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Keywords

neuroscience, neuroimaging, fMRI, PET

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Introduction

In the movie *12 Angry Men,* the jury proceeded into the deliberation room to decide a teenager's fate after he was accused of murdering his father. Following an initial vote, only one juror stood between a death sentence and freedom for the teenager. While the eleven other jurors relied on questionable eyewitness testimony to convict the teenager, juror eight did not. Each of the other jurors attempted to convince juror eight of the boy's guilt using two eyewitness testimonies. A middle-aged woman who lived across the train tracks from the murder location gave the first testimony, and an older man who lived in the apartment below the scene of the crime gave the second. Juror eight spent hours highlighting weak points in the witnesses' testimonies until all of the jurors were convinced that the boy should not be found guilty. He explained that the woman across the train tracks could not have seen the murder as she claimed because she was not wearing her glasses at the time. Furthermore, the older man could not have heard the murder occur due to the noise created by the train, or seen the assailant running down the hall due to his limp. Without juror eight, the jury would have sentenced the teenager to death solely based on faulty eyewitness testimony (Fonda, Rose & Lumet, 1957). Though fictional, this movie highlighted potential issues that can accompany the use of eyewitness testimony in court.

Just as the jurors analyzed the two eyewitnesses' testimonies in the movie, neuroscientists analyze the memories on which these testimonies are based. The primary way that neuroscience affects the justice system can be seen in the new techniques for imaging the brain, referred to as neuroimaging. Even though neuroimaging is a young science, it has made great advances in understanding the human brain. Not only has neuroimaging changed the way scientists look at the brain in relation to eyewitness testimony, this technology has also challenged the court's view of human actions as they relate to the brain. Neurobiologists have begun to analyze parts of the brain responsible for the construction and recollection of memories. Memories are important to the judicial process because they are the basis for eyewitness testimony. Therefore, neuroscientific findings regarding the brain and memories also impact the justice system. Neuroimaging can distinguish between true and false memories by examining what portions of the brain are active when subjects perform various tasks. This is an important breakthrough for determining the validity of eyewitness testimony in court. These advances can aid both prosecutors and defense attorneys during trial when utilizing eyewitness testimony.

Context

Evidence used in court can be grouped into two categories: direct and circumstantial. In the past, direct evidence has been given the greatest weight in the courtroom, but, as society has learned more about the nature of human memory, the legal system has begun to rely more heavily on circumstantial evidence. Human memories are not like recordings; instead, memories are constructed by the brain, which fills in any gaps with assumptions or guesses. Memory is subject to outside influence. If an eyewitness to a crime overhears another witness's account of the incident, their memories may change to more closely resemble what they have heard (Fraser, 2012). Eyewitnesses are subject to cross-examination in order to assess the witnesses' character as it relates to the validity of their testimony. The aim of the cross-examination of a witness is to test that individual's memory of the event in light of other facts and to determine if the witness is lying about his or her empirical observations. While cross-examination helps to accord eyewitness testimony the appropriate sway, many issues remain regarding the current cross-examination methods, including its inability to determine if a witness's memory is true.

Recent neuroscientific research is able to reduce, if not completely eradicate, some of the issues that accompany the use of eyewitness testimony in the courtroom. Neuroscience studies how the brain functions and how the central nervous system operates in relation to the brain. The brain is divided into four sections, all of which are responsible for different tasks: the brainstem is responsible for basic functions that are necessary to survive; the cerebrum is responsible for thought and action; the cerebellum is responsible for balance and coordination of muscle movements; and the limbic system is responsible for regulating emotions, memories, and other sensations. While all four of these areas are important to scientific research, neuroimaging tends to focus on the cerebrum and the limbic system (Baskin, Edersheim & Price, 2007).

Scientists have devised various methods in order to study how the human brain works. Along with other techniques, Functional Magnetic Resonance Imaging (fMRI) and Positron Emission Tomography (PET) are common ways neurobiologists study the human brain today. FMRI is the most commonly used neuroimaging technique. In this procedure, scientists use a magnet to monitor the brain's activity. The brain requires highly oxygenated blood to perform tasks. This blood reacts to the magnet in a different way than deoxygenated blood does. Therefore, scientists are able to view which areas oxygen rich blood is going to at any given time, and can then correlate the observed brain activity to the task that is being performed

(Gazzainga, 2011; Baskin, Edersheim & Price, 2007). PET is another technique used to study the brain. Scientists inject subjects with a radioactive substance and then monitor their brain activity. As blood goes to active brain regions, the radioactivity in those regions increases. Neuroscientists then determine what region of the brain the increased blood flow navigates to depending on the task. By studying the radioactivity in certain regions of the brain when a subject is lying, the scientist is then able to determine if that subject is being truthful when questioned in the future.

While the methods are different, both fMRI and PET testing aid in validating memories and statements given by subjects. Eyewitness testimony forces the court to rely on the competence of cross-examiners and witnesses, an issue that could be greatly reduced with the use of neuroimaging technologies. Neuroimaging would allow the court to further look into the witness's brain and the validity of that individual's memory. Neuroimaging results can be used as evidence to validate statements made by eyewitnesses in court, thus providing a better understanding of not only the witnesses, but also their memories and testimonies.

When False Memories Hurt

Many individuals have been convicted solely based on eyewitness testimony. With recent advances in science, such as the use of DNA evidence, many individuals convicted based on eyewitness testimony are being set free. In November 2003, Larry Henderson was accused of being an accomplice to the murder of Rodney Harper. While his alleged partner shot Harper, Henderson held James Womble at gunpoint. About two weeks later, Womble identified Henderson in a photo array presented by the police. With the aid of Womble's testimony, Henderson was convicted of both aggravated assault and reckless manslaughter. On the surface, this may seem to be a simple case where justice was served, but further details suggest otherwise. In the beginning, Womble was unable to identify Henderson, until police officers continued to pressure him into positively identifying a suspect. Furthermore, Womble was under the influence of cocaine and alcohol at the time of the murder. These factors were not taken into account or even mentioned when Womble's testimony was presented at trial (Schacter & Loftus, 2013).

In response to numerous cases like Henderson's, the Innocence Project was launched. This non-profit organization is dedicated to exonerating individuals who have been wrongfully convicted. In June 1981, a man entered a home where three girls were sleeping. After carrying one nine-year-old girl to a bed next to her seven-year-old sister, the stranger approached the ten-year-old who was sleeping alone on the couch. After waking up to the naked stranger standing above her, she ran and was caught by the attacker in the front yard of the home. The attacker then beat her until she was unconscious and sexually assaulted her. The next morning, the police interviewed the girls and found that none of them saw the stranger's face, but did notice his shoes and hat. After overhearing neighbors discuss Calvin Willis as a possible suspect, the girls relayed this to the police, who then went in search of the suspect. Willis was subsequently arrested and the girls said that his boots looked similar to the attacker's. Despite the fact that the lack of lighting in the room during the time of the attack would have made identification very difficult, their testimony was used in court. Though Willis's alibi was solid, he was convicted of rape and was sentenced to life in prison. About twenty years later, DNA testing compared Willis's DNA to the DNA found on the victim's clothing and the attacker's boxers that were left at the scene. The evidence excluded Willis as the attacker (The Innocence Project, n.d.).

In both cases, the witnesses' memories were heavily relied upon and resulted in faulty convictions. If neuroimaging had been performed on the witnesses, their memories could have proved faulty. In Henderson's case, this would have been because Womble was under the influence of both drugs and alcohol at the time of the murder, thus increasing the likelihood that his memory was filled with assumptions constructed by his brain (Schacter & Loftus, 2013). In Willis's case, the children's memory could have proved faulty because they had not actually seen the attacker's face and had not seen his boots in clear lighting. This spurred their memories to change to more closely resemble what they had heard from their neighbors, thus driving them to conclude that Willis's boots looked similar to the attacker's (The Innocence Project, n.d.). The court should therefore have had to, at the very least, advise the jury about the nature of memories and how the direct evidence presented in court may not be entirely accurate.

The Truth and Nothing But the Truth?

Neuroimaging can lend a hand in distinguishing between the truth and a lie, as well as between true and false memories. While both neuroimages and cross-examination can help determine if a witness is lying, neuroimaging can also determine if what an individual perceives as the truth is actually a false memory constructed by his or her brain. Greene and Paxton (2009) studied the parts of the brain that are activated when an individual is telling the truth and telling a lie. In their experiment, they imaged the brains of individuals who were determining whether or not they were going to lie about their ability to accurately predict a simple coin toss. Their results uncovered that the individuals who chose to answer honestly did not have any extra activity in brain regions that are responsible for impulse control. They also found that when individuals were dishonest, the same regions of their brains showed additional activity. Schacter and Loftus (2013) found similar results when studying neuroimaging research regarding the validity of memories. The authors found that while the same brain region is active when recalling both true and false memories, the regions that are responsible for retrieving information are more active when recalling a true memory than a false memory. Furthermore, in many studies, the authors note that the right hemisphere of the prefrontal cortex tends to be activated when the individual is recalling a false memory (Slotnick & Schacter, 2004; Gutchess & Schacter, 2012; Garoff-Eaton, Kensinger, & Schacter, 2007).

Too Much Or Just Enough Influence?

Many scientists assert that introducing scientific evidence, such as neuroimaging, into the courtroom will result in prejudicial jury decisions. Monterosso, Royzman, and Schwartz (2005) explored this in their study of 196 undergraduates. These individuals initially read vignettes and then filled out a questionnaire rating the guilt of the individual depicted in the vignette. Twenty-eight of the participants completed a follow up interview, where they explained their original responses in detail. The authors found that when physiological evidence (fMRI evidence) was the reason behind deviant behavior, the individual was perceived to be less culpable. In this study, the participants viewed the fMRI evidence as proof that the deviant behavior was due to a biological factor beyond the individual's control, therefore making that person less blameworthy for the undesirable behavior.

McCabe, Castel, and Rhodes (2011) also explored this topic when they compared the effect of fMRI evidence on juror's perception of the defendant's culpability, as opposed to thermal imaging and polygraph tests. They found that when fMRI evidence was presented in court to show that the defendant was lying, participants were more likely to return a guilty verdict. While this may appear to be damning evidence, the authors also found that when the evidence was cross-examined for validity in the trial, participants were significantly less likely to return a guilty verdict. Like any evidence brought into court, neuroimaging would be subject to cross-examination, at which time the possible issues associated with the brain images would be explained in order to mitigate any unnecessary influence that the evidence may have on jurors.

Questionable Methods?

Moriarty (2009) contends that the methods used in neuroimaging, specifically in the most popular technique, fMRI, are questionable. She states that the results and methods across studies are inconsistent. Due to these factors, many scientists believe that it is difficult to integrate neuroimaging results into a trial. Furthermore, Moriarty contends that the studies are not large enough to properly represent the population and that the questions asked in these studies are far too simple as compared to the practical implications of the methods. Morse (2011) concurs by stating that most of the neuroimaging studies have been performed on small sample sizes of college students. He states that this is not a proper representation of the criminal population in today's world. Due to the nature of the samples used in a large amount of neurological research, he contends that the findings would not apply to the real world.

What Morse (2011) and Moriarty (2009) fail to realize is that the age range most likely to experience and commit criminal acts is precisely the age range of the college students that are generally selected for fMRI and PET studies. Individuals, ages sixteen to nineteen, are the highest age group to experience victimization of crimes, according to a report by Perkins (1997). Individuals in that same age range, as reported by the Uniform Crime Reporting Program, are those most often arrested across both genders (Federal Bureau of Investigation, 2003). Therefore, it is appropriate that researchers are testing on college freshmen and sophomores, as they are the individuals who are most likely to experience and perpetrate criminal acts.

They also fail to note that not every brain is identical and not every person reacts the same way, therefore the methods used by neurobiologists must be altered in an attempt to account for differences between individuals. A one-method-fits-all approach cannot be successfully applied to something that is unique and dynamic, like the human brain. In order to account for these special circumstances, the scientific community may need to reevaluate what is considered the proper science for studying the human brain.

Conclusion

Many scientists have begun to question the courtroom's rules for admitting evidence into trial as it relates to neuroscientific evidence. While many elements of criminal trials may need more time before they can be addressed using neuroscience, eyewitness testimony is not one of them.

Neuroimaging can determine not only if individuals are lying or telling the truth about their memories, but also whether those memories are correctly recalled or constructed by their minds. Furthermore, PET and fMRI techniques have been widely researched and can aid both prosecutors and defense attorneys when eyewitness testimony is used. Though the methods used in these techniques vary from subject to subject, it is important for the scientific community to re-evaluate how current rules of evidence apply to neuroscientific research, as not all scientific findings will always fall within the specified rules.

FMRI and PET results form a pattern that should be recognized by the scientific community. When an individual lies, the brain must construct the lie—it does not simply present itself for that individual to read from, as it would a script. When the brain must perform a task, such as creating a false story, blood flows to the areas correlated with that task. Therefore, it is logical that when an individual lies, heightened activation of certain regions of the brain occurs. Depending on the methods used, the portion of the brain with heightened activity may change, but the heightened activity itself does not. If the scientific community will not endorse the methods used by neurobiologists to identify lies and false memories, they should at least recognize the pattern connecting the research at its base level.

This research may be used by both neuroscientists who are evaluating how to present their data for use in the courtroom and individuals wishing to either validate or invalidate eyewitness testimony brought into court. Although the benefits of using neuroimaging are evident, as with all new types of evidence, precautions must be taken to ensure that its prejudicial value is as low as possible. Cross-examination of the evidence is highly encouraged and jury instructions regarding how the presented evidence should be utilized are necessary whenever neuroimaging is presented in court.

Neuroimaging can be a great asset in the courtroom and should not be excluded. These data can be used to both further understand the brain and to reveal whether or not there is more happening in that person's brain than is actually being said. Therefore, not only can neuroimaging speak to the facts of a testimony, but also to the character of the witness. With this information, false or incomplete memories will result in fewer individuals being wrongly convicted.

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