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Does the seriousness of a crime impact memory detection? A mock-crime experiment combining the *autobiographical Implicit Association Test* (aIAT) with eye-tracking

La gravità del crimine ha un impatto sulla rilevazione della memoria? Un esperimento di simulazione di reato che combina *l'autobiographical Implicit Association Test* (aIAT) con la tecnica di eye-tracking

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Abstract

Although several studies have been conducted with the aim of identifying physiological measures related to lie detection, few have had practical applications in the forensic field. Methods requiring reaction times, such as the autobiographical Implicit Association Test (Sartori et al., 2008), appear to have the most application among these.
However, previous research (Dhammapeera, Hu, & Bergström, 2020) has shown that guilty subjects who have been imagining an alibi for some time can significantly alter their performance on the aIAT (whether voluntarily or not). Also, the aIAT's ability to identify the true (guilty) memory may also be affected by the degree of a crime. This is a critical issue, especially concerning crimes associated with sexual harassment.

The aim of this study is to examine whether and how the performance at the aIAT can be affected by the degree of a crime (i.e., soft vs. hard) and whether the combination of aIAT and eye-tracking can outperform the aIAT alone in identifying the true memory.

We expect behavioural performance to be modulated by the severity of the crime, with soft crimes being detected less accurately by focusing on the aIAT alone. Nevertheless, we expect accuracy to be higher when the behavioural performance is analysed together with its oculomotor correlates.

CHAPTER 1

INTRODUCTION

1.1 Neuroscience and law: what is the relationship?

New technical advances in the ability to image the human brain have encouraged speculations about the application of neuroscience to different fields, for example, law. While forensic science seeks to understand the origins and motivations behind certain behaviours or (illegal) acts, the application of neuroscience to law focuses on examining those causes (Fuselli, 2017).

Discussions regarding the potential of neuroscience frequently contain a peculiar blend of nervous hope and desperate fear; nowhere it is more evident than in the impact that cognitive neuroscience might have on legal cases (Buckholtz & Faigman, 2014).

Just like every other field, neuroscience can be divided into different sub-fields. In this thesis, we will focus on tools often implicated in a particular field of neuroscience that is forensic neuroscience which deals with assessing the reliability of neuroscientific tools to serve as evidence within a trial and examining their compatibility with current procedural guarantees; in other words, it deals with neuroscientific tools that have relevance in judicial assessment (Gulotta, 2002).

Law and neuroscience appear to be strange bedfellows; but their relationship is complicated by fundamental differences, the effects of which can be quantified in a variety of ways, such as what law wants neuroscience to be able to achieve, what people say neuroscience is capable of, and what neuroscience is actually capable of (Buckholtz & Faigman, 2014).

While the law is a humanities' science based on responsibilities, deriving from common sense and abstract notions, neuroscience is a natural science based on experiments and inferential claims.

As many legal academics now contend, law is actually a social phenomenon created by the social compact. This raises the important question of how the interaction of these two disciplines might be proposed and defended, which answer lays in the ultimate goal of both parts. The end purpose of law is to protect human dignity to realize a person's humanity and fulfil true justice, which can be achieved if society has better and more precise rules. Neuroscience, on the other hand, claims to assist law in having more precise regulations in this sense by keeping an open mind to neurological phenomena that happen in the brain. So, the interaction between these two areas more clearly illuminated the legal system's justifications within its particular field of science (Petoft, 2015).

In this sense, the engagement between these two fields was inevitable: the legal system’s ability to regulate behaviour and administer justice frequently depends on how the reasons behind and the quality of a person’s actions are evaluated (Jones et al., 2013).

As a result of this, and because of the remarkable growth and visibility of neuroscientific research, a distinct field of law and neuroscience, has rapidly developed in the last decade (Garland, 2004): this new field is called neurolaw.

1.1.1 Neurolaw

Even though Taylor and colleagues (1991) are credited with being the first legal experts to use the term[1].

Neurolaw is an interdisciplinary field that provides a more detailed and accurate approach to legal phenomena; in other words, it is an effort to understand the connection between the law and the brain by considering recent advances in neuroscience (Pardo & Patterson, 2013); it investigates how advancements in neuroscience impact the law (Shafi, 2009). Given that neurolaw is a relatively new field of study, as is the case with other new scientific fields, it is crucial to carefully consider the benefits and drawbacks of its use. Starting from the benefits, neuroscience has the potential to identify liars, objectively determine criminal responsibility, measure suffering, and foretell violent behaviour. According to Jones (2013), the law may benefit from neuroscientific evidence at least in seven ways:

- Buttressing: bolstering juror confidence in a finding that was already supported by other non-scientific evidences;
- Challenging: challenging or refusing a crucial legal assumption or other evidence in the case;
- Detecting: determining whether there are any legally significant facts;
- Sorting: dividing people into useful groups;
- Intervening: offering ways to accomplish legal objectives;

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[1] The earliest published uses of the term ‘‘neurolawyer’’ and ‘‘neurolaw’’ were in 1991 and 1995 by Attorney J. Sherrod Taylor. Sherrod J. Taylor, et. al, Neuropsychologists and Neurolawyers, 5 Neuropsychology 293 (1991); Sherrod J. Taylor, Neurolaw: Towards a New Medical Jurisprudence, 9 Brain Injury 745 (1995).

- Explaining: increasing the ability of law to predict the likelihood of future behaviour;
- Predicting: enlightening decision routes with information that may lead to more informed and less biased decisions.

Neuroscience has initially been used primarily in Procedural Law to support legal claims of criminal and civil culpability but, despite this practical use of neuroscience, many different legal subfields have adopted it. While criminal defences of the "the brain made me do it" variety has received a lot of attention, it is also important to highlight that neuroscience is not limited to the criminal law arena (Petoft, 2015).

Moreover, lawyers on the civil side invented the term neurolaw in 1995, as already mentioned, and neurologists and lawyers have a long history of collaboration in personal injury litigation.

In civil cases, brain evidence, such as functional Magnetic Resonance Imaging (fMRI) or Electroencephalography (EEG), is becoming more prevalent in disputes involving head injuries, including tort claims and disability compensation suits (Jones et al., 2013).

On the other hand, in a criminal context, in a review of the final sentence of four years in jail for the offense of sexual assault (lawyer prof. Gulotta), the autobiographical Implicit Association Test (aIAT)[2] , a technique for inducing cognitive conflicts, the consequences of which are evaluated by reaction times, was introduced as new evidence (Sartori, 2021).

As demonstrated by the aforementioned instances, neuroimaging and other more specific methods can be considered valuable[3] tools in the legal field.

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[2] aIAT will be covered extensively later.

[3] The validity of an evidence will be investigated later on this thesis.

Regarding neuroimaging, visual brain delineation is produced by neuroimaging techniques and interpreted by an imaging specialist (Baskin et al., 2007). The most appealing feature of using these technologies is their functionality, that is their ability to return a scene in motion, simplifying, to visualize directly what happens in the brain when an action is performed, rather than providing a descriptive frame of anatomical state in its immobility. In this context, the relevance of subjectivity cannot be overstated. EEG, fMRI, and other neuroimaging technics have the potential to fool the person's subjectivity and be carried out without his will impacting the outcome of the analysis; on the other hand, the conscious collaboration of the individual under inquiry is required for the study of behaviour. However slight, subjectivity can impact examinations since it is loaded with worries, tensions, expectations, and beliefs, as well as lies and false memories that taint the exam's results (Bianchi et al. 2009).

On the other hand, the employment of different technics which do not involve neuroimaging, such as memory and lie detection tools, aIAT, certain sorts of questioning, etc., focuses on the subject's behaviour in particular instances, thereby contributing significantly to judicial cases.

Consequently, it is evident what impact neuroscience research could have on the practice of law. In fact, for many people interested in the neurolegal discussion, it is obvious that neuroscience will have an impact on legal practice in addition to the fact that it has a meaningful contribution to offer to the legal system (Pickersgill, 2011). According to the LANP website[4], neuroscience will deepen our comprehension of acts that our laws regulate and of attitudes that our laws reflect (LANP, 2010).

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[4] LANP – The Law aNd Neuroscience Project www.lawandneuroscienceproject.org

However, as anticipated, it is also appropriate to assess the risks that could lead to ethical, or more accurately, neuroethical, difficulties in emerging scientific disciplines.

1.1.2 Neuroethics

Even though cognitive neuroscience and bioethics are now fully recognized as a discipline in its own right, they are also both strongly related to the very broad-ranging topic of study known as neuroethics[5].

Neuroethics is the study of what is ethical and wrong, good, and evil, in the treatment, refining, unwanted intrusions, and troubling alterations of the human brain. It attempts to provide answers and guidelines to a variety of questions, such as: what ethical norms and legal constraints should be in place for treatments targeted at changing criminal behaviour? Should we create a medicine that enhances or erases all memories? Is subjecting a terrorism suspect's brain to a sort of torture, or at the very least a method of pushing an individual to self-accuse? (Safire, 2002).

There are roughly two streams of neuroethics. The "narrow" view is one branch that focuses on the more immediate or close-by implications of cognitive neuroscience: it discusses the more individualized and useful applications of neuroscientific knowledge. Instead, the "wide" perspective of neuroethics can be used to describe the second stream of this discipline. This branch of neuroethics is best understood as addressing the distal consequences of neuroscientific knowledge (Tieu, 2007).

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[5] After the San Francisco conference *Neuroethics: Mapping the Fields* in 2002, the term neuroethics gained popularity (Marcus, 2002).

As already mentioned, neuroethics evaluates what is morally desirable, or undesirable intrusion and upsetting manipulation of the human mind; this has to do with our consciousness and identity. So, it not only establishes standards but also increases its interest in the consequences of the expanding implications that the outcomes of neuroscience research can have and will have on people's lives (Roskies, 2002).

1.2 Scientific Evidence in Courts

The concept of scientific evidence refers to investigative procedures for which science and technology-related tools of knowledge are employed during the admission, recruitment, and assessment processes, i.e., scientific, and technical principles and methodologies that call for expert assistance (Dominioni, 2005).

As previously mentioned, resorting to different technics can be useful in terms of being able to prove or disprove a theory, but to be accepted, these tools should be suitable to constitute valid proof, and in order to do that every kind of evidence must comply with specific criteria.
In Italy, Cozzini[6] and Kerscher[7]'s Sentences, which correspond to the Daubert[8] (USA) and Turner[9]'s (UK) Sentences, govern the process of evaluating scientific evidence. Daubert's sentence establishes the guidelines that the Judge must adhere to when determining whether the evidence was conducted scientifically. More specifically, every

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[6] Sentenza Cozzini, Cass. Sez. IV n.43786/2010

[7] Cass. pen., Sez. I, sentenza 24 febbraio 2011 n. 7195

[8] Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579 (1993)

[9] Turner v. State of California, 15D0489 [2015 WL 4606737] (Cal. Ct. App. July 31, 2015)

tool, technique, method, or theory that is proposed must meet the following criteria, known as Daubert criteria:

1) Verifiability: the degree of the method or conclusion's acceptance within the relevant scientific community, meaning there should be coherence;
2) Falsifiability: the theory or the technique should be falsifiable;
3) General acceptance of the scientific community: whether the theory or technique used by the expert can be and has been tested;
4) Known error rate: the known potential rate of error of the method used;
5) Peer-review: whether the theory or technique has been subjected to peer review and publications.

As a result, the ability of the Magistrate and the lawyer will be to identify the part of the report that indicates the logical step on which the expert's conclusion is based.

Although the Daubert criteria give Judges more discretion and allow for a more complex examination.

However, it is not without its critics, in fact, it is also true that because of this flexibility, it is more ambiguous and may result in inconsistent admissibility decisions.

Nevertheless, it can be claimed that the introduction of the Daubert criteria resulted in a revolution of the relationship between judges and experts, between law and science (Sanders et al., 2002), furthermore, the ability to rely on scientific tools is a significant advantage in court procedures.

These criteria define what the Judge should consider when examining the quality of the scientific tool. Mentioning the Cozzini Sentence: "the Judge is the process's curator and guarantee of the scientific nature of the factual knowledge expressed in the trial" (Sartori, 2021). Consequently, the Judge is compelled to show in technical terms why it detracts from the expert opinion or method.

It’s important to note that there is a difference between tools that have already been used and accepted in judicial cases and new and controversial ones.

The first category has gained a high degree of reliability over time, making them usable as evidence, such as DNA analyses; however, it should be noted that new techniques might put old ones to the test.

Instead, the second category refers to new proofs that involve new science and technology-related tools whose reliability has yet to be established because they are the outcome of recent discoveries and controversial ones which are not necessarily considered “new”, yet there is still debate over their reliability (Dominioni, 2005), in this instance, the reference is to neuroscientific techniques. Therefore, the New Scientific Evidence catalogue is always evolving.

The role of the law is to establish scientific evidence supervision that considers both defence guarantees and the preservation of the individual's fundamental rights and freedoms (Bonzano, 2011); in fact, procedures, or techniques capable of affecting self-determination or altering the ability to remember and evaluate facts are prohibited by the Criminal Code, even with the cooperation of the individual concerned (art. 188 c.p.p.). The most important aspect is that the norm does not restrict the employment of specific methodologies; rather, it permits the employment of science and what it has to offer while emphasizing the value of the individual in his freedom.

In court cases, neuroscientific evidence is presented more frequently. As a result, the legal system requires neuroscientists to serve as expert witnesses who can describe the constraints and interpretations of research findings so that judges and juries can draw valid conclusions. This raises concerns about potential misinterpretations that may result from disclosing neuroscientific information that may be complex for non-neuroscientists to understand (Jones et al., 2013), and that's because science, in general, and neuroscience, more specifically, portrays things as they are in existence, while law employs artifices to determine abstract justice; despite this, courts frequently seek scientific assistance (Eastman & Campbell, 2006).

1.3 Neuroscience of lying

Consideration of the neuroscience of lying is appropriate given that situations, where one or both parties lie regularly, occur in both civil and criminal contexts.

It is worth mentioning that a lie is a wrong answer, but not all incorrect responses are lies (Sartori, 2021). The wrong response must take into account the liar's mental state, which means that the lies are intended to persuade the targeted audience that the claim is true.

According to Abe (2009), deception is a psychological process where a person wilfully tries to persuade someone else to believe something they know to be false, usually for their own profit but occasionally for others as a way to gain something or prevent losing something.

But a lie is very hard to identify because deception includes a wide range of different types of circumstances and activities:

- Truth reversal lies that consist of providing the opposite of the response;
- White lies, circumstantial lies told in front of others generally in order to avoid upsetting them;
- Exaggerations that emphasize an existing quality or feature;

- Machiavellian lies that are a very complex type of lies;
- Lies that are publicly accepted as factual.

In general, lying can take two forms: low and high-stakes lies. Low-stakes lies are those that don't pose a danger and represent routine deception that occurs frequently in social situations (De Paulo et al., 1996). Directly in opposition, high-stakes falsehoods contain risk where the liar could stand to win or lose a significant amount of something (Gonzaga et al., 2001).

Given that there are different varieties of falsehoods, a turbulent history of ethics and philosophy has been nourished by the scientific study of deception and lying.

The subject continues to be at the intersection of various fields, even within psychology, despite being frequently brought to the forefront of the public's attention through a criminological or psychopathological perspective (Makowski et al., 2021).

Over the years numerous researchers have tended to concentrate on identifying the crucial elements, personality traits, and underlying mechanisms that motivate lying, but most usually the emphasis has been on lie detection or pathological situations, despite the fact that lying may be intrinsic in everyone (De Paulo et al., 1996).

Mazar and colleagues (2008), in this respect, have suggested conducting research to determine the typical person's rate of spontaneous lying when it goes undetected. The findings demonstrated that although participants can lie, they refrain from taking advantage of it because only lying a little bit—but not too much—is socially acceptable. In a criminal context, when the subject stands to gain from the falsehood, lying happens at this rate.

The liar must carefully choose unprovable issues in criminal prosecution, so producing plausible falsehoods is seen as a mental activity since it requires time and thought to verify and determine the topics on which he might lie. This makes it a lot more challenging to identify a true witness from a liar.

Starting with this premise, deception can be described as the process of misrepresenting a piece of information's objective properties in order to create a false impression of it. Thus, lying can be defined as a form of intentional deception.

Although lying is frequently studied as an act, including but not limited to its production or reception, it could also be understood and researched as a dispositional quality, i.e., as a metastable personality trait (Makowski et al., 2021).

For example, Hart and colleagues (2020) found that an increased tendency to lie is associated with low scores on extroversion, life satisfaction, conscientiousness, and openness to experience. Moreover, Machiavellianism, a personality trait characterized by a lack of empathy, cunning, and morality, appears to be connected to an increase in lying (Geis & Moon, 1981).

Similarly to people who have low moral character, those with low honesty and humility tend to lie more (Tasa & Bell, 2017).

Narcissism is another personality dimension linked to deception (Zvi & Elaad, 2018), a trait usually found in several personality disorders.

This is why deception is most commonly studied in relation to antisocial and hostile features like psychopathy, which has a positive correlation with how often people lie (Halevy et al., 2014). In this manner, it is evident that there are arguments in aid of interindividual variation in lying.

As a result of these pieces of evidence, deception can be considered a phenomenon supported by a neurocognitively distributed network of processes and this underlines the significance of investigating the neuroscience of lying.

1.3.1 Neurobiology of lying

Furthermore, as it can be pertinent to the discussion on this topic, it is important to pay attention to the fundamental neurobiological element of lying, which has received greater attention recently.

As previously stated, technical advances have significantly influenced the application of neuroscience in various fields, but it's also noteworthy that they have contributed to the ability to examine the psychology of deception more precisely in terms of the specific neuroanatomical mechanisms involved.

Since deception is linked to complex social interactions, it is not just observed in humans but also in animals, particularly in species with higher intelligence like primates. According to Byrne and Corp's (2004) investigations, deception frequently and significantly relates to different animals' neocortex volume and neocortex ratio. These findings lend considerable support to the notion that the neocortex's role in supporting such complicated activities as lying. Higher cognitive tasks like memory and language are carried out by the neocortex, which is the cerebral cortex's phylogenetically most recent region in humans. So, it is plausible to infer that deception is directly related to the function of the neocortex and that it was made possible by the biological evolution of the human brain. Recent research on human deception using neuroimaging strongly supports this theory (Abe, 2011).

Not only the neocortex but also other structures seem to be linked to deceptive behaviour. For instance, the striatum, which mediates parts of cognition and behaviour, is closely linked to the cerebral cortex, especially the frontal cortex, and is another component that evolved to be responsible for deceptive behaviour (Cummings, 1993). Also, it is believed that the striatum is involved in the brain's integration of reward-related information and, since deception is typically used to obtain an advantage or prevent loss, the striatum is likely to play a crucial part.

Other studies have used functional neuroimaging methods, such as PET or fMRI, in order to measure brain activity while a task is being performed. For instance, Spence and colleagues (2001) described their initial efforts to understand the brain processes involved in deception; they discovered that deception was connected to slower reaction times and higher activity in the ventrolateral prefrontal cortex.

From this point on, the advancement of cognitive neuroscience of lying has been accelerated by the functional neuroimaging of deception (Abe et al., 2006).

Regardless of the experimental protocols used in previous research, the frontal executive system has been consistently linked to deception (Christ et al., 2009).

1.4 Alibi

The examination of this topic at this point of the discussion assumes special relevance since lying is intimately related to alibis, especially in criminal cases.

In the legal system, an alibi is defined as follows: “a defence that places the defendant at the relevant time of the crime in a different place than the scene involved and so removed therefrom as to render it impossible for one to be the guilty party” (Nolan, 1990).

Lies can also be told regarding a variety of subjects, with autobiographical events being one of the most relevant; in fact, a false alibi is a common component of lying about autobiographical experiences when inaccurate information is used to cover up or disprove real-life occurrences (Foerster et al., 2017).

The Activation-Decision-Construction-Action Theory (ADCAT) is a well-known method for understanding the mental operations that underlie lying (Walczyk et al., 2014). According to the hypothesis, people often activate a representation of the truth first, which must be blocked to create and deliver a credible lie, though, once the respondent decides to lie based on the social environment and prior choices.

In a criminal investigation, a variety of people who may have been involved in the crime are frequently expected to recall their actions and whereabouts at the time of the incident and then back up their memories in order to rule them out as potential suspects. To put it another way, people are frequently expected to have an alibi in order to demonstrate their innocence. This necessitates people being able to accurately recall what they were doing at particular times in the past and being able to appropriately weigh alibi evidence in light of the numerous other factors that are involved in a case (Burke & Turtle, 2003).

An alibi implies, strictly speaking, that a person could not have committed the crime because it would have been physically impossible for them to be in two places at the same time; simply claiming that you were somewhere else is an alibi. On the other hand, having an alibi is easy; demonstrating an alibi is another matter by and large (Olson & Wells, 2004).

As previously stated, establishing the alibi's truthfulness is challenging. If sufficient evidence demonstrates that the witness was in another place at the time of the fact, which ought not to be just problematic, then doing this for an innocent person will suffice. However, the difficulty increases in the case of a guilty party who must mentally verify that there are not too many verifiable details and construct an alibi. The efficient liar avoids verifiable details because they are information with external feedback. Though, it takes a complex mental operation to persuade the other person to believe a reconstruction of facts that the liar knows was made.

A single mistake can create a cascading result, delivering an innocent person's alibi, unexpectedly, evidence of culpability.

As we said, an important part of the investigation is giving people the chance to provide an alibi when they are accused of a crime. Sometimes, their alibi can serve as their legal defence (Nolan, 1990).

In a survey of the 347 (starting around 17 November 2016) Innocent Project[10] DNA exemption cases, countless respondents, who were unfairly sentenced, introduced an alibi at trial, and some of them had numerous observers and proof to brace that explanation (Burke et al., 2007); on the other hand, others' alibies were never investigated. This example is significant in this context since it features how certain people were sentenced notwithstanding their alibi; but what if, because of their alibi, they were found guilty instead? This and other questions have been the starting point for increasing research regarding alibies.

Naturally, it is not a new phenomenon for psychological research to challenge long-standing but incorrect assumptions about legal issues; studies on the memory of eyewitnesses (National Academy of Sciences, 2014; Wells et al., 1998), recollections of sexual abuse as a child (Loftus & Ketcham, 1994), interrogation techniques (Hartwig et al., 2006), lie detection capability (Hartwig & Bond, 2011), and false confessions (Kassin et al., 2010) has changed the way of thinking about this kind of topics.

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[10] www.innocenceproject.org/cases

At its generally essential level, alibi generation is a memory test: to be able to recall that information when the police ask us later (retrieval phase), we need some memory of the time in question (encoding phase) (Crozier et al., 2017).

However, many expectations about creating an alibi are mistaken and start from wrong assumptions about how memory works.

Actually, despite the fact that it is now well known that memory does not function in the same way as a video camera, it is not uncommon for people to make the mistake of thinking that we remember events accurately as we actually experience them and then recall them with the same accuracy later on, even after a considerable amount of time has passed. This kind of logic is flawed because it doesn't consider the fact that memory is affected by forgetting, external factors, or, most importantly, time. In fact, the main issues arise precisely in relation to recollection's accuracy and inaccuracy. It is erroneous to believe that a person's memory is judged to be more accurate if there are fewer errors reported. Indeed, the "Reid Technique" (Inbau et al., 2013) instructs interrogators to look for inconsistencies as a sign that a suspect is lying. Those irregularities, or absence of detail for a helpful vindication, can bring about various flowing immediate and backhanded dangers to a blameless' opportunity for equity.

1.5 The severity of a crime

There is some evidence that an alibi's believability may be affected by a crime's severity, even though this has not been extensively researched in the scientific literature.

Various aspects of the problem have attracted the attention of some researchers; for instance, Snow and colleagues (2018) found that participants who evaluated crime as more serious would in general rate the suspect's alibi as less conceivable. Their study assumes that jurors' decision-making is frequently an emotionally charged process due to the inherent unpleasantness of criminal trials.

The observation that emotions can influence juror decision-making has been widely documented, despite the historical presumption of their impartiality (Semmler & Brewer, 2002).

Additionally, it has been theorized that when jurors disregard the law and rely on their emotions, the outcomes of their decisions are chaotic (Horowitz et al., 2006). In fact, the results of this study lead to the conclusion that emotional arousal can influence perceptions of crime severity, alibi belief, and victim responsibility, which has helped the issue of evaluator emotions enter the field of alibi believability research.

Another study (Allison & Brimacombe 2010) focused on the strength of the alibi evidence, finding that strong alibis were seen as more believable than weak alibis.

Believability is the underlying psychological concept in Olson and Wells' (2004) alibi taxonomy. The taxonomy says that the perception of the alibi corroborator's motivation to lie to protect the accused is one of the key determinants of a strong versus weak alibi's believability and the ease with which the alibi's physical evidence could be made also has an influence on the alibi's believability.

As can be seen from the two studies above, which are just two examples of alibi research, the analysis focuses on the credibility of an alibi but does not directly investigate the relationship between it and the severity of the crime. This is why the aim of this thesis is to shed light on a topic that has not yet received sufficient research: the possibility that the severity of the crime has a direct impact on the alibi and memory detection.

1.5.1 The case of sexual assault and sexual harassment

On the sexual nature of an act, two main proposals contend the field: the first one resorts to the support of medical-psychological sciences and the anthropological-sociological one; the second one holds that in order to hold the exact meaning of a sexual act, it is essential to refer to the concrete affair as a whole.

The first notion asserts that physical contact between any part of a person's body and the partner's genital, anal, or oral area is required for a sexual act. As indicated by the second, on the other hand, it doesn't demonstrate conceivable to draw the qualification between a sexual act and a nonsexual one with sureness in the event that reference is made principally to physical parts of the body or to the intensity of actual contact (Puzzo, 2010). In this sense, it proves to be more fruitful to take into account the significance of the entire context in which the contact takes place and, as a result, the intricate intersubjective dynamic that emerges in a situation that is further characterized by the presence of coarticulating factors (Fiandaca, 2017).

Because of this, only acts that involve physical contact between a person's body and partner's genital or anal area are considered sexual violence, preferring an approach that gives prominence only to "objectively sexual" acts and, conversely, excludes only subjectively sexual acts from the norm.

On the other hand, harassment is defined as a clear sense of discomfort experienced by the passive actor. In legal language, it is defined as any act restricting the right holder's ability to enjoy their rights.

At the moment, it is possible to say that the Supreme Court's approach is based on the conviction that a violation of the victim's sexual freedom has an inherent gravity that should take into account the victim's level of bodily intrusion and, as a result, the act's objective sexual nature. This is in line with the second notion that, as cited, does not disregard the definition of acts that are objectively sexual.

We live in a society where sexual harassment is a pervasive feature that takes place in both public and private settings. It is distinctive both in its role in social interactions and in its phenomenology for those who experience it (Crosthwaite, & Priest, 1996).

There is a lot to consider based on these presumptions and the significance of the topic. As previously stated, this is a very complicated subject that allows for a wide range of interpretations, which is why the literature search is limited to the most complex cases.

1.6 Tools in forensic neuroscience

Research indicates that it is challenging to identify lies, despite veracity judgments being crucial in various contexts. Numerous meta-analyses have concluded that a person's ability to distinguish between lies and reality is almost entirely random.

Even though determining the prevalence of deception in everyday life is difficult from a methodological standpoint, research consistently demonstrates that lies occur on a daily basis (Kashy & De Paulo, 1998).

The lie has been attempted to be identified using several methods that can be classified as lie or memory detection methods. Lie detection methods are used to identify lying, while memory detection techniques are employed to investigate memory[11].

As we know, under certain conditions, it is possible to analyse witness recollection using methods that have been proven scientifically valid. Some of these methods look at the

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[11] It is a specific memory detection method used in lie detection is the focus of this thesis.

structure of the narrative, while others look at the individual's recollection directly by using methods that use reaction times.

The scientific literature on memory detection techniques is extensive and includes methods that do not have potential practical applications in the forensics field. One example is magnetic resonance imaging, which is useful but necessitates the use of a specialized machine—the MRI—and specialized personnel—both of which are not always available. Because of this, it was thought that it might be beneficial to implement user-friendly methods that could be used to investigate memory, which is an extremely important aspect of forensics.

For the purpose of this discussion, we will focus on methods for detecting autobiographical recollections based on reaction time.

The sub-techniques of reaction-time-based lie detection can be divided into techniques that do not require true memory among the response alternatives and techniques that do embed true memory among the alternative memory responses.

The first makes it possible to determine the true response between two options and includes:

- Latency analysis of responses to control, expected, and unexpected questions;
- Concealed Information Test (CIT);
- Implicit Association Test (IAT), and autobiographical Implicit Association Test (aIAT).

The fundamental assumption behind the interest in the analysis of response latency is that lying necessitates the use of numerous cognitive resources by the person in order to convince and conceal the truth. Indeed, a person is physiologically disposed to be honest, so lying calls for complex mental tasks.

An extremely straightforward method is required to conduct an analysis of response latencies, particularly when recordings of interrogations can be viewed: working out the dormancy between the finish of the questions and the finish of the response likewise using special software (Audacity).

The procedure consists of three steps that require calculating the average latencies for control questions (questions to which the liar cannot lie), expected questions (questions to which the liar can prepare an answer), and unexpected questions (questions to which the liar cannot prepare an answer because they are unpredictable). The truthful person will have similar times for expected and control questions. This is because when the question is expected, the perpetrator can pre-package the answer, which is the innocent witness, on the other hand, does not experience significant elongations in response times to unexpected questions.

Concealed Information Test literally means a test that looks for hidden information. It is based on the idea that the subject will respond to critical and controlled information with identical reaction times even though they do not have any critical information, making them "innocent." Instead, the subject with guilty knowledge will have significant elongation considering the improvement connected with the weapon the person in question utilized.

Lastly, reaction times measure the effects of the Implicit Association Test (IAT), which induces cognitive conflict. The IAT is a measure designed to detect the strength of a person’s automatic association between mental representations of objects (concepts) in memory. In other words, a contention is misleadingly made and its consequences for response times are noticed. The autobiographical Implicit Association Test (aIAT) is a variant of the IAT, that efforts to autobiographical memories.

1.6.1 Memory detection techniques: autobiographical Implicit Association Test (aIAT)

Inaccessible influences of past experience on one's evaluations or judgments regarding a current issue are known as implicit associations (Greenwald et al., 2003).

The Implicit Association Test (IAT) is a technique that looks to reveal what a subject's implicit attitudes are by estimating their underlying automatic evaluations that arise in light of the fact that they are set off via automatic judgment processes (Greenwald et al., 1998). This test seeks to measure this paradigm.

The autobiographical Implicit Association Test (aIAT) refers to this procedure's application to the subject's memories.

The aIAT is a computerized task that has great potential for determining the implicit truth value of autobiographical statements. As a result, it can be used to find hidden memories from one's past (Sartori et al., 2008). The aIAT estimates response times and precision in a straightforward sentence grouping task as markers of whether a self-portraying occasion is valid or false for an individual and is consequently significantly simpler and less expensive to implement than physiology and brain activity-based strategies that require expert hardware and highly trained administrators. According to Gulotta (2011), classification times will be reduced if two concepts are thought to be related to one another. Due to their importance, forensics utilizes reaction times for lie detection, simulation, and false memories (Verschuere, 2014).

In a criminal context, the aIAT requires suspects to categorize four distinct types of statements based on two dimensions: logically true versus false, or crime-related versus innocent-related, by pressing two different buttons (Dhammapeera & Bergström 2020). The first dimension's sentences are true or false for everyone taking the test, whereas the second dimension's sentences are true or false depending on whether the suspect has committed the crime or not. For instance, true if guilty/false if innocent for a crime-related sentence (congruent condition) vs. false if guilty/true if innocent for an innocence-related sentence (incongruent condition).

Statements that are logically true and related to a crime share one button in guilt congruent blocks, while statements that are logically false and related to an innocent person share a different button. Statements that are logically false and related to a crime share one button in guilt incongruent blocks, while statements that are logically true and related to an innocent person share a different button. Crime-related sentences have implicit and automatic associations with the truth, so guilty suspects are expected to respond more quickly and accurately in guilt-congruent blocks. It is expected that innocent suspects will exhibit the opposite pattern.

Since the aIAT consists of two double categorization blocks of congruent and incongruent types (Block 3 and Block 5) and three simple blocks (Block 1, Block 2 and Block 4), this implies that the impact connected with response latency is shown in the dual categorization blocks (Block 3 and Block 5), each of which associates a potentially truthful autobiographical recollection with events that are definitely true.

Each key in simple blocks is used to classify sentences that are only linked by one of two opposite labels, which are displayed on the left and right bottoms of the screen, respectively. On the other hand, in the double blocks, the subject categorizes sentences that are connected by two distinct categories, the first of which is logical (true/false) while the second describes one of the two autobiographical events (Agosta & Sartori et al., 2013).

The association between a true autobiographical recollection and sentences related to true events should facilitate the subject to respond, and the reaction time in the two blocks should therefore be an index of truth or falsehood: short latencies indicate a correct association between the two events and reveal which of the two autobiographical events described is true and which false (Sartori, 2008).

The aIAT has been shown in numerous studies to be very good at detecting memories (Suchotzki et al., 2017). Furthermore, the aIAT is better at identifying true memories than false memories that the participant believes to be true, in addition to determining which of two autobiographical events is more strongly associated with truth (Marini et al., 2012). The fact that a person can attempt to beat the aIAT using various strategies is interesting and useful to understand the potential of applying this technique in the forensic field. For example, guilty suspects can slow down responses in the guilt-consistent blocks (Verschuere et al., 2009) or accelerate responses in the guilt-incongruent blocks (Hu et al., 2012), particularly when they are permitted to practice ahead of the test. However, suspects who employed such strategies may have been caught by selectively altering their response times only during critical blocks and not during other non-critical blocks (Agosta et al., 2011).

In order to evade forensic memory detection, guilty suspects may also choose to intentionally alter their memories prior to the test in order to make these memories more consistent with innocence. Consequently, altering memories prior to a memory detection test may be an effective countermeasure that is less detectable than online faking attempts during the test.

Numerous studies have utilized IAT in conjunction with EEG to obtain a more precise measurement of brain activity while a suspect is lying.

Another source of psychophysiological information is the study of eye movements. Indeed, eye-movement dynamics can provide information about intrinsic brain dynamics (Celli et al., 2022). That is, endogenous brain processes (e.g., top-down) can be reflected in eye-movements spatiotemporal properties, thus giving us a behavioural window on covert mental state. This is true for both stable intrinsic characteristics such as impulsivity (e.g., Zangrossi et al., 2021) but could be applied also to ongoing brain processes (e.g., lying).

1.6.2 Eye-tracking

Research studies that specifically focus on applying various judgment and decision-making theories to improve our understanding of how scientific evidence is interpreted in forensic reconstruction approaches have increased, as a result of the growing recognition that expert decision-making is influenced by cognitive processes (Edmond et al., 2017). As a result, research within the expertise, decision-making, and situation awareness literature has shifted its focus to include forensic science and law enforcement agencies as well as human judgments in the social, psychological, and behavioural economics domains (Ask & Granhag, 2005).

The application of modern technology in forensic investigations to develop novel strategies for accurate scientific measurements has been the subject of some of the most recent published research in the field of forensic science (Kloosterman et al., 2015). Such procedures have incorporated the use of eye trackers to additionally comprehend how experts go about visual tasks, especially concerning the reliability and reproducibility of methods (Nakhaeizadeh et al., 2020).

The term eye-tracking refers to the recording and study of the movements of the eyes in following a moving object, lines of printed text, or other visual stimuli, used as a diagnostic procedure or a means of evaluating and improving the visual presentation of information. Simply, it refers to recording a participant's eye movements while examining a visual stimulus (Collewijn, 1998).

As previously stated, eye trackers are estimation measurement technics used to catch eye developments and have been applied to survey implied information from human experts and their presentation (Duchowski, & Duchowski, 2017). According to recent research, human eye movement focuses on parts of a scene that provide relevant information. (Tatler et al., 2010). Looking at specific areas of interest (AOI), the technology specifically enables the collection of data related to the visual and attention processes involved in a particular task. This enables measurement of how long the participant's attention is focused on a particular attribute (Bojko, 2013), indeed, a simple eye-tracking parameter such as the duration of a fixation (i.e., the time spent looking at a specific element) is known to correlate with the depth of cognitive processing (Just & Carpenter, 1980).

In spite of the many applications of eye-tracking, ranging from diagnosis of neurological diseases to neuromarketing, the application of eye-tracking technology to the study of forensic decision-making has been largely underutilized within forensic science (Nakhaeizadeh et al., 2020).

Eye-tracking could be a method for working on the reliability and validity of psychological research and it has significant advantages. First, the examiner's skill requirements are minimal for eye movement registration. Second, eye-tracking technology makes it possible to perform non-invasive, covert diagnostics from a distance and delivers extremely precise results in a fraction of the time required for calibration, testing, and data processing. Thirdly, a lot of psychological indices are often uninformative because they respond slowly and with a lot of latency. Eye-following has high estimating exactness; high-frequency data recording and high-speed calibration, survey, and result processing allow us to capture more subtle changes in eye movement, such as saccade velocity, among other things. Fourthly, eye-tracking relies on the measurement of cognitive responses rather than emotional responses, which is regarded as unreliable based on the respondent's status and the testing conditions (Bessonova & Oboznov 2018).

Given all these advantages, the eye tracker is a very useful tool that has already proven to be quite effective in a range of forensic topics, including the effect of weapon exposure (Hope & Wright, 2008), visual attention in antisocial personality disorder (Ceballos & Bauer, 2004), the role of expertise in deception detection (Bond, 2008), eyewitness decision processes in criminal lineup identification (Mansour et al., 2009) and child sexual offenders (Godet & Niveau, 2021).

With specific regard to the last topic mentioned, the eye tracker has been used in studies to measure sexual attractiveness using attentional processes, particularly in relation to sexual offenses.

Nevertheless, even though there is a certain amount of enthusiasm for the method in the context of the evaluation of sexual offenders, there are very few specific studies that are relevant to its application.

CHAPTER 2

OUR STUDY

Due in part to the development of technology, forensic techniques have undergone several changes and evolutions over time.

Since behaviour and neuropsychological tools have been studied for many years, also in relation to forensic applications, these techniques are more commonly adopted in forensic psychology, as compared to neurophysiological indices. Techniques belonging to these categories can also be employed to study memory in forensic cases, an approach called "memory detection". To this end, one possibility is the use of behavioural tools based on response time (RTs).

Among these, as broadly demonstrated previously, the aIAT (Sartori et al., 2008) appears to have the greatest potential for application in the forensics field, given its flexibility and the possibility to be integrated with other techniques.

2.1 Study's objectives

The aim of this study is to investigate aIAT performance in a mock-crime scenario, by investigating also how it might be affected by the degree of a crime (i.e., soft vs. hard) and whether the combination of aIAT and eye-tracking can outperform the aIAT alone in distinguishing genuine crime-related memory.

This study is part of a broader project whose main goals are:

1) Examine the ways in which the performance at the aIAT can be affected by how strong the familiarity with an alibi (i.e., an alternative version of the criminal event) is;

2) Evaluate whether the degree of the crime—soft vs. hard—can affect how well you do on the aIAT (e.g., sexual harassment vs. sexual abuse);
3) Examine whether eye-tracking and behavioural aIAT performance can outperform the aIAT alone in uncovering the true memory, eventually outperforming the effects of alibi and degree of the crime.

Importantly, points 2) and 3) will be the focal points of the analysis of this thesis, specifically point 3) will be investigated with regard to the severity of crime.

2.2 Participants

The experiment was carried out with the participation of a total of 100 students from the University of Padua who ranged in age from 19 to 32. The study was approved by the ethical committee of the School of Psychology of the University of Padua and was conducted according to the principles expressed in the Declaration of Helsinki. All participants were informed about the general experimental procedure and signed a written consent form.

Participants' recruitment was performed by means of advertisements placed at the University as well as on social media platforms like Facebook and WhatsApp groups to find participants. No incentives (e.g., monetary reward, university credits) have been given to the participants in the experiment.

In this experiment, there are two macro-dimensions under investigation (*Figure 1*). First, whether the participants belonged to the Innocent group (INN) or the Guilty (GUI) group. The distinction between guilty and innocent participants was based on whether they participated to the mock-crime scenario or not (see next paragraphs for details). Second, within the GUI were further subdivided into those being involved in a soft version (i.e., sexual harassment; GUI_S), or a hard version of the crime (i.e., sexual assault; GUI_H). Furthermore, participants assigned to the guilty condition (GUI) were divided into several groups according to whether they were required to rehearse an alibi and the frequency of the repetition of the alibi:

- A group without an alibi (nA);
- A group that repeats the alibi 1 time a week (A1);
- A group that repeats the alibi 5 times a week (A2).

As specified above, for the purpose of this thesis the focus will be the division between hard and soft crime groups, the alibi groups will not be discussed.

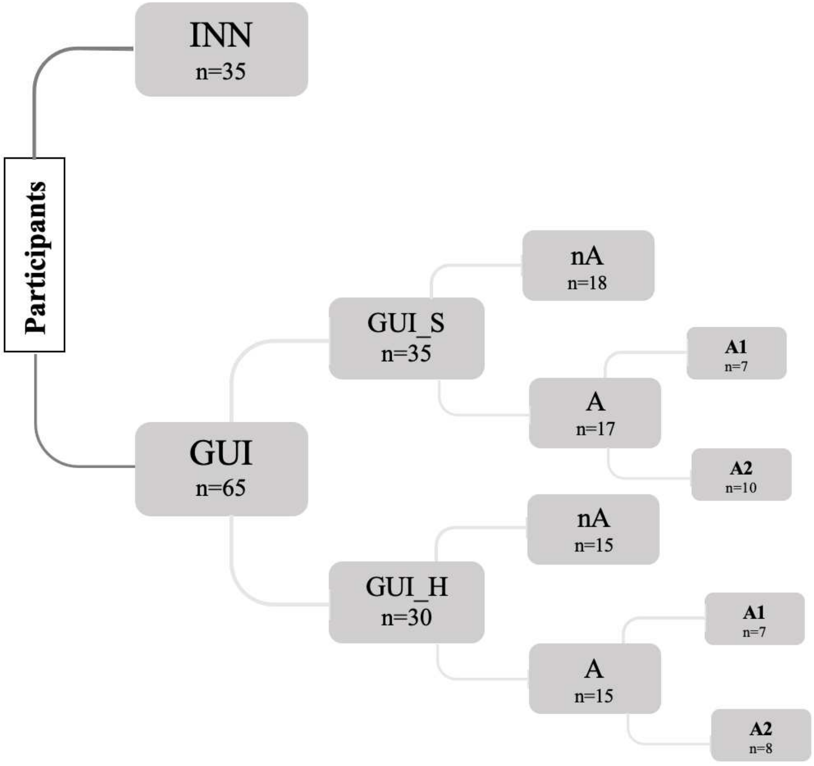


Figure 1: groups and number of participants for each category (INN=Innocents, GUI=Guilty, GUI_S=Guilty Soft crime, GUI_H=Guilty Hard crime, GUI_nA_S=Guilty no Alibi Soft crime, GUI_nA_H=Guilty no Alibi Hard crime, A1=the participant has to repeat the alibi once, A2=the participant has to repeat the alibi five times

Specifically, each group taking part in the experiment was composed by (see also *Figure 1*):

- 65 participants for GUI group
    - 35 participants for GUI_S group
    - 30 participants for GUI_H group
- 35 participants for INN group

The following (*Table 1*) are the averages of the participants divided into GUI and INN groups according to age, years of education, gender, and distance between phase 1 and phase 3 of the experiment:

GROUP	**Age**	**Years of education**	**Gender**	**Distance between phase 1 and phase 3**
GUI_H	23,43	17,1	F: 24 M: 6	6,93
GUI_S	23,18	16,76	F: 22 M: 13	7,07
INN	24,18	17,56	F: 31 M: 4	7,031

Table 1: average and number of participants in different groups of the experiment

2.3 Materials and procedure

The study was carried out at the University of Padua's Department of General Psychology (DPG), lasted approximately 40 minutes, and was composed by three phases:

- Phase 1: in which participants in the GUI group are requested to commit a mock-crime (see below for details), while, participants belonging to the INN group were asked to write their code on a sheet of paper hanging on the wall;
- Phase 2: involving only participants in the GUI group who were assigned to the alibi groups (GUI_A1 and GUI_A2), in which an alibi had to be recorded and sent to the experimenter;
- Phase 3: in which an aIAT and eye-tracking eye movement recording were carried out.

2.3.1 The mock-crime

The "crimes" utilized in a variety of studies, in order to establish ground truth, have taken different forms. For the most part, they are "mock-crimes": i.e., crimes in which subjects know they are role-playing being criminals for the purpose of the experiment.

In this experiment, every participant is told to follow the instruction that one of the experimenters gives them in the first session. These instructions are contained in an envelope and will indicate an action that must be taken (the mock-crime). Depending on the assigned group, the activity to be performed is different:

- INN group: the must write their code on a sheet of paper in the hallway of the laboratories on floor -1:
- GUI group: they must snatch an image depicting sexual harassment (GUI_S) or sexual assault (GUI_H). In this group, there is a subcategory: the A1/A2 group in which participants must repeat an alibi (saying that they wrote their code instead of snatching an image) by sending a voice message on WhatsApp for one day (A1) or five (A2).

In order to make the condition more ecological, the images used in the mock-crime, for GUI groups, were printed on photographic paper. Images employed in the mock-crime were frames representing a soft (sexual harassment) and hard version of a sexual crime (sexual assault) (*Figure 2*).

Figure 2: frames used in the experiment representing a soft (sexual harassment, above) and hard version (sexual assault, below) of a sexual crime.

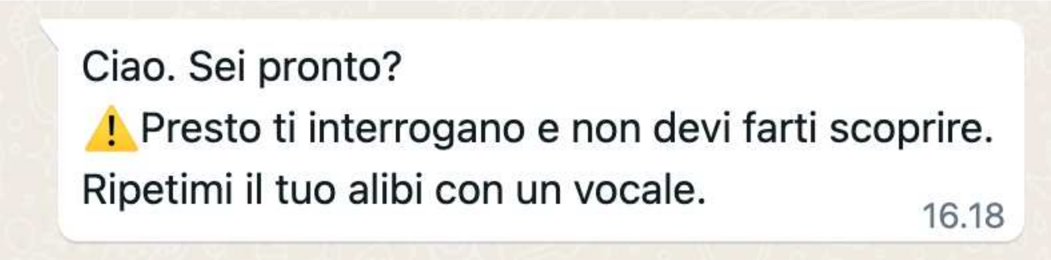
Four experimenters performed cross-analysis on a set of whistleblowing and protest films, videos, and other materials used in previous publications to select the stimuli.

Nevertheless, none of the previously used stimuli were appropriate so the play "Extremities," written by William Mastrosimone and directed by Bruno Armando, served as the final source of the selected stimuli. The relevant YouTube video[12] frames were extracted.

In particular, the soft crime film features a scene in which two actors engage in unwelcome physical contact, whereas the hard version features an attempt at sexual assault by the actors. Genitals and explicit sexual scenes are not included in the image.

In addition to the photos, at the beginning of the first phase of the experiment, after signing the informed consent form and handling the information form, participants received an envelope containing group-specific instructions (Appendix 2) and a map (Appendix 3).

For the Alibi group, we used a sim card to send a message (*Figure 3*) and ask the participant to repeat the alibi (Appendix 4). According to their category, participants had to repeat the alibi for one day (GUI_A1) or five days (GUI_A2).



Ciao. Sei pronto?
⚠ Presto ti interrogano e non devi farti scoprire.
Ripetimi il tuo alibi con un vocale.
16.18

***Figure 3*:** the message sent to the participants in the alibi group.

All the materials used in different phases were approved by the Ethics Committee.

2.3.2 The aIAT and eye-tracking record

Once the participants have completed the previous part (i.e., mock crime vs code writing on the wall), they are asked to return a week later (precisely six, seven, or eight days after

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[12] https://www.youtube.com/watch?v=WzplxoeR7Zs

the mock-crime) and complete a computerized test (aIAT). During the test, eye movements are detected and recorded through a non-invasive eye movement tracking system.

The aIAT is composed of five blocks in which each block consists of a series of randomly repeating sentences, the participants' task is to categorize them according to two categories placed at the bottom of the screen by pressing only two response keys (A and L buttons). See the next paragraph for an in-depth description of the aIAT procedure used. Before starting the experiment, the eye tracker that detects eye movements throughout the experiment is calibrated following a 9-point calibration.

A further note concerns the initial part of the experiment: the participant (regardless of his/her condition) is asked to freely look at the photograph of the room he or she is in (*Figure 4*), which is the same one in which the participants placed in the Guilty category tore up the photo, and then answer whether they have already seen it or not by pressing the A or L button on a keyboard. The purpose of this is to check whether those who entered the room move their gaze differently than those in the Innocent category who did not enter the room before this step. Nevertheless, this point was not investigated in the present thesis. Once this is done, proceed with the five blocks of the aIAT.

***Figure 4**:* picture of the room where participants are conducting the experiment, the same room they entered the previous week for mock-crime.

Based on the hypothesis that the combination of aIAT and eye tracker should enable better participant classification, we test the proportions of fixations in the two boxes according to condition and block type.

The aIAT structure

Sartori et al.'s aIAT (2008) is an expansion of the highly influential Implicit Association Test (IAT) method (Greenwald et al.,1998) which is employed in the social psychology literature to measure implicit attitudes.

The aIAT requires participants to complete a series of simple or double categorization tasks, as in the IAT procedure, to determine which of two contradictory autobiographical events is true for them. Response times are assumed to be facilitated if the true autobiographical event is associated with other true events or facts, because the aIAT exploits the compatibility effect. This effect reflects the common observation that the motor response to coded information (such as memory traces) associated with each other in a subject's mind is faster than the motor response to coded information not associated with each other.

According to Fuselli (2017), this method can be described as a stimulus-response type of test in which the examinee sits at a computer and must respond to various sentences about autobiographical events.

In the aIAT the participant is required to perform a variety of computerized categorization tasks divided into five blocks based on response times. The stimuli are sentences, approximately of the same length, describing experiences from one's life and facts that might be true (Appendix 1).

In particular, two types of stimuli are used:

1. Statements that are objectively true (e.g., “Sono a Padova”) or false (e.g., “Sto scalando una montagna”);
2. Statements that represent two distinct versions of the memory under investigation, one of which is true according to the INN group (e.g., “Ho scritto il mio codice su un foglio”) and one is true for the GUI group (e.g., “Mi sono disfatto della prova del reato”).

Stimuli in each block are presented one at a time in the center of a computer screen.

At the lower left and right of the screen are presented two labels indicating categories, and the participants are asked to classify each sentence using two distinct response keys (button A or L) in accordance with clearly stated instructions; the classification must be as quickly and precisely as possible.

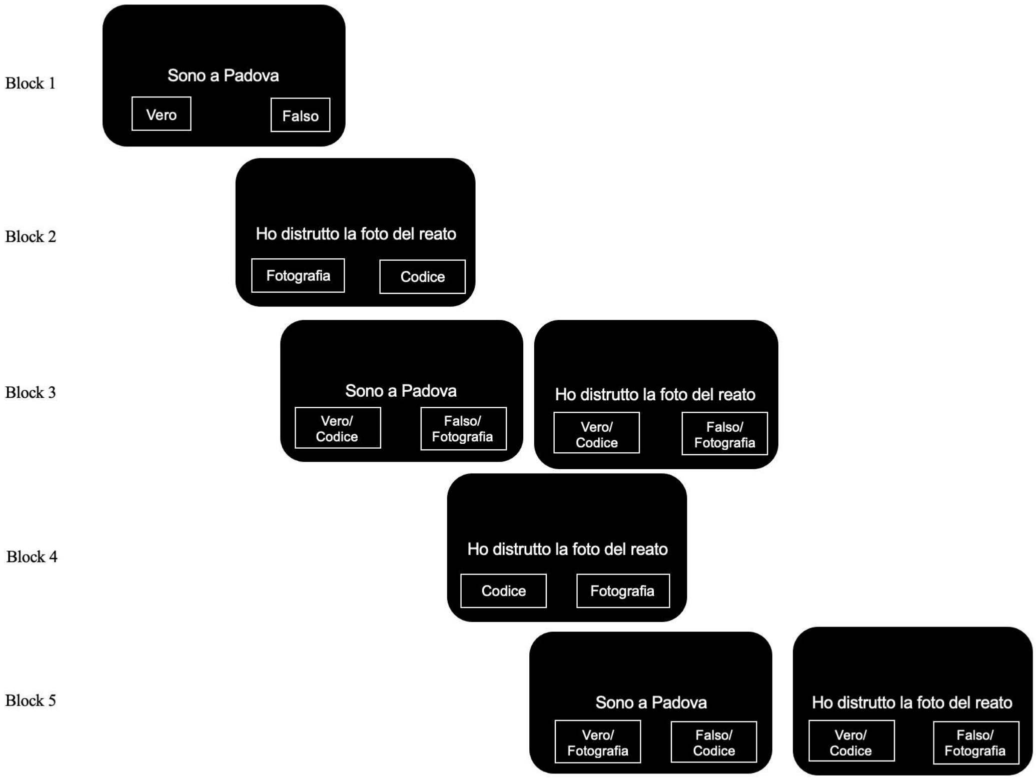

***Figure 5**:* structure of the aIAT used in this experiment, version A

As known, the aIAT is made up of five classification blocks (*Figure 5*): three simple categorization blocks (1,2, and 4) and two double categorization blocks (3 and 5).

Only one type of stimulus is used in the simple blocks, and the response buttons A and L are used to classify sentences that fall into only two categories, which are displayed on the lower-left and lower-right of the screen, respectively (e.g., Vero vs Falso or Fotografia vs Codice).

Because both stimulus types are used in the double blocks, four categories come into play. This implies that every reaction button is shared between two classifications (e.g., the same button for true sentences (Vero) and sentences referring to the photo (Fotografia)).

In Block 1, participants must classify a series of sentences describing facts as true (e.g., “Sono seduto su una sedia”) or false (e.g., “Sono a pranzo in un ristorante”).

In Block 2, participants have to perform a similar categorization task but with reference to the critical guilty (e.g., “Ho distrutto l’unica prova del reato”) or innocent (e.g., “Ho scritto un codice su un foglio”) categories.

In Block 3, which is one of the double categorization blocks, participants are randomly presented with true sentences, false sentences, and sentences related to possible autobiographical events connoted by Guilt or Innocence and are asked to simultaneously classify the stimuli relating to both categories of interest. True sentences and sentences related to one version of the autobiographical event (e.g., “Ho scritto il codice su un foglio” – innocent category) are paired on the same response key, while false sentences and sentences related to the other version of the autobiographical event (e.g., “Ho distrutto l’unica prova del reato” – guilty category) are classified with the other response key[13].

Block 4 is structured like the second, but the response labels are reversed. Participants are then presented with sentences associated with the category guilty (e.g., “Ho distrutto l’unica prova del reato”) and the category innocent (e.g., “Ho scritto il codice su un foglio”) and are asked to classify them by pressing, respectively, the right or left button, reversing the instructions given in the second block.

Lastly, Block 5 is structured like the third, but the categories' matching is reversed. Participants classify with the same response key true sentences and sentences related to the guilty category sentences (e.g., “Ho distrutto l’unica prova del reato”) while false and sentences related to the innocent category (e.g., “Ho scritto il codice su un foglio”) are paired with the other response key.

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[13] This is the structure used in version A of the experiment, in version B the matching categories are reversed: Vero/Fotografia vs Falso/Codice in block 3, and Vero/Codice vs Falso/Fotografia in block 5.

Two versions[14] of the same experiment (Version A and B, *Table 2*) were proposed in order to avoid biases related to the cognitively most difficult blocks (3 and 5). Version A, in Block 3, presents true and innocent category sentences (label "Vero/Codice") that have to be classified with the same response key, while false and guilty category sentences (label "Falso/Fotografia") are paired with the other response key (congruent condition – Cong). This condition is reversed in Block 5 (incongruent condition – Incong).

In Block 3 of version B, the previous classifications are reversed: true and guilty category sentences (label "Vero/Fotografia") are paired, while false and innocent category (label "Falso/Codice") sentences are classified with the same response key (incongruent condition – Incong). As in version A, this condition is reversed in Block 5 (congruent condition – Cong).

GROUP	**VERSION**	**CONG**	**INCONG**	**VERSION**	**CONG**	**INCONG**
INN	A	3	5	B	5	3
GUI_nA_H	A	3	5	B	5	3
GUI_nA_S	A	3	5	B	5	3
GUI_A1_H	A	3	5	B	5	3
GUI_A1_S	A	3	5	B	5	3

Table 2: experimental groups and administered versions ("Cong" = congruent block, "Incong" = incongruent block)

The logic behind the aIAT is essentially gotten from the first IAT strategy: if two sentences having a similar motor reaction are both related to the idea of truth in the respondent's mind (Congruent condition), then the subject will show quicker RTs in contrast with the circumstance in which two sentences having a similar reaction key are

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[14] The assignment of participants to one version rather than the other is random.

not related in the mind of the respondent (Incongruent condition). That is, if a sentence is paired with a true autobiographical event, it should encourage responses, resulting in faster RTs. Therefore, the autobiographical event that is either true or false can be deduced from the pattern of RTs in the double-categorization blocks.

In double-categorized blocks, reaction time (RTs) and D-index are considered significant measures for data analysis (Greenwald et al., 2003).

Each subject's correct or incorrect response, as well as their RTs, which is measured in seconds, are recorded. According to the research conducted by Agosta and Sartori (2013), RTs ought to be converted into milliseconds (RT x 1000).

D-index[15] (D600, Greenwald et al., 2003) is calculated by combining the speed of responses and classification accuracy. It expresses the difference in the mean latencies of the double categorization blocks (RTs of the Congruent block and the Incongruent block) scaled by the standard deviation of response latencies.

This yields a value that can be positive or negative, demonstrative of how much effort the subject makes in the Incongruent blocks.

This kind of estimation is applied to each subject.

$$D - \text{index} = \frac{\mu(RT\text{Incong}) - \mu(RT\text{Cong})}{sd(\text{Cong Incong})}$$

Each participant's error is penalized. The penalty is calculated by replacing RTs with ACC=0 (ACC refers to accuracy: 0 is assigned to incorrect answers, 1 for each accurate one) with the average of correct RTs (ACC=1) increased by 600 milliseconds.

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[15] D-index and D-aIAT refer to the same index.

In addition, to obtain a better analysis, all responses with RTs less than 150 msec and greater than 10,000 msec are eliminated: RTs less than 150 milliseconds are indicative of too fast responses that may reflect random keypresses, whereas RTs greater than 10,000 milliseconds indicate responses that are too slow, indicating that the subject has likely reasoned a lot before pressing the key. Thus, times that fall outside of the range of 150 to 10,000 milliseconds, i.e., RTs < 150 and RTs > 10,000, are excluded.

The subject experiences longer reaction times (in milliseconds) in the Incongruent block if the D-index is positive; as a result, it is likely to fall under the INN category. Conversely, the reaction times are opposite when the D-index is negative: since the subject has a harder time connecting true to innocent-related sentences and takes longer to respond in Congruent blocks, he or she will fall into the GUI category.

The eye-tracking recording

The eye tracker record provides a way to record eye movement data within an experiment. In this experiment, the Tobii Spectrum Pro 600 eye tracker was used. It includes the use of a camera and an infrared light producer, undetectable to the human eye and totally innocuous. The camera doesn't record data with regarding the individual (e.g., no video of the face is recorded), instead, it can distinguish the directions of the eye in space and the size of the pupil, communicated in units. For such information to be properly detected, infrared light is required.

Participants are asked to sit in a comfortable position and avoid excessive head and body movements in order to get a good record of their eye movements. To additionally balance out the head, participants will use a comfortable chin and forehead support.

The sampling rate is a measure of how many samples are taken per second in a digital recording or signal processing[16]. It is typically measured in Hertz (Hz) or samples per second (sps). A higher sampling rate can allow higher frequencies to be recorded without distortion, increasing the digital file size. In this case, the sampling rate is 600 Hz.

As previously stated, eye-tracking data can be informative for a wide range of research and can be processed to extract important information and used to draw conclusions about the participants' mental state.

Some types of data that can be generated from eye tracking are:

- Fixation and gaze point: in eye tracking, these are the most frequently used terms and the fundamental output measures of interest. The focus of the eyes is shown by the gaze points (Mahanama et al., 2022);
- AOI (areas of interest): AOIs are defined by researchers prior to the study as specific regions of interest on the screen. They can be utilized to measure the amount of time spent by participants looking at particular areas (Hessels et al., 2016);
- Duration of fixations: these are typical features derived from the data. They describe a particular characteristic of eye movement;
- Saccades: between fixations, rapid eye movements are called saccades.
- Blinks: the blink is when the eyelids close and open (Ranti et al., 2020);
- Pupil dilation: the enlargement of the pupil in response to changes in light or cognitive load (Goldfinger & Papesh, 2012).

For our study's analyses, the focus is on saccades, fixations, and pupil dilation.

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[16] https://connect.tobii.com/s/article/eye-tracker-sampling-frequency?language=en_US

Involuntary miniature eye movements, also known as fixational eye movements, occur when we view a scene that is stationary. Tremor, drift, and microsaccades are all subdivided into the noisy low-level oculomotor phenomena that are traditionally associated with these micromovements (Ciuffreda, K. & Tannen, 1995).

Microsaccades can be suppressed voluntarily without training in high-acuity observational tasks like threading a needle or rifle shooting, which makes it impossible to demonstrate a specific functional role for them (i.e. one that could differentiate them from drift). Based on these findings, it was decided that microsaccades are an evolutionary puzzle because they are not required for processing visual information (Kowler & Steinman, 1980).

When it comes to controlling saccades, visual attention is a crucial factor.

Actually, the fact that the orientation of attention and gaze position can differ is an important finding from research on visual attention (Deubel & Schneider, 1996). When a participant is focusing on a fixed object, microsaccades can be seen in eye movement recordings (Nachmias, 1959). Microsaccades are ballistic movements that embed small linear sequences in the trajectory, whereas small drifts produce a rather erratic trajectory (i.e., a random walk); the same can be related to saccades.

Saccades and fixations are extracted for each time-point (600ms) during eye tracker detection.

In particular, Engbert & Kliegl (2003) developed a method for calculating saccades, which can be defined as movements that shift attention to a new spatial location without using visual processing: when a velocity reaches a certain threshold, it is said to be a saccade because peak velocities have been identified. As a result, fixation can be determined from the beginning and end of the saccade; to put it another way, fixation is like looking between saccades.

As stated, for detecting saccades in eye-tracking data, Engbert and Kliegl’s (2003) algorithm is widely used. To find saccades, the algorithm uses a velocity-based detection method. This algorithm provides for:

- Utilize the first-order differentiation of the eye position data to calculate the eye movements' horizontal and vertical velocities.
- Determine the velocities' standard deviation for each trial.
- Determine the median of all trials' standard deviations.
- A multiple of the median standard deviation should be used as the velocity threshold for each trial.
- Identify saccades as periods of time when the velocity exceeds the threshold.

Depending on the data's noise level, the threshold is typically set to 4-6 times the median standard deviation (Schweitzer & Rolfs, 2020). Both microsaccades and larger saccades can be detected using the algorithm.

In our study, we propose the consideration of D-aIAT with an index that we will call D-eye, referring to the indices of eye movements that are detected by the eye tracker. In particular, the D-eye allows testing the proportions of fixations in the two boxes depending on the condition (GUI or INN) and the type of block (Congruent or Incongruent):

$$D - \text{eye} = \frac{\text{proportion of fixations in AOI (Incong)} - \text{proportion of fixations in AOI (Cong)}}{sd}$$

AOI = boxes with labels

As we know, eye tracking technology allows researchers to track eye gaze as a series of fixations and saccades, which can provide detailed qualitative and quantitative assessments of how and where the eyes move during interpretation (Brunyé, et al., 2019). By combining the data from the eye tracker and those from the aIAT, this kind of analysis enables us to determine whether the analysis of eye movements improves the classification of experiment participants into INN and GUI groups.

CHAPTER 3

ANALYSIS AND RESULTS OF OUR STUDY

To test our hypotheses, we design an experiment with two macrogroups: INN and GUI (further divided into GUI_H and GUI_S groups). After an initial phase in which participants were asked to perform a mock-crime, they were subjected to an aIAT with simultaneous eye movement detection with eye-tracking to see if this could improve the aIAT's ability to determine whether they belonged to one group or the other.

The data were analysed with R (https://www.r-project.org) software.

The first part of the statistical analysis used mixed-effects models, which are a class of models that allow studying, specifically, very complex data structures. These models take into account two kinds of factors or effects: random effects, which are considered as noise, and fixed effects, referring to the variables of interest, i.e., the predictors of the model. As such, they permit simultaneous consideration of all factors that contribute to the comprehension of the collected data. The fundamental benefit of utilizing mixed models is that mean qualities are considered as well as interindividual variability is considered so the group can be evaluated.

Specifically, RTs served as the dependent variable in our series of 3 mixed-effects models, and participants served as the random factor. The following was done to build the models:

- M0: only random factors
- M1: block
- M2: block + group + block*group

Using a Likelihood Ratio test, we determined that M3 was the most appropriate model to explain our data (*Table 3*). This suggests that the likelihood of the model was significantly increased when the interaction Block*Group was included.

Model	AIC	BIC	χ^2	Df	p-value
M0	23781	23803	-	-	-
M1	23783	23812	.109	1	.74
M2	23787	23831	.166	2	.92
M3	23237	23296	553.839	2	<.001*

Table 3: we determined that M3 was the most suitable model to explain our data by applying a Likelihood Ratio test.

The following shows the main effects of model 3 (*Table 4*):

Predictors	χ^2	Df	p-value
Block	.0216	1	.883
Group	.0791	2	.961
Block*Group	559.29	2	<.001 *

Table 4: the main effects of model 3

To further describe the interaction between Block*Group, we ran post-hoc comparisons and found that:

- after Bonferroni correction for multiple comparisons, we discovered significant differences between INN and GUI_H (z=2.904, p=.011) and INN and GUI_S (z=2.92, p=.0106) in the block "Vero/Codice". Participants in GUI_S and GUI_H did not differ significantly;

- we did not find any significant differences in the "Vero/Fotografia" block.

Furthermore, when we compared the two blocks within groups, we found that there was a significant difference between all groups (GUI_S: z=-9, p<.001; GUI_H: z=-8.68, p<.001; INN: z=19.55, p<.001).

Also, we found a significant difference between INN and GUI participants (including both Hard/Soft and Alibi/NoAlibi): t[84.7]=-8.78, p<.001. This difference is shown in *Figure 6* below:

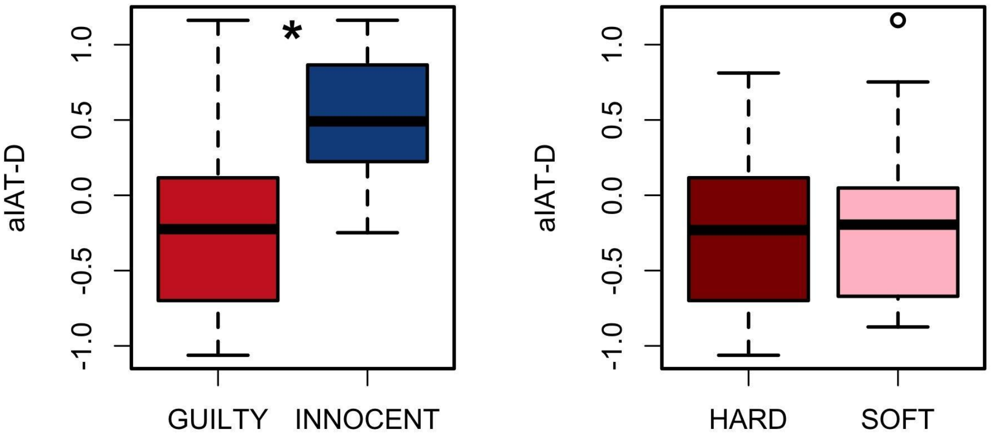


Figure 6: differences between INN and GUI groups (left) and between GUI_H and GUI_S groups (right)

As previously stated, the D-index is calculated based on the difference in RTs between the two double categorization blocks of the aIAT. Based on this, it is possible to classify participants as being either part of the INN or GUI category. This categorization depends on whether the D-index is positive or negative (the distribution of the index is shown

Figure 7): if it is positive, the participant is slower in Incongruent blocks, intending it to be part of the INN group; otherwise, if it is slower in responding to Congruent blocks, it is likely to be part of the GUI group.

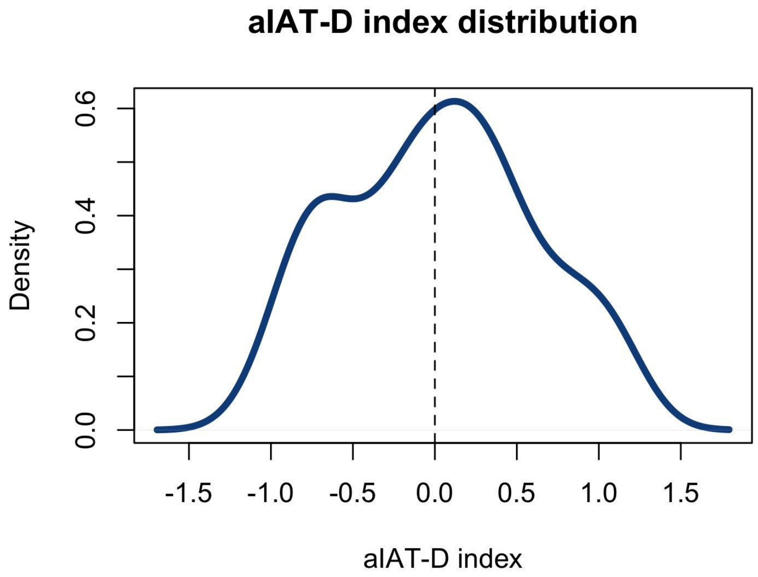


***Figure** 7*: computation of individual aIAT-D indices

Then, a ROC analysis was considered to examine the Block*Group interaction.

The ROC (Receiver Operating Characteristic) analysis is a graphical plot used to show the diagnostic ability of binary classifiers. The ROC curve shows the relationship between clinical sensitivity and specificity for every possible cut-off.

We conducted this type of analysis for the classification of GUI and INN with D-aIAT(*Figure 8*).

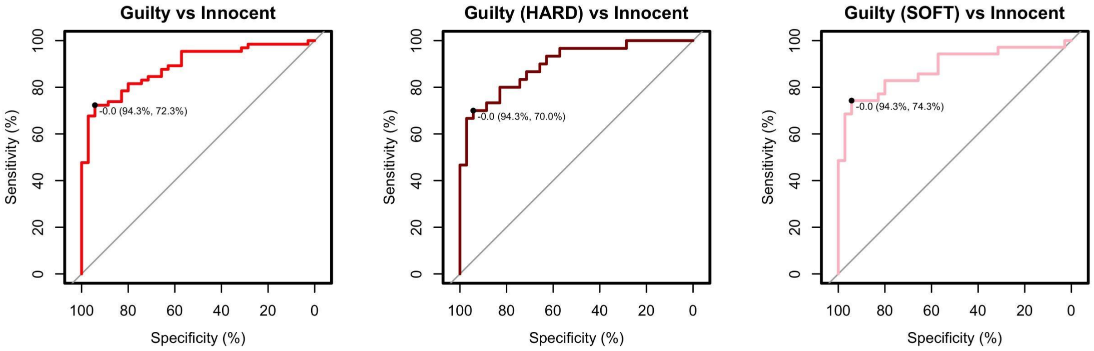


Figure 8: classification of Guilty and Innocent with aIAT-D (ROC analysis)

The accuracy of D-aIAT in the identification of Guilty participants is comparable between Hard and Soft conditions.

- Guilty (N=65) vs Innocent (N=35): AUC=88.84% [95% C.I. 82.56%-95.11%], 72.3% specificity and 94.3% sensitivity
- Guilty Hard (N=30) vs Innocent (N=35): AUC=89.71% [95% C.I. 82.23%-97.2%], 70% specificity and 94.3% sensitivity
- Guilty Soft (N=35) vs Innocent (N=35): AUC=88.08% [95% C.I. 79.78%-96.38%], 74.3% specificity, and 94.3% sensitivity

The same kind of analysis was proposed for the eye tracker data focusing mainly on the number of saccades, fixations, and pupillary dilation.

In relation to eye movement, we cut off the coordinates greater than those possible in the screen, which, in our case, has dimensions 1440x900 pixels, so on the X-axis we keep the values contained in the range from -720 to +720, and for the Y-axis we keep the values contained in the range from -450 to +450. See the density distribution of the eye movements on the X and Y axes in the plot below (*Figure 9*):

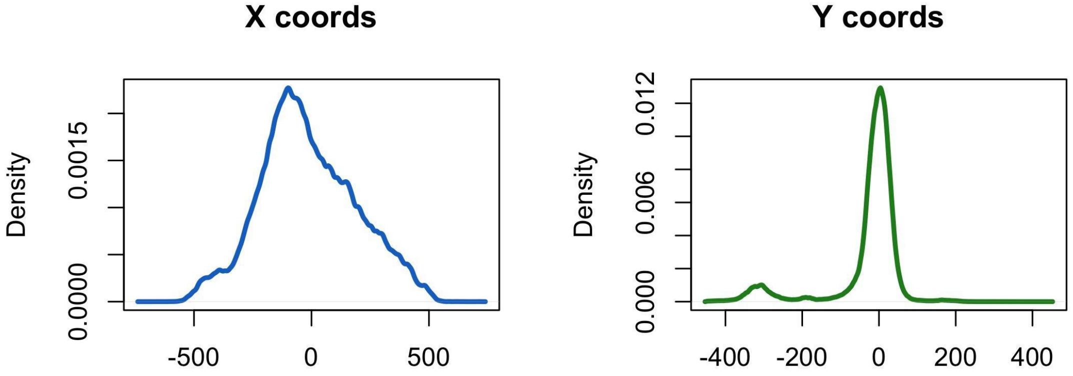


Figure 9: distribution of eye movement during aIAT

As reported by the graphs, participants range more on the x-axis, while on the y-axis they focus more on the center of the screen; the peak indicates that they are looking at the labels.

The correlation (*Figure 10*) between eye movements and aIAT is evidenced by the D-eye index, which allows us to test the proportions of fixations in the two boxes depending on condition and block type.

The difference, as shown in the figure, between the proportion of fixations within the two boxes (Congruent/Incongruent) correlated with the D-aIAT index (r=0.72, p <.001). The results, moreover, show that GUIs look more at the Congruent blocks ("Vero/Codice") than participants in INN group; this result is reversed for the Incongruent block ("Vero/Fotografia").

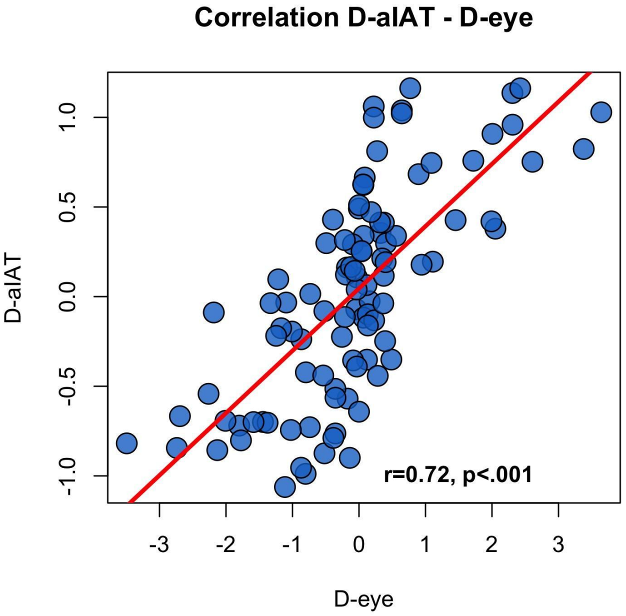


Figure 10: aIAT congruency effect in eye movements: D-eye index

As with the analysis of the aIAT, an ROC analysis was performed for the eye tracker to evaluate the classification of GUIs and INNs through the D-eye (*Figure 11*). The results are shown below.

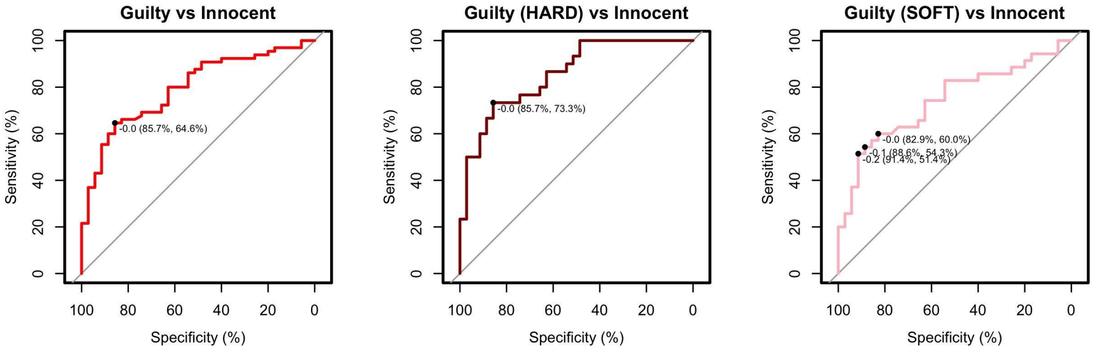


Figure 11: classification of Guilty and Innocent with D-eye (ROC analysis)

The accuracy of D-eye in the identification of GUI participants is comparable between Hard and Soft conditions.

- Guilty (N=65) vs Innocent (N=35): AUC=79.41% [95% C.I. 70.53%-88.28%], 85.7% specificity and 64.6% sensitivity
- Guilty Hard (N=30) vs Innocent (N=35): AUC=85.62% [95% C.I. 76.76%-94.48%], 85.7% specificity and 73.3% sensitivity
- Guilty Soft (N=35) vs Innocent (N=35): AUC=74.08% [95% C.I. 62.22%-85.94%], 82.9% specificity and 60% sensitivity

Another classification can be made based on the D-aIAT and D-eye indices, this allows us to indicate how often the two respective indices are able to correctly detect the participant's membership in the GUI category. When D-aIAT=1 or D-eye=1, it means that the index is able to categorize correctly (*Table 5*).

		IDENTIFIED		**MISIDENTIFIED**		**TOTAL**
		D-aIAT	**D-eye**	**by D-aIAT but not by D-eye**	**by D-eye but not by D-aIAT**	
GUILTY	**HARD**	21	22	9	8	30
	SOFT	26	21	9	14	35
	TOTAL	47	43	5	9	65
INNOCENT		33	27	2	8	35

Table 5: classification based on RTs-based (D-aIAT) or eye-movements-based (D-eye) indices.

At this point we move on to analyse the saccades, what is expected is that in the Incongruent block the saccades go from one label to another. This expectation is confirmed because the number of saccades between the AOIs in the two blocks differs significantly between the GUI and INN, showed by the results of the Wilcoxon signed rank test, W=1568.5, p=.0014 (*Figure 12*).

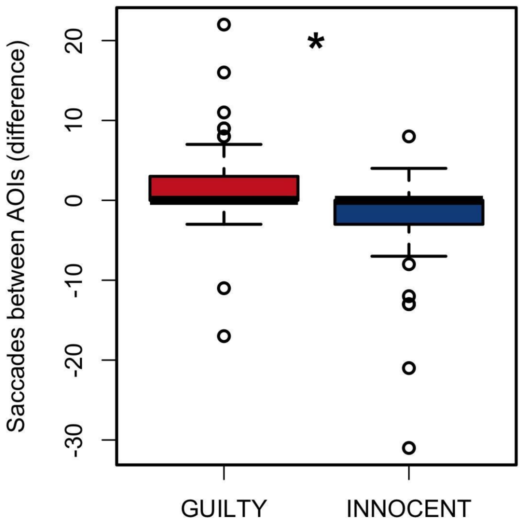


***Figure 12**:* Number of saccades between the AOIs

Duration of fixation and pupil dilation are also investigated.

It is useful to investigate the duration of fixations as it can give an idea of how much the combination of aIAT and eye tracker can improve in predicting the group of INN and GUI. There is only a trend toward significance in the difference in fixation duration between the GUI and INN blocks (*Figure 13*). This is shown by the results of the Wilcoxon signed rank test (W=1370, p=.09).

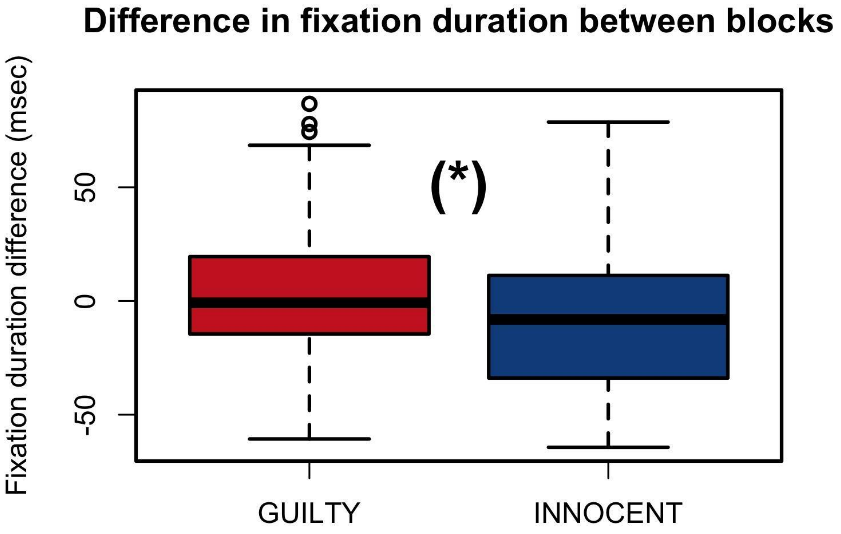


Figure 13: duration of fixation.

Another feature that we analysed in order to identify if there were a significant difference between the two groups was pupil dilation. The analysis showed that the difference between GUI and INN in the difference of pupil dilation between the two blocks (“Vero/Fotografia” – “Vero/Codice”) is significant (*Figure 14*). This is shown by the results of the Wilcoxon signed rank test (W=466, p<.001).

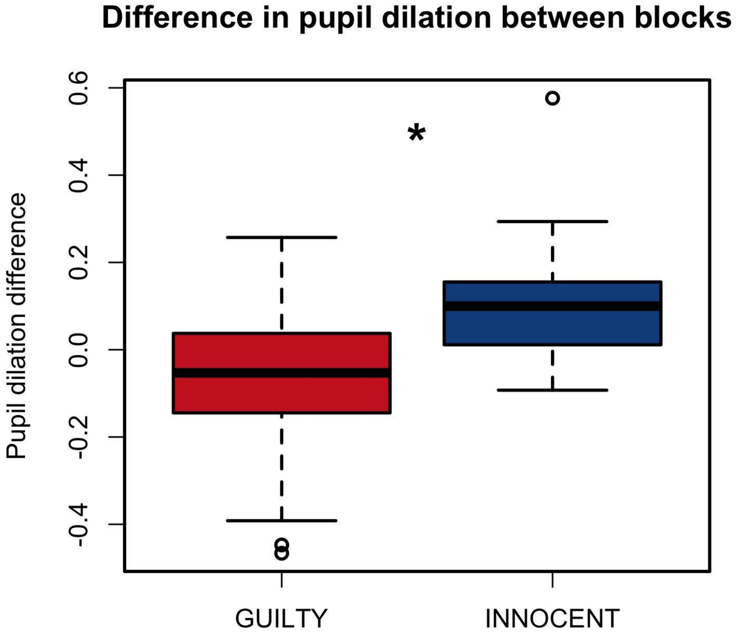


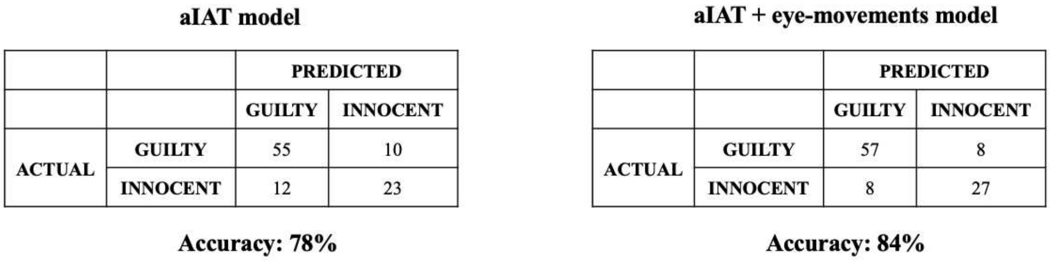
Figure 14: pupil dilation.

Finally, using aIAT-based or eye movements-based indices, we tested the prediction of labels (GUI/INN) made by our logistic regression model. 10-fold cross-validation was used to test the classification.

In aIAT model, the predictor was only the D-aIAT, while in the model including aIAT and eye movement models, the predictors were:

- D-aIAT
- D-eye
- saccade AOI difference
- pupil dilation difference

The comparison between these two models showed that the aIAT model has Accuracy=78%, while the aIAT combined with eye-tracking has Accuracy=84% (*Table 6*).



aIAT model

		PREDICTED	
		GUILTY	INNOCENT
ACTUAL	GUILTY	55	10
	INNOCENT	12	23

Accuracy: 78%

aIAT + eye-movements model

		PREDICTED	
		GUILTY	INNOCENT
ACTUAL	GUILTY	57	8
	INNOCENT	8	27

Accuracy: 84%

Table 6: classification and comparison between aIAT-D and eye movements-based indices; aIAT model accuracy is on the left, while aIAT and eye movement model is on the right.

This data, in line with our hypotheses, allows us to conclude that there is an improvement in predicting the participants' group.

CHAPTER 4

DISCUSSION

This study aims to find out if and how the severity of a crime (soft vs. hard) affects performance on the aIAT, as well as if the combination of the aIAT and eye-tracking outperforms the aIAT alone in identifying a true memory.

First of all, we analysed the behavioural data obtained through the aIAT. In the Congruent blocks, the aIAT test demonstrated resistance and discrimination between the Innocent and Guilty Hard group (p=.011) and between the Innocent and Guilty Soft group (p=.0106).

The employment of mixed-effects models led to the achievement of these outcomes: our data were best explained by the M3 model, which demonstrated that the Block*Group interaction significantly increased the likelihood of the model. However, this distinction we measured between the two macrogroups, is not significant within the Guilty group, where the difference is in the severity of the crime (Hard crime = sexual assault, Soft crime = sexual harassment). This suggests that the degree of the crime does not seem to significantly impact the performance of the aIAT.

After that, we used a statistical model to determine whether the experimental group affected the value of the D and made the D-aIAT index, combining the speed of responses and classification accuracy. This allowed us to conclude that in both the Hard and Soft conditions, the D-aIAT's ability to identify Guilty participants is comparable.

Then we proposed an alternative to D-aIAT adapted to the data we collected through the eye-tracking analysis, which is the D-eye index that let testing the proportions of fixations in the two boxes depending on the condition (GUI or INN) and the type of block (Congruent or Incongruent).

Mainly, we found a strong correlation (r=0.72) between eye movement and aIAT, which is evidenced by the D-eye index; this result is particularly relevant because it indicates that there is a difference between the proportion of fixation within the two labels and that participants that are in the Guilty condition look more at the Congruent blocks ("Vero/Codice") than Innocent; this is reversed for the Incongruent block ("Vero/Fotografia"). Thus, we conclude that depending on the group and the block there is a difference in the duration of fixations: participants in the Guilty group tend to look longer at Congruent blocks than participants in the Innocent group.

Besides the duration of fixations, we were able to extract other indices relevant to the distinction between participants in the two categories, such as the number of saccades and pupil dilation.

As expected, the number of saccades between the AOIs in Congruent and Incongruent blocks differs significantly between the groups; in fact, guilty participants provide more saccades associated with the Incongruent block.

Moreover, pupil dilation was measured. From the analysis of this feature, we can conclude that there is a significant difference between the two groups. Specifically, guilty participants have a greater pupil dilation in Congruent blocks. This result is consistent with the literature, because as previously mentioned, several aspects of cognitive and attentional processes, such as processing intensity and processing load (Just and Carpenter, 1993; Beatty, 1982), are known to be linked to small fluctuations in pupil diameter. Since lying requires great cognitive effort, and because this causes pupillary dilation, Osagwa and colleagues (2021) claim that this feature could be used as an additional non-invasive method for determining who is lying and who is not.

At the conclusion of this discussion, we are able to determine that the combination of aIAT and eye movement detection results in a significant improvement, which can primarily be derived from three specific data:

1. Number of fixations: participants in the Guilty group look more at the Congruent block than the Innocents;
2. Number of saccades between the labels: there is a significant value between Innocent and Guilty groups in relation to the block;
3. Duration of fixation: there is a clear distinction between the Guilty and Innocent groups. Participants in the Guilty group showed the mindset of liars, with longer fixations and a paradox effect that makes them slower even when they are not lying, whereas the Innocent group does not have this effect.

One of this study's primary drawbacks was undoubtedly that the participants had nothing to lose, as opposed to a situation in which people had actually committed a crime.

Overall, this study's findings are encouraging and provide additional evidence of the aIAT's usefulness in forensics. They also add significant information, namely that the simultaneous use of an eye tracker recording, and the detection of eye movements can help improve this tool's mode of action in distinguishing true autobiographical memories from false ones.

This may be the subject of additional research in the future, with the intention of demonstrating the utility of combining these two tools to further enhance the accuracy of memory detection techniques and their application to real-world scenarios.

CONCLUSIONS

Taking into account the technological advancements that neuroscience has undergone, we began our discussion by defining the role that neurolaw has taken on in recent years for a better understanding of the connection between the law and the brain.

The tools that are used vary depending on the specific case; we have focused mainly on memory detection techniques, in particular the aIAT which, as we have seen, is a computerized task developed by Sartori et al., (2008) that requires the categorization of sentences into two categories, the goal is to detect the genuineness of a true or false memory.

In both applied and experimental settings, the aIAT is not new; in fact, it was first used in a sexual assault case involving lawyer Gulotta.
The main advantage of this tool is that it can tell the difference between an able liar and a truthful subject. This raises the question of whether or not these results can be used as evidence in court.

Our research aimed to test the aIAT's ability to detect liars based on eye movements while performing the task and expand its aim of application. Participants were divided into two macrogroups—Innocent (INN) and Guilty (GUI)—and asked to perform an aIAT following a mock-crime in our experimental paradigm.

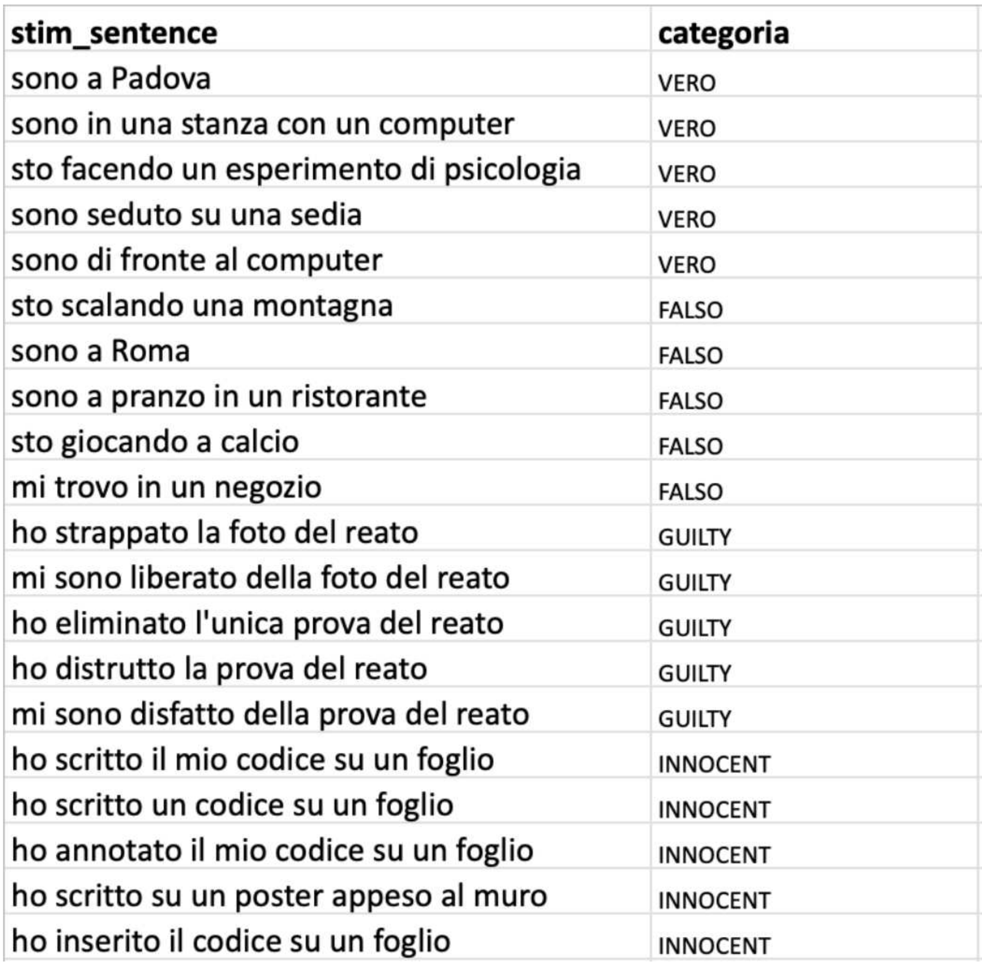
It was possible to identify significant differences between the Innocent group and the Guilty group, particularly based on the number of fixations, the number of saccades between the two labels, and the duration of fixations. These results demonstrated that combining the aIAT with eye movement detection does indeed result in an improvement.

Therefore, we are able to draw the conclusion that the results obtained by combining these two tools are positive and may be useful in the investigation of actual cases in which, in contrast to our study, criminals have something to lose. That last statement, to which I am referring, is dependent on the fact that the aIAT, like the IAT from which it derives its foundation, causes cognitive conflicts that cause reaction times for categorizing sentences to get longer. Those who lie are much slower, and this is evident from test results because they need more time to provide an answer that is in opposition to what reflects the truth in order to be considered innocent.

Lying requires more cognitive effort than telling the truth, so we ask ourselves, how good are we at lying but, more importantly, how useful can neuroscientific tools be in identifying good liars?

APPENDIX

APPENDIX 1



stim_sentence	categoria
sono a Padova	VERO
sono in una stanza con un computer	VERO
sto facendo un esperimento di psicologia	VERO
sono seduto su una sedia	VERO
sono di fronte al computer	VERO
sto scalando una montagna	FALSO
sono a Roma	FALSO
sono a pranzo in un ristorante	FALSO
sto giocando a calcio	FALSO
mi trovo in un negozio	FALSO
ho strappato la foto del reato	GUILTY
mi sono liberato della foto del reato	GUILTY
ho eliminato l'unica prova del reato	GUILTY
ho distrutto la prova del reato	GUILTY
mi sono disfatto della prova del reato	GUILTY
ho scritto il mio codice su un foglio	INNOCENT
ho scritto un codice su un foglio	INNOCENT
ho annotato il mio codice su un foglio	INNOCENT
ho scritto su un poster appeso al muro	INNOCENT
ho inserito il codice su un foglio	INNOCENT

APPENDIX 2

Instructions for GUI_nA_H group

Ho bisogno di aiuto, ho commesso un reato, vogliono incriminarmi per violenza sessuale.

C'è una sola prova di ciò che ho fatto, e si trova nella stanza contrassegnata dal pallino nero (vedi sulla mappa). Per arrivare alla stanza ● scendi le scale e prendi il corridoio a sinistra dell'ingresso, poi segui le indicazioni per gli ascensori e vai al piano - 1.

A destra dell'ascensore troverai una porta rossa 🔴 che puoi aprire con la carta nella busta, poi segui la linea rossa sulla mappa.

Nella stanza ● troverai una foto, unica prova del reato.

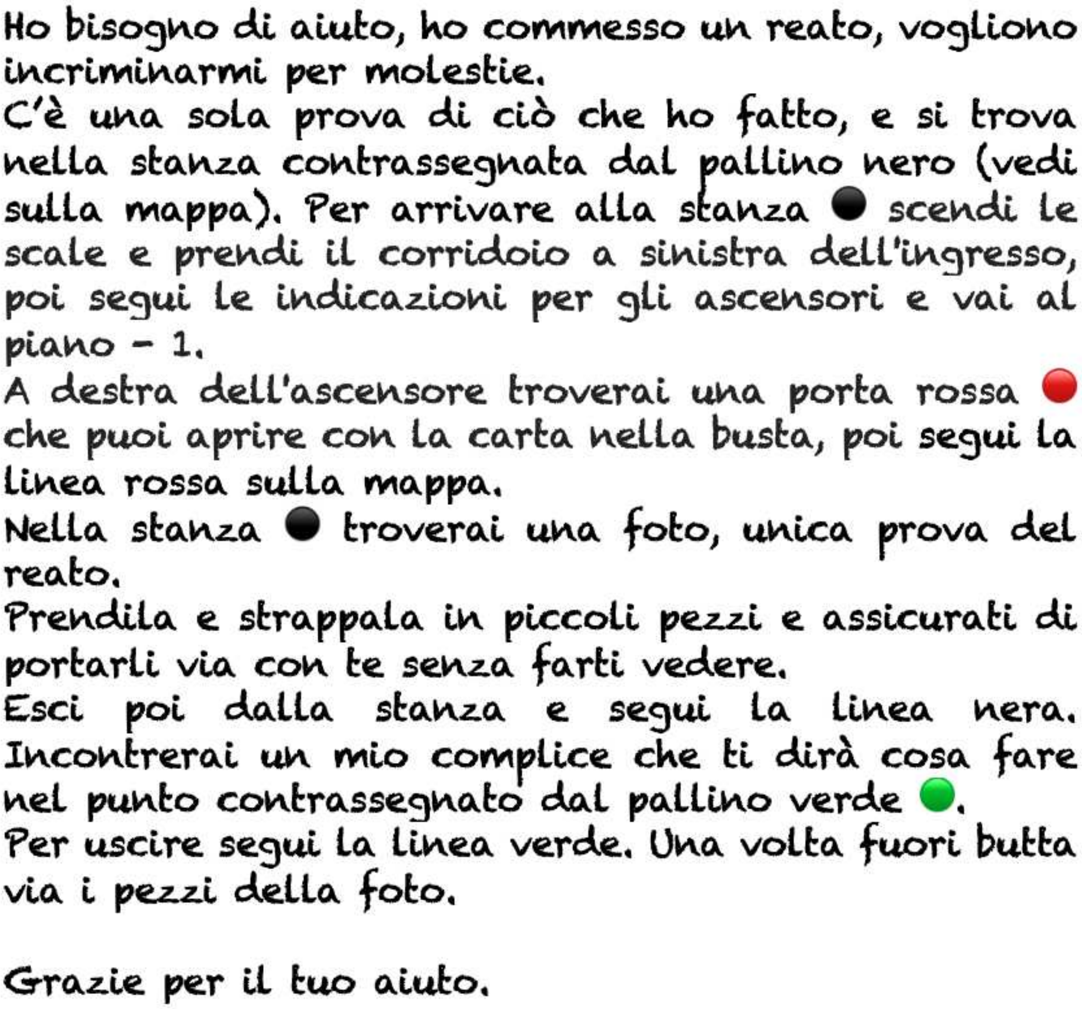
Prendila e strappala in piccoli pezzi e assicurati di portarli via con te senza farti vedere.

Esci poi dalla stanza e segui la linea nera. Incontrerai una persona nel punto contrassegnato dal pallino verde 🟢. Riconsegna a lei la carta senza dare troppo nell'occhio.

Per uscire segui la linea verde. Una volta fuori butta via i pezzi della foto.

Grazie per il tuo aiuto.

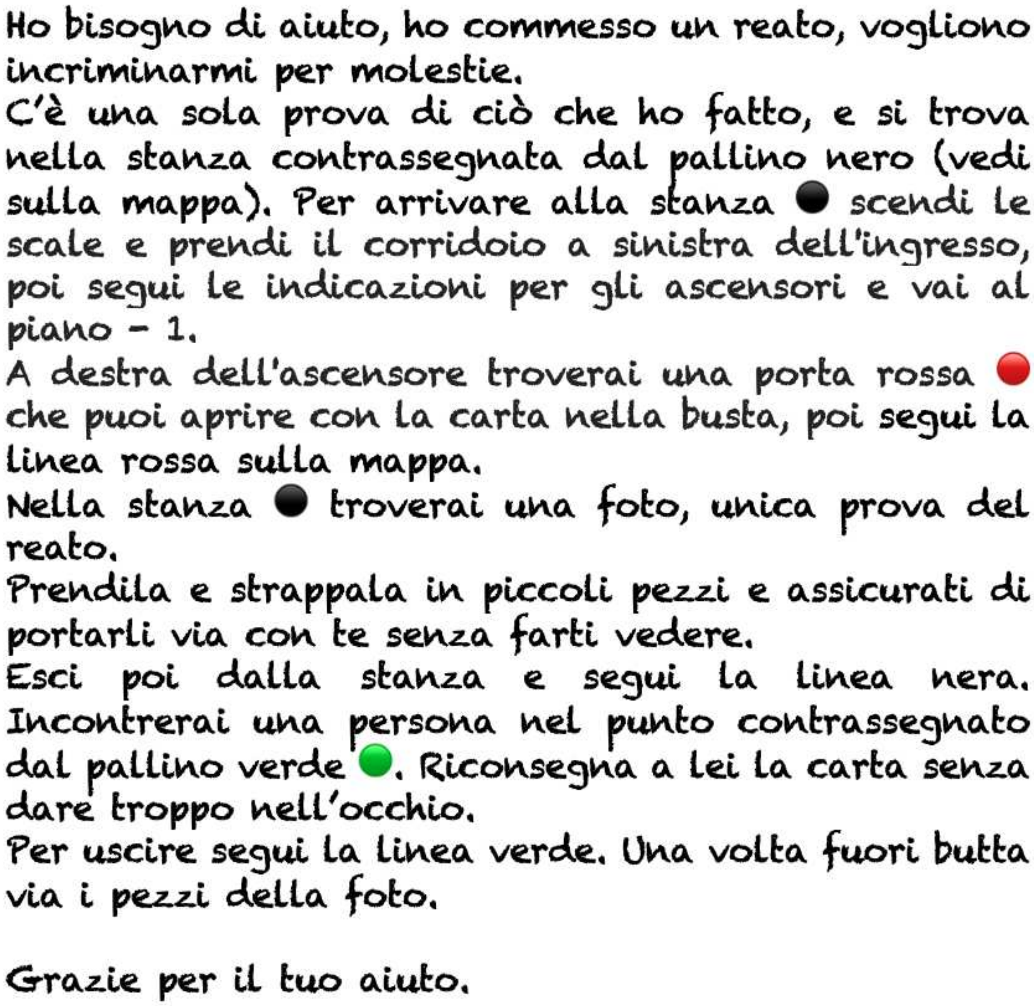
Instructions of GUI_A1_H and GUI_A2_H groups



Ho bisogno di aiuto, ho commesso un reato, vogliono incriminarmi per molestie.
C'è una sola prova di ciò che ho fatto, e si trova nella stanza contrassegnata dal pallino nero (vedi sulla mappa). Per arrivare alla stanza ● scendi le scale e prendi il corridoio a sinistra dell'ingresso, poi segui le indicazioni per gli ascensori e vai al piano - 1.
A destra dell'ascensore troverai una porta rossa 🔴 che puoi aprire con la carta nella busta, poi segui la linea rossa sulla mappa.
Nella stanza ● troverai una foto, unica prova del reato.
Prendila e strappala in piccoli pezzi e assicurati di portarli via con te senza farti vedere.
Esci poi dalla stanza e segui la linea nera. Incontrerai un mio complice che ti dirà cosa fare nel punto contrassegnato dal pallino verde 🟢.
Per uscire segui la linea verde. Una volta fuori butta via i pezzi della foto.

Grazie per il tuo aiuto.

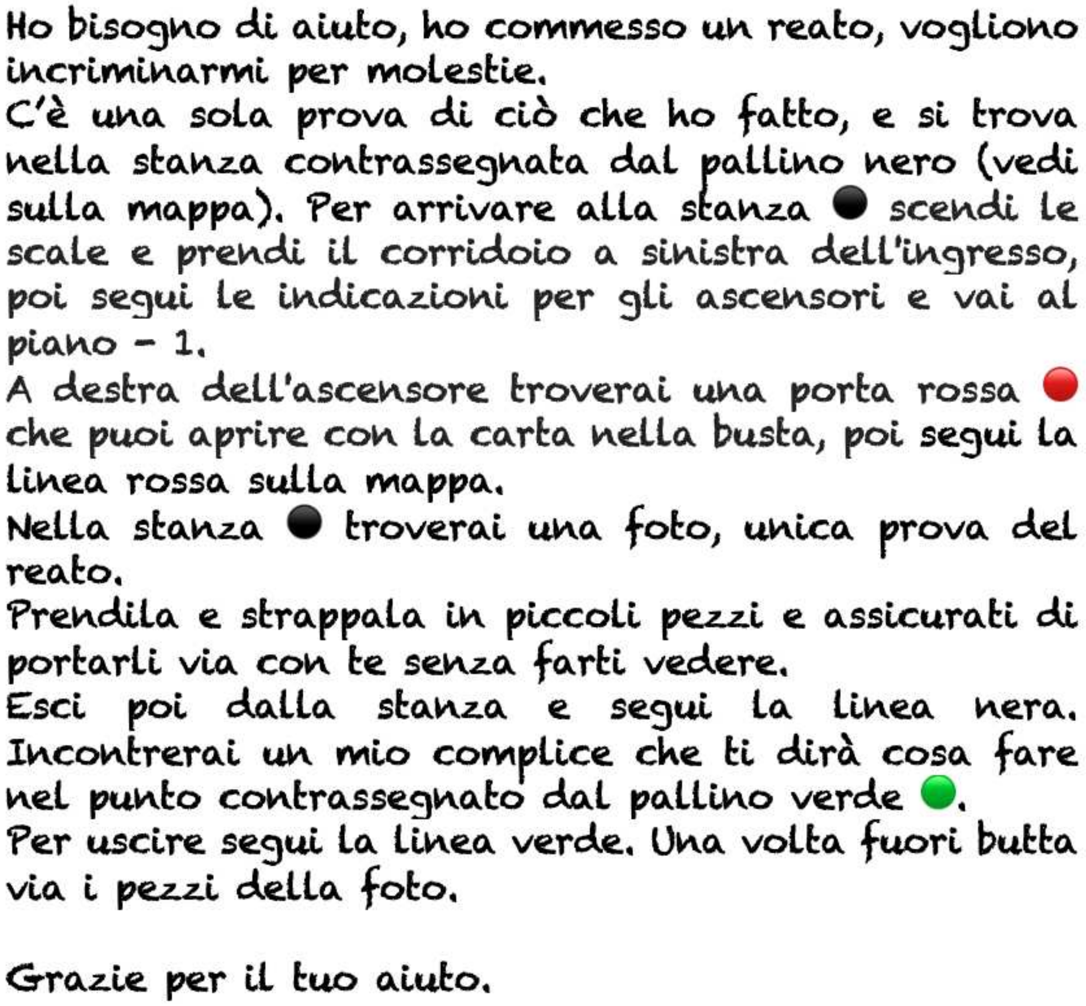
Instructions for GUI_nA_S



Ho bisogno di aiuto, ho commesso un reato, vogliono incriminarmi per molestie.
C'è una sola prova di ciò che ho fatto, e si trova nella stanza contrassegnata dal pallino nero (vedi sulla mappa). Per arrivare alla stanza ● scendi le scale e prendi il corridoio a sinistra dell'ingresso, poi segui le indicazioni per gli ascensori e vai al piano - 1.
A destra dell'ascensore troverai una porta rossa 🔴 che puoi aprire con la carta nella busta, poi segui la linea rossa sulla mappa.
Nella stanza ● troverai una foto, unica prova del reato.
Prendila e strappala in piccoli pezzi e assicurati di portarli via con te senza farti vedere.
Esci poi dalla stanza e segui la linea nera. Incontrerai una persona nel punto contrassegnato dal pallino verde 🟢. Riconsegna a lei la carta senza dare troppo nell'occhio.
Per uscire segui la linea verde. Una volta fuori butta via i pezzi della foto.

Grazie per il tuo aiuto.

Instructions for GUI_A1_S and GUI_A2_S groups



Ho bisogno di aiuto, ho commesso un reato, vogliono incriminarmi per molestie.

C'è una sola prova di ciò che ho fatto, e si trova nella stanza contrassegnata dal pallino nero (vedi sulla mappa). Per arrivare alla stanza ● scendi le scale e prendi il corridoio a sinistra dell'ingresso, poi segui le indicazioni per gli ascensori e vai al piano - 1.

A destra dell'ascensore troverai una porta rossa 🔴 che puoi aprire con la carta nella busta, poi segui la linea rossa sulla mappa.

Nella stanza ● troverai una foto, unica prova del reato.

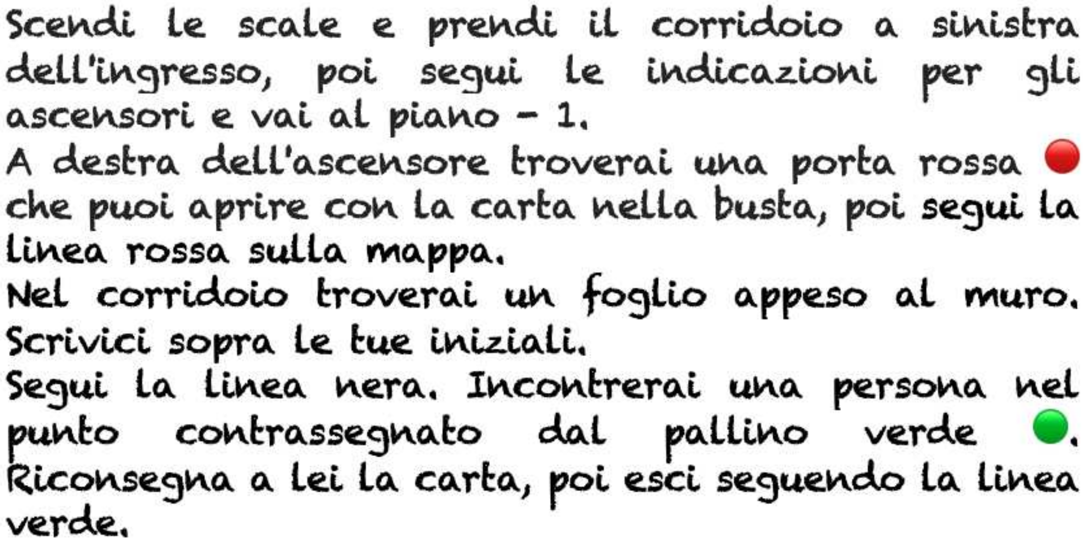
Prendila e strappala in piccoli pezzi e assicurati di portarli via con te senza farti vedere.

Esci poi dalla stanza e segui la linea nera. Incontrerai un mio complice che ti dirà cosa fare nel punto contrassegnato dal pallino verde 🟢.

Per uscire segui la linea verde. Una volta fuori butta via i pezzi della foto.

Grazie per il tuo aiuto.

<u>Instructions for INN group</u>



Scendi le scale e prendi il corridoio a sinistra dell'ingresso, poi segui le indicazioni per gli ascensori e vai al piano - 1.
A destra dell'ascensore troverai una porta rossa 🔴 che puoi aprire con la carta nella busta, poi segui la linea rossa sulla mappa.
Nel corridoio troverai un foglio appeso al muro. Scrivici sopra le tue iniziali.
Segui la linea nera. Incontrerai una persona nel punto contrassegnato dal pallino verde 🟢. Riconsegna a lei la carta, poi esci seguendo la linea verde.

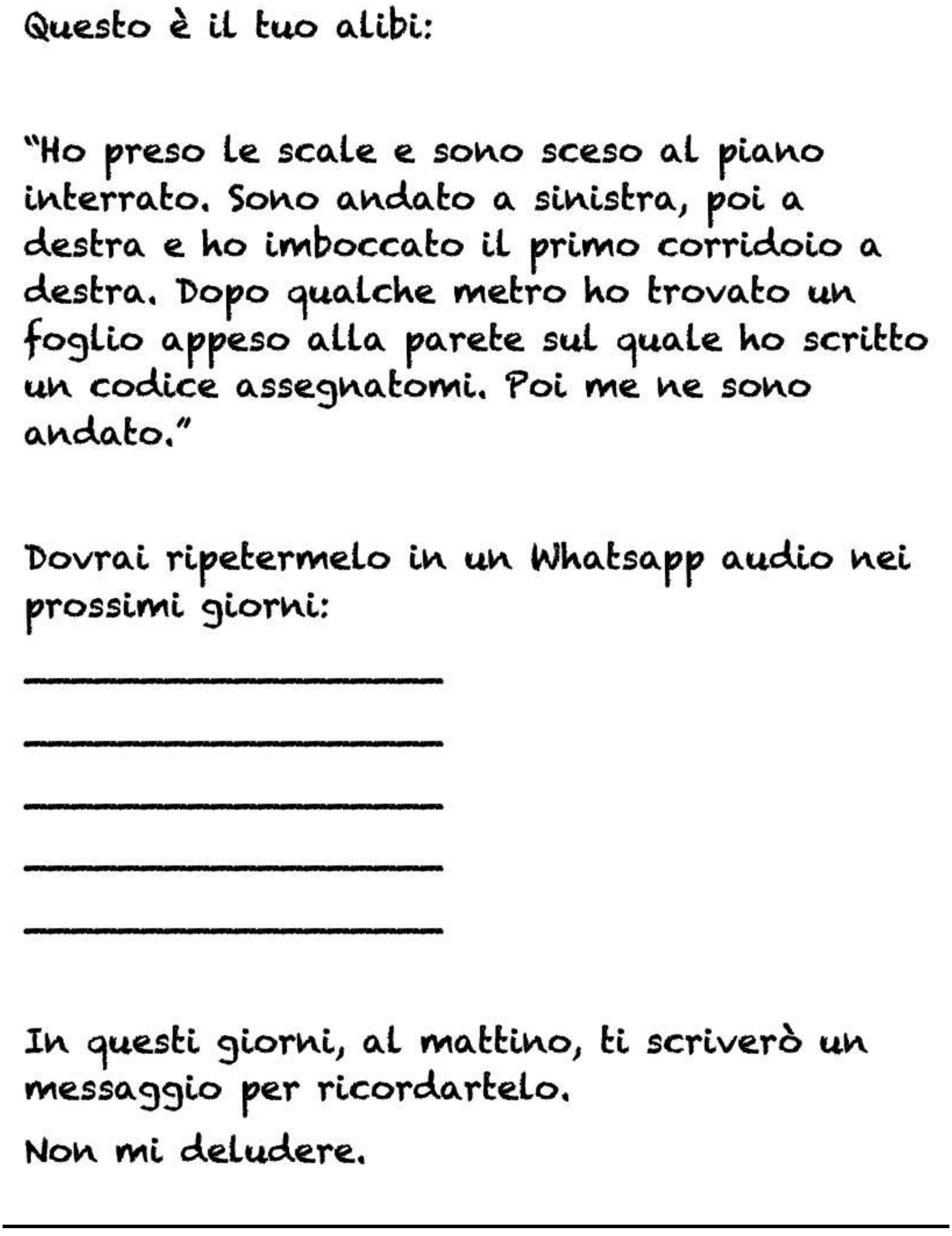
APPENDIX 3

Map for GUI groups

Map for INN group

APPENDIX 4

Alibi for GUI_A1_H, GUI_A2_H, GUI_A1_S, GUI_A2_S groups



Questo è il tuo alibi:

"Ho preso le scale e sono sceso al piano interrato. Sono andato a sinistra, poi a destra e ho imboccato il primo corridoio a destra. Dopo qualche metro ho trovato un foglio appeso alla parete sul quale ho scritto un codice assegnatomi. Poi me ne sono andato."

Dovrai ripetermelo in un Whatsapp audio nei prossimi giorni:

____

____

____

____

____

In questi giorni, al mattino, ti scriverò un messaggio per ricordartelo.

Non mi deludere.

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