled in producing details when talking about intentions. However, accuracy rate of independent observers was around 70% when analysing intentions, and intentions and past activities combined. According to Granhag and Knieps (2011), questions about intentions should address the planning phase in order to potentiate the differences between liars and truth tellers concerning the amount and richness of details. A further study conducted by Warmelink, Vrij, Mann, Jundi, and Granhag (2012) suggested that unexpected questions about planning ("What part of the trip was easiest to plan?"), transport ("How are you going to travel to your destination?" and core events (“Keep in mind an image of the most important thing you are going to do on this trip. Please

describe this mental image in detail.") resulted in fewer details provided by liars comparing to truth tellers to the same questions.

Undercover interviewing may also be quite relevant not only when trying to determine veracity in the stage of intentions, where no crime has occurred yet, and a formal interrogation may not be suitable, but also in situations where it is useful to extract information without the suspect being aware (e.g. undercover agents). However, many of the promising interviewing techniques that were discussed in this thesis cannot be employed without raising suspicion. The first undercover interviewing study revealed encouraging results concerning planning and spatial questions (Vrij, Mann, Jundi, Hope, & Leal, 2012). Truth tellers, who were real tourists, gave answers with more details, were more exact about specific details (e.g. chronologic time and locations) and were more willing to be taken a photograph by the undercover agent (acting as a doctoral student or an amateur photographer). When asked after the experiment, truth tellers revealed only finding odd the request to take their photograph and nothing else. Liars (voluntary participants on a mock mission with a cover story of being tourists) may be more unwilling to be photographed in order to avoid any association to their criminal activity (Vrij, 2014), and these results support this hypothesis.

Another important area of research may be *interviewing suspects simultaneously*. Most sophisticated criminality involves pairs or larger groups of people. Investigators may need to interview people in situations involving more than one person and only one interviewer (e.g. border control, airport). Research is not giving enough attention to this issue since most studies are directed to individual lie detection techniques. *Collective interviews* allow the observation of how members communicate with each other when lying or recalling a truth. While truth tellers reconstruct the event from memory and prefer a "tell it all approach" with rich and numerous details, liars report an alibi previously rehearsed, favouring a "keep it simple" approach with just enough detail to evade suspicion – they do not know which details the interviewers are aware of or can find out (Granhag, Strömwall, & Jonsson, 2003; Hartwig et al., 2007; Strömwall et al., 2006). Research has started to show that these contrasting approaches may result in different interactions between liars and truth tellers when being interviewed at the same

time. Truth tellers are more likely to interrupt, correct each other and add information to each other's answers than pairs of liars (Vrij, Jundi, et al., 2012). Also, according to Jundi and colleagues (2013), pairs of liars looked more at the interviewers and less at each other than pairs of truth tellers.

Lastly, an important line of research that we must outline and that is not having the proper investment is *working with real populations in real-life situations*, such as actual suspects, high-stakes lies, and professionals from the legal system. It is not easy to develop protocols for lie detection in real-life situations, especially because it is very difficult to establish what is true and what is not (*the ground truth*) in order to make comparisons. Independent case facts, such as medical evidence, material evidence, DNA evidence, or reliable eyewitnesses are crucial to establish that ground truth, and they are frequently unavailable (Vrij, Granhag, et al., 2010). Recent laboratory studies have been trying to create situations that are more similar to real-life studies, by creating mock missions and involving professionals from the legal system. Obtaining authorizations to access police interviews and prison establishments is also challenging, yet sometimes possible. Given that the final goal of lie detection research is to improve lie detection in police interviews and intelligence settings, real-life studies are necessary to test the efficacy of lie detection techniques that are developed in laboratory settings.

5.5. Conclusion

Our findings contributed to a deeper understanding of the complexity of lie detection processes and the subtleties around the methods used to increase cognitive load. They also helped us realise that some common errors, such as relying on emotional states to discriminate liars and truth tellers, also occur in some security forces in Portugal. Regarding future studies and direct applications of this work, it would be interesting to develop protocols with the security forces, such as offering training in forms of workshops and briefings on "How to detect lies – common errors and how to improve", in exchange for collaborations in studies. It would also be interesting to access some real-life interrogations in Portuguese forensic settings.

The importance of detecting deceit is well-known. Discovering when a suspect, alleged victim or witness is lying is often a necessity in forensic contexts. Also, using lie detection to prevent terrorism or other organised attacks is of major importance. Concerning tools developed to detect deceit, a lot has been done but there is still much work to do. We believe that the findings of this thesis come as a valuable aid to the process.

Chapter 6. References

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Chapter 7. Appendix

Participant nº ___
Video_____
Code _____

Sociodemographic questions

Sex: M □ F □

Age: _____

Academic qualifications: _____

Questionnaire

1. Mark your answers with a cross (x) in the selected option. From 1 (one) to 7 (seven), being **1** "**very low/none/not at all…**" and **7** "**very high/very much/very…**":

	1	2	3	4	5	6	7
What is the level of cognitive effort that the interviewee seemed to be experiencing during the interview?							
How much did the interviewee appear to be thinking while answering to the interview?							
How mentally difficult did the task appear to be to the interviewee?							
Did the interviewee appear to attempt to control his/ her behaviour?							
Did it seem that the interviewee was trying to regulate his/ her conduct?							
Did the interviewee appear to try to dominate his/ her attitude?							
Did the interviewee seem to be nervous?							
Did you identify anxiety in the interviewee's behaviour?							
Do you consider that there were signs of jitters in the interviewee's performance?							
How demanding do you consider the task that the interviewee was performing?							
How difficult did the interviewee's task seem?							
How hard do you assess the task of the interviewee when answering the questions?							

2. From 1 (one) to 7 (seven), being **1** "**not at all**" and **7** "**very much**", how much do you consider the interviewee to be telling the truth?

1	2	3	4	5	6	7

3. Have you ever taken part in a lie detection study?
   Yes □ No □