Uluslararası Avrasya Sosyal Bilimler Dergisi / *The International Journal of Eurasia Social Sciences*
Cilt/Volume: 16, Sayı/No: 59, Yıl/Year: 2025, ss. / pp.: 511-565
E-ISSN: 2146-1961
URL: https://rrpubs.com/index.php/ijoess

The examination of neuroscientific evidence in the criminal trial process: The importance of collaboration between criminal law and neuroscience

Celal Hakan KAN[1]

[1]İzmir Regional Court of Justice, Criminal Division, İzmir, Turkiye

Araştırma Makalesi/*Research Article*		**DOI:** 10.70736/ijoess.592
Gönderi Tarihi/ *Received:*	Kabul Tarih/ *Accepted:*	Online Yayın Tarihi/ *Published*:
23.10.2024	16.02.2025	15.03.2025

Abstract

This study addresses the significance of utilizing neuroscientific evidence within the criminal trial process and explores the potential collaboration between criminal law and neuroscience. Advances in the field of neuroscience have enhanced our understanding of human behavior and decision-making processes, allowing for a reevaluation of core concepts in criminal law, such as volition, fault, and liability. Initially, the research provides an overview of the historical development of neuroscience and fundamental insights into the functioning of the human brain. Subsequently, it focuses on the potential of neuroimaging techniques to shed light on the brain mechanisms behind criminal behaviors. These methodologies offer new perspectives on predicting criminal actions, rehabilitating offenders, and personalizing penalties. The evaluation of neuroscientific evidence during the criminal trial process emerges as an area capable of inducing significant changes in legal practice. Employing this evidence to base judicial decisions on scientific data contributes to the more effective protection of the right to a fair trial. The paper advocates for a multidisciplinary approach to enhance the interaction between criminal law and neuroscience, aiming to ensure that decisions within the judicial process are both fair and scientifically grounded.

Keywords: Criminal procedure law, fair trial, neuroimaging, neuroscience, neuroscientific evidence

Ceza yargılaması sürecinde nörobilimsel delillerin incelenmesi: Ceza hukukunda nörobilim ile işbirliğinin önemi

Öz

Bu çalışma, ceza yargılaması sürecinde nörobilimsel delillerin kullanımının önemini ve ceza hukuku ile nörobilimin nasıl bir işbirliği içerisinde olabileceğini ele almaktadır. Günümüzde, nörobilim alanındaki ilerlemeler, insan davranışının ve karar verme süreçlerinin daha iyi anlaşılmasını sağlamakta; bu da ceza hukukunun temel kavramlarından olan irade, kusur ve sorumluluk gibi unsurların yeniden değerlendirilmesine olanak tanımaktadır. Çalışma, öncelikle nörobilimin tarihsel gelişimine ve insan beyninin nasıl çalıştığına dair temel bilgileri sunmaktadır. Daha sonra nöro görüntüleme tekniklerinin, suç davranışlarının arkasındaki beyin mekanizmalarını aydınlatma potansiyeline odaklanılmaktadır. Bu teknikler; suçun önceden tahmin edilmesi, suçluların rehabilite edilmesi ve cezaların kişiselleştirilmesi gibi konularda yeni perspektifler sunmaktadır. Ceza yargılaması sürecinde nörobilimsel delillerin değerlendirilmesi, hukuk pratiğinde önemli değişikliklere yol açabilecek bir alan olarak belirginleşmektedir. Bu delillerin kullanımı, yargı kararlarının bilimsel verilere dayandırılmasını sağlayarak, adil yargılanma hakkının daha etkin bir şekilde korunmasına katkıda bulunabilir. Çalışma; multidisipliner bir yaklaşımla, ceza hukuku ve nörobilim arasındaki etkileşimin, yargı sürecindeki kararların daha adaletli ve bilimsel temellere dayalı olmasını sağlayacak şekilde nasıl geliştirilebileceğini tartışmaktadır.

Anahtar Kelimeler: *Adil yargılanma, ceza muhakemesi hukuku, nörobilim, nörobilimsel deliller, nöro görüntüleme*

Sorumlu Yazar/ Corresponded Author: Celal Hakan KAN, **E-posta/ e-mail:** hakankan0231@gmail.com

INTRODUCTION

In comparison to the universe's formation, the time humans have spent on Earth is minimal. The reason for their significant development during their existence is primarily their ability to stand on two legs and use their thumbs, and secondly, their capability to transform the world into a habitable space for themselves. These capabilities are crucial for human survival, as humans lack innate protections against extreme temperatures or pressures. Consequently, humans must utilize the world's resources in their favor, leading to the invention of various tools (Balkuv, 2020:17). The creation and use of these tools have made an undeniable contribution to human brain development. However, brain development is not only dependent on tool use and creation but also on communication and the ability to live in communities. Living in a society necessitates a certain order, which in turn requires the implementation of rules by its members (Lawrence, 2012, p. 104). For a society to function, actions that are considered good and right must be performed, without infringing on others' freedoms and respecting everyone's rights. Fulfilling these requirements depends on the human ability to behave accordingly, which is enabled by higher cognitive functions such as perception, attention, thinking, planning, decision-making, and choosing between options, associated with the brain's cortex layer.

When examining criminal law and criminal procedure law alongside neuroscience, it is essential first to understand some basic neuroscience concepts. Therefore, the first section chronologically explores neuroscience and its historical development, starting from the prehistoric period and including significant developments up to the 21st century, with a focus on the 19th, 20th, and 21st centuries where brain-related advancements were particularly concentrated. The structure and transmission mechanism of neurons are described according to contemporary data (Eren, 2014). The brain's anatomical structure, higher cognitive functions, mirror neurons, and brain plasticity are discussed, including how criminal behaviors could arise. This context will deepen the understanding of the topic. A brief overview of the brain's anatomical structures is provided, emphasizing how they influence thoughts, feelings, and behaviors. The mechanisms behind decision-making and the realities underlying behaviors are also discussed, highlighting the importance of the frontal lobe and prefrontal cortex in our personality, decisions, and actions.

The study links developments in neuroscience with criminal law and criminal procedure law through a multidisciplinary approach. It addresses how human behaviors, emotions, and thoughts are formed, the brain's structure and function, and examines if a criminal's brain

operates differently, whether behaviors can be explained neuroscientifically, if free will exists, and if behaviors can be controlled by will. These questions necessitate a neuroscientific perspective on criminal law, as understanding behavior mechanisms can illuminate legal issues requiring resolution. Repeated behaviors pave the way for their establishment in the brain, a rule that applies to criminal actions. The recurrence of a crime solidifies the behavior in the brain. Understanding the mechanism behind learning and the permanent establishment of information in the brain can lead to rehabilitation, replacing criminal behaviors with new information, and possibly eradicating the desire to commit such actions. The brain's plastic nature underscores the reversibility of any condition. In this vein, the second part of our study jointly addresses neuroscience and criminal law. The concept of will, crucial in criminal law, is examined from both neuroscience and legal perspectives (Zergeroğlu, Simge, & Nalçacı, 2015). The concepts of fault and culpability are briefly mentioned, followed by an examination of factors that reduce or eliminate culpability, such as youth, mental illness, and the influence of alcohol or drugs.

Human physical security and survival have been enhanced by advancements in various scientific fields. With technological development, many previously hidden areas have been discovered. In neuroscience, this is reflected in the development of neuroimaging techniques (Dauvergne, 2004; Eder-Rieder, 2015). Until now, the structure and functions of the human brain were explored through autopsies and animal experiments. The advancement of devices such as computed tomography, functional magnetic resonance imaging, electroencephalography, and positron emission tomography has enabled detailed anatomical and functional examination of the brain. Functional magnetic resonance imaging is particularly significant for showing the brain region active during a behavior, making it possible to study criminal behaviors. Criminal behaviors disrupt societal peace and instill fear of victimization in others. According to criminal law, committing an act defined by law as illegal constitutes a crime. Failure to comply with commands and prohibitions results in legal sanctions. Although imprisonment may seem deterrent, it can also facilitate learning various methods of committing crimes, potentially leading to repeated offenses. However, the necessity of subjecting offenders to sanctions to compensate for societal harm remains. Therefore, preventing crime should be the primary goal, with rehabilitation provided for first-time offenders. If rehabilitation fails, imprisonment may be necessary for reform (İçer, 2021). The development of neuroimaging techniques allows for understanding which brain regions are associated with crime and how they can be intervened. Rehabilitation can be achieved through targeted treatment and

rehabilitation centers designed for specific brain region impairments. The goal of integrating neuroscience into criminal law is to tailor punishments to individuals, believing in the benefits of such an approach. The strengthening of the concept of criminal justice depends on making correct decisions based on accurate and real data. In this context, the third part of our study addresses neuroscience and criminal procedure law together, examining the concept of evidence and types of evidence in criminal procedure law. Primarily, the neuroscientific examination of eyewitness testimonies is discussed, followed by the potential use of neuroimaging techniques as neuroscientific evidence. Finally, the use of neuroscientific evidence in courts of other countries is addressed.

The significance of our study lies in considering the biological structure, physiology, chemistry, and functions of the human brain in conjunction with its social aspects. The main goal of our study is to explore criminal law and criminal procedure law from a neuroscience perspective, opening new horizons in our understanding of law. When examining criminal law and criminal procedure law alongside neuroscience, it is crucial for researchers to establish a methodologically valid connection. For such a connection to be established, two different disciplines must be able to comment on the same events or phenomena from their respective and external viewpoints, expanding their research. The aim of jointly examining neuroscience with criminal law and criminal procedure law is to create a common ground in health law and expand this field. While it is evident that different disciplines can come together and use neuroscientific data in court, increasing the functionality of evidence is among the goals. Approaching a social science field like law from a different perspective can also lead to new opportunities and research possibilities.

General Overview

Concept

The brain distinguishes humans from other living beings and makes them unique; it is a soft structure weighing approximately 1300-1500 grams (Uzbay, 2021, p. 91). It is responsible for the execution and control of behaviors ranging from simple to complex. Other living beings also display simple behaviors and meet their needs. However, what distinguishes humans is the highly developed cortex layer in their brains (Dowling, 2018, p. 19). Neuroscience is the branch of science that studies the structure of the brain, nerves, and how the nervous system works. We use specific units of our brain when smelling a flower, looking at a photograph, or hearing a person. Additionally, our brain is in operation when managing social human relations, deciding what is right or wrong, or maturing morally. Examples here are limited and can be

expanded. These are behaviors that seem fundamentally simple but are complex in the background, and their execution is possible thanks to the brain. Neuroscience seeks to illuminate the complex structure and functioning of the brain and has made significant progress in our century. As a result of this progress, many positive sciences have begun to be considered together with neuroscience. Fields such as neurophilosophy, neuropsychology, neurolaw, and neurocriminology have emerged with the prefix "neuro-" (Rose & Rose, 2018, p. 11; Lee, 2020).

The investigation of both the physiological and emotional sections of the brain is important for understanding the principle of operation. Although the study of emotions began long before the emergence of neuroscience and these studies continued, by the last century, focus has shifted to how the anatomical structure of the brain works and is realized (Damásio, 2006, p. 7). The study of an organ, complex and still not fully understood in terms of how it functions, as a whole has become possible with the development of technology. This implies that since we use our brains to understand our brains, even if it were a simple structure, we would need to have a complex structure to comprehend it (Karasu, Aygen, Sabancı, Sağlam, Civelek, Eskandar, 2008; Uzbay, 2021, p. 152). Because a structure that solves complex mathematical problems, produces a work of art, progresses morally, and engages in legal activities fundamentally cannot be easily understood. To understand human behaviors, we need to understand the human brain and have ideas about its structure and functions. For this, the movements of simpler living beings and the examination of their brain-like structures have come into question. This examination has laid the foundation for understanding the working mechanism of the human brain. Insights about the working mechanism of the human brain have been obtained by looking at the simple movements and reflexes of basic sea creatures (Jones et al., 2014; Dowling, 2018, p. 125).

Developments in neuroscience in the 20th and 21st centuries

After the discovery that neurons can be stimulated by electrical currents, two German physiologists, Eduard Hitzig (1838-1907) and Gustav Theodor Fritsch (1838-1927), electrically stimulated neurons (Gross, 2007, p. 321). The main reason they could stimulate neurons in the brain was the absence of pain receptors. Thus, there was no need for anesthesia since no pain was felt. When they applied electrical currents to the back of the skull where electrodes were placed, they observed movement in the eyes. Their conclusion was that the brain could be stimulated electrically. They then conducted an experiment to further this research, directly accessing the brain from under the skull of a dog. In this experiment, they removed parts of the

brain and stimulated specific areas of the cortex with electrodes, affecting certain muscles in the body (Gross, 2007, p. 321-323). Another finding was that the right side of the brain affects the left side of the body. They struggled to map the motor cortex in the brain, but a second experiment was conducted because not only the areas they identified as the motor cortex but also other regions of the brain could initiate movement. In this second experiment, they performed ablation. When they removed parts of the brain other than the motor cortex, the movements created by the motor cortex in the muscles were neither hindered nor changed. However, the removed areas did affect the organs. It was seen that as one ascends to higher structures in the brain, these structures could perform more complex movements (Balkuv, 2020:28).

The difficulty of electrical stimulation arises from the variety of movements produced depending on when and which area is stimulated. Looking at the skull, the brain has a forward-leaning structure. Due to this difference, electrical stimulation results vary when starting from the front of the brain to the back and when mapping is attempted starting from the back to the front; the outcomes do not match. Therefore, the unit and starting points determined in the mapping have diverged (Smith Churchland, 2020, p. 191).

The reflex responses are specific to the stimulus, and the occurrence of an opposite reflex is prevented. The mechanism called “reciprocal control” allows for only one of these opposite reflexes to occur. This mechanism also explains motor behaviors. The explanation of reflex movements is important for understanding higher brain functions. “The motor neuron gathers all the excitatory and inhibitory signals that reach it from other neurons...” (Kandel, 2019, p. 103) the reflex response given is related to the calculation of these signal sums and which is more predominant. “Every perception we have, every movement we make, is essentially the result of numerous similar nervous system calculations (Burnett, 2017, p. 17).” When people move, they use their consciousness up to a certain point; most of the movement occurs unconsciously, with certain areas taking over this function. The nerves in the spine stimulate the necessary structures for walking without consciousness and receive feedback from these structures (Burnett, 2017, p. 17-18). “The ability to move easily and without thought... has allowed our species to survive easily.” When learning a new behavior, consciousness is initially involved. As the movement is repeated, it becomes ingrained, and the use of consciousness is no longer necessary. The learned motor skill is transmitted to other areas of the brain and stored there. Later, when the movement is performed, there is no need to think about it (Eagleman, 2021, p. 229). Regarding how learning and information storage occurs, research on “Aplysia”

examined the "gill withdrawal reflex". Stimuli were given to the organism at various frequencies and durations, leading to habituation or sensitization, thus showing that even simple reflex movements could be altered and that information acquired as a result of stimuli forms memory. Investment was made in brain research in the early 20th century (Rose, Hilary and Rose, 2018, p. 20). Efforts were made to understand the brain's functions such as mind, memory, attention, etc. Therefore, a multidisciplinary approach was developed. Many positive sciences were related to neuroscience and the brain's working mechanism was sought to be understood. Despite a reductionist approach being displayed, understanding the operation of the brain requires the consideration of many sciences together as it was attempted with other brains. The discovery of genes and DNA has been enlightening (Rose, Hilary and Rose, 2018, p. 23). These new concepts were wanted to be used to understand the brain. Especially, they have made significant contributions to understanding the physiology and biochemical reactions of the brain. Due to the advanced research and investments, by the year 1990, both in the USA and Europe, the years were declared as "The Decade of the Brain" (Rose, Hilary and Rose, 2018, p. 15). By the 21st century, the concept of mind is perceived as merely the processing of data by the brain. The mind has been explained as resulting from the electrical activities of neural networks and synaptic structures. Later, like many newly established fields, this field too was attempted to be used for warfare. With the understanding of evolution, attempts were made to decipher the structure of the human mind, and artificial intelligence was sought to be created by utilizing computer technologies (Rose, Hilary and Rose, 2018, p. 27). Politicians interested in neuroscience up until the 21st century, which emphasized brain development, have worked to raise individuals from childhood as social beings to improve the country's economy and enhance their intelligence. According to them, the welfare level of a family can be measured not only by their income but also by the absence of harmful habits such as smoking, alcohol, and drug use, their education level, and their social relationships (Rose, Hilary & Rose, 2018, p. 24).

Individuals raised in such families, with careful behavior and responsibilities of their parents, will elevate the country's economy according to politicians and, unlike individuals raised in the opposite environment and manner, will continue their lives unaffected by potential negatives in later years and without committing any crimes, thus contributing to the country's development (Rose, Hilary and Rose, 2018, p. 20). Although the money spent on projects developed on this basis may now seem like a loss and unnecessary, the investment in neuroscience will lead to less crime requiring prisons, a reduction in drug use and depression,

and the development and economic growth of the country. The effects of the disruption of the brain's biochemistry and physiology on human biology are significant. A damaged body implies a damaged mind. Sciences that attempt to correct the mind at the molecular level have also started working in more specific areas with the "neuro-" prefix (Kandel, 2019, p. 251-252). Every major molecule affecting the brain has been studied under the name of neuroscience, and various drugs have been attempted to be developed. The idea that our being is related to a few small molecules is related to the individual's own identity in neuroscience. The advancement of technology and brain imaging techniques have been pioneers in understanding the mechanisms of the brain's operation (Rose, Hilary & Rose, 2018, p. 31).

The brain and its cognitive functions: Examples

Cognitive functions are facilitated by four regions of the cortex. For instance, the processing of visual information is carried out by the occipital lobe. The temporal lobe is pivotal for auditory data processing and also plays a critical role in distinguishing objects and individuals, integrating these perceptions with emotions. It is essential to differentiate between the right and left parietal lobes. These lobes synthesize information from the body's musculoskeletal and sensory systems with external inputs, providing a cohesive perception of sight, sound, and balance (Üngüren, 2015, p. 203-204). The right parietal lobe, responsible for spatial perception, goes beyond mere object recognition, encompassing the mental representation of space, as well as the position, condition, and movements of the body within it (Ramachandran, 2011:48-50). Conversely, damage to the left parietal lobe impairs the ability to perform tasks requiring fine motor skills or intricate balance adjustments. Furthermore, such damage can lead to the loss of crucial abstract abilities necessary for understanding positive sciences, such as reading, writing, and arithmetic (Ramachandran, 2011:49). The frontal lobe's functions include planning, decision-making, execution of decisions, and motor function execution. It is also notable for its role in short-term memory functionality. Damage to the prefrontal cortex can lead to significant changes in personality, observable to those familiar with the individual, despite the outward appearance of normalcy (Üngüren, 2015, p. 198-199). The prefrontal cortex is instrumental in enabling socially harmonious and balanced living, with ethical behavior and respect for others' rights and freedoms being linked to its proper functioning. The inability to exhibit moral behaviors and impulsivity are characteristic of individuals classified as sociopaths, with neurologist Antonio Damasio suggesting such individuals may possess undetectable frontal function disorders.

Evolutionarily, our brains have developed folds to maximize space within the confines of the skull (Eagleman, 2021, p. 9). A rat's brain, being less convoluted, indicates limited higher brain function capabilities. Humans possess the capability for thought and problem-solving, necessitating advanced cerebral functions for innovation. This necessitates growth and development, heavily influenced by parental care and the environment. "The human brain cannot develop normally in environments devoid of emotional engagement and cognitive stimulation (Eagleman, 2021, p. 8)." Children model their behavior on their observations of their parents, with brain development and the formation of behavioral patterns progressing accordingly. Society-endorsed behaviors are learned through interactions within the familial and broader social context (Eagleman, 2021, p. 16). Given the incompleteness of brain development at birth, human infants learn by mimicking their caregivers. This modeling process establishes the foundation for subsequent behavioral development in the brain, with the patterning of undesirable behaviors indicating how future similar behaviors might be enacted. "Mirror neurons" play a crucial role in this process. Giacomo Rizzolatti's experiments with primates demonstrated that the same brain regions activated during the execution of a task are also activated upon observing another performing the task, suggesting the observational learning of behaviors (Günşen İçli, 2021:25). The discovery of mirror neurons aids in understanding others' intentions and assessing potential dangers, with these neurons having evolved as a defensive mechanism to anticipate others' actions (Ramachandran, 2011:167).

Observing someone in pain activates related muscles due to mirror neurons, leading to empathetic physical responses. While the brain regions associated with pain activate generally, observing someone in pain triggers muscle contractions similar to those experienced directly during pain (Sınıgaglia & Rizzolatti, 2019, p. 80). Experiments have shown that observing someone experiencing pain can induce muscle tension in observers, even without their conscious awareness, illustrating the brain's unconscious response mechanisms (Sınıgaglia & Rizzolatti, 2019, p. 124). The initiation of avoidance responses to painful stimuli occurs unconsciously, influencing physical reactions (Thagard, 2010, p. 117). Mirror neurons and empathic capabilities indirectly influence conscious actions through unconscious systems, enhancing the individual's adaptive behaviors. The brain's learning mechanism, crucial for behavioral adaptation, suggests that consciously contemplated behaviors stimulate unconscious processes, facilitating the execution of those behaviors at their most advanced (Sınıgaglia & Rizzolatti, 2019, p. 175).

The propensity for individuals raised in high-crime areas to commit crimes themselves can be attributed to mirror neurons. Sociological theories in criminology posit that a person's likelihood of committing a crime is significantly influenced by their social environment. Even individuals born with normal biological and psychological traits can become criminals under the influence of their surroundings (Corradini & Antonietti, 2013, p. 1154). People tend to replicate behaviors they observe; exposure to positive behaviors and the opportunity to practice them facilitates moral alignment, whereas continuous exposure to negative behaviors increases the likelihood of adopting them. "Individuals who are not inherently inclined to criminal activity may commit crimes due to external circumstances and the influence of their environment (Sınıgaglia & Rizzolatti, 2019, p. 31)." Therefore, for first-time offenders without severe criminal records, alternatives to imprisonment, such as community service and rehabilitation, could be considered to prevent recidivism. The repetition of criminal behavior solidifies it in the brain, making understanding the brain's mechanisms essential for addressing legal questions concerning criminal behavior. The learning mechanism of the brain elucidates various phenomena. Essentially, if the brain consistently associates a specific response with a given command, reinforcing the synapses involved, the command and response become inseparable, teaching the brain a strong connection between them (Dönmezer, 1994, p. 71). This mechanism explains, for example, why criminals repeatedly offend, potentially altering their brain structure. Here, the concepts of habitual criminals and crime recidivism must be examined. Repeatedly performing the same actions within a year constitutes habitual crimes, with crime becoming a habitual behavior for the person (Artuk & Alşahin, 2022, p. 286). Habitual criminals pose a significant risk, and in some jurisdictions, offenders undergo physiological and psychological evaluations. If predisposed to criminal behavior, individuals may face sentences applicable to habitual criminals, even if offending for the first time (Ramachandran, 2011:62). The Turkish Penal Code (TPC) Article 6, clause h, defines a habitual criminal as a person who commits the basic or qualified forms of an intentional crime more than twice at different times within a year. According to TCK Article 58/9, a special execution regime applies following the conviction of a habitual criminal. Recidivism, involving the commission of a new crime after a definitive sentence for a previous crime, triggers the application of recidivism provisions. Recidivism does not require the execution of the previous sentence but a definitive conviction sentence (Demirbaş, 2022, p. 250-251). The recidivism period is five years for sentences involving more than five years of imprisonment and three years for sentences involving less than five years of imprisonment or a judicial fine. In cases of

simple recidivism, imprisonment is chosen, and a special execution regime for repeat offenders along with probation is required (Dönmezer et al., 2020, p. 322). The special execution regime imposes stricter conditional release conditions for repeat offenders. In the case of second recidivism, the individual cannot benefit from conditional release provisions (Dönmezer et al., 2020, p. 86-87). "The probation period starts after the completion of the sentence execution and lasts for at least one year." Ideally, such individuals should be monitored, and the reasons for their recidivism investigated. The concept of recidivism in criminal law differs from that in criminology, where multiple offenses suffice to classify an individual as a repeat offender (Dönmezer et al., 2020, p. 323). Continuing criminal behavior indicates the individual's increased danger to society.

Rehabilitation plans aligned with the brain's learning mechanisms can potentially prevent the recurrence of criminal behaviors. However, the brain remains a complex structure, and responses to rehabilitative efforts can vary. The brain's adaptability to new situations suggests that behavioral change is possible, emphasizing the importance of environmental and rehabilitative interventions (Dönmezer et al., 2020, p. 325). The evolution of human survival strategies, including the ability to perceive and respond to motion as a primary characteristic, underscores the brain's role in defense mechanisms (Dönmezer et al., 2020, p. 348). Investigating brain development, particularly the process of vision and its cortical pathways, provides insights into the complex interactions between perception, learning, and behavior. Rehabilitation in clinical criminology aims to prevent reoffending by medically evaluating criminals, with neuroscience offering valuable insights into treatment strategies aimed at reintegration and socialization (Dönmezer et al., 2020, p. 335). The analysis of criminals' brain structures and physiological responses to prohibited behaviors can inform treatment approaches, emphasizing the importance of early intervention and comprehensive rehabilitation plans (Artuk & Alşahin, 2022, p.267). Understanding the biological, physiological, and psychological factors influencing an individual's behavior can facilitate changes in decision-making and behavior, contributing to safer societies.

Examination of the concept of will in the context of neuroscience and criminal law

The concept of will signifies the ability to select one among various behavioral options. As long as an individual's choices conform to societal norms and the moral order, they naturally will not conflict with legal rules. The concept of free will, however, denotes the capacity to make a choice among these options without any external or internal interference (Onur, 2020, p. 14).

The concept of will holds significant importance in disciplines such as philosophy and law. Explaining this concept within the realm of neuroscience and delineating its boundaries will also influence criminal law. Free will, for some, is the power to direct behaviors, for others, it is the capacity to shape one's future and thus one's actions, and for others still, it signifies the ability to freely determine behavior in meeting legal responsibilities (Onur, 2020, p. 18).

The will within the framework of neuroscience

When discussing the concept of will from a neuroscience perspective, it's necessary to examine the workings of the brain and related concepts. Themind exists prior to consciousness, reflecting the outcome of processes not requiring conscious awareness (LeDoux, 2020, p. 44). The advent of consciousness, coupled with awareness, results from previously recorded inputs in the brain. Following sensory inputs, the brain compares these with its memory, triggering consciousness if a match is found, thereby facilitating object recognition. When no match is found, these inputs are stored in memory until a future match occurs (LeDoux, 2020, p. 36).

Behavior originating from will in neuroscience includes the state of being conscious. However, for establishing the link between will and behavior, the necessary consciousness involves the concept of intent formed in the mind (Zeman, 2017, p. 43). Yet, often, subconscious processes underlie behaviors. Since conscious actions require significant energy, the brain tends to control behaviors through subconscious processes. When questioned why a behavior was performed, the brain fills in gaps with narratives based on past experiences, social surroundings, rules of engagement, or beliefs (LeDoux, 2020, p. 327).

Our experiences recorded by the brain essentially determine who we are or will become, necessitating long-term memory. However, short-term memory, also known as working memory, is crucial for the formation of immediate memories, leading us to the concept of consciousness. The efficacy of working memory facilitates awareness of the present moment (LeDoux, 2020, p. 328). The subconscious comprises numerous functioning units. Consciousness creates virtual images from these operations, of which we become aware. We remain oblivious to the underlying processes. If we consider the subconscious and conscious parts as layers; the subconscious processes data in the lower layer and sends the results to the upper layer, i.e., consciousness. The information formed in the mind and perceived by consciousness relies on the functioning of working memory (Eagleman, 2015, p. 79). The mind constructs the closest version of reality based on external stimuli. This perception of reality shapes behaviors. The brain interprets stimuli from the external world through sensory organs,

thus the concept of reality depends on what and how our brains perceive and interpret these stimuli.

Free will is a subject neuroscience enthusiasts seek evidence for its existence. Accordingly, numerous experiments have been conducted. In one study, participants were shown a selected segment of a film and asked to perform 3 behavior models (Eagleman, 2015, p. 60). The first was to try to feel what the person in the film felt. The second was for the subjects not to feel what the person in the film felt. The third requested the participants to experience their own emotions. MRI results from the first two tasks indicate that individuals have conscious control over their emotions (Karakoç, 2020, p. 156). In another experiment, stimuli were sent to a participant's amygdala to observe aggressive behaviors. Despite the stimulated amygdala, social norms and moral values prevented violence. As a result, the existence of free will led participants not to engage in violence (Karakoç, 2020, p. 156). Kornhuber and Deecke asked participants to move their index fingers at any given time and measured this moment with an EMG device (Informationphilosopher.com, n.d.). They identified activity in the motor function area 50 milliseconds before the behavior and referred to this activity as movement potential, which begins 800 milliseconds before the behavior and reaches its peak just 100 milliseconds before (Karakoç, 2020, p. 157). Benjamin Libet, believing that neural activity should occur over a shorter duration, placed electrodes on participants' skulls, asking them to lift their fingers when they felt the urge and to record the moment this desire arose. The impulse related to the behavior was recorded as occurring 200 milliseconds before the action. Neural activities related to the decision for the behavior were observed 550 milliseconds before its execution (Onur, 2020, p. 26). "Libet discovered that participants became aware of the urge to move a quarter of a second before the movement itself" (Eagleman, 2022, p. 169). According to EEG data, neural activity occurs long before the impulse to move, followed by the actual movement. The preparation for the action in the brain has already been completed before the individual decides to act and becomes consciously aware of it (Eagleman, 2022, p. 170). "John-Dylan Haynes (https://to.pbs.org/3pgfguG, A.D., p. 27.03.2024) "also conducted an experiment. In this fMRI study, participants sat in front of a screen displaying various letters every half-second and were given buttons to press, one on the right and one on the left. They recorded the moment they felt the urge to press a button and which letter was on the screen when they pressed it. The fMRI data revealed which button the participants would press before they made the decision, indicating that neural activity related to the action occurs before the decision and execution (Alıcı, 2021, p. 62). Both studies might initially suggest that

our actions lack free will. However, these experiments focus solely on a single motor function process and are limited. Therefore, the absence of free will is not definitive. Human behaviors are complex by nature, resulting from the operation of many mechanisms. Although many behaviors can be determined through devices like fMRI due to chemical events in the brain, one should not solely view humans from a materialistic perspective (Onur, 2020, p. 27).

The will within the context of criminal law

The significance of free will in criminal law lies in an individual's ability to direct their own actions, which underpins concepts of responsibility and fault. "For an act to be considered a crime, it is essential that the action, conforming to the legal definition and being unlawful, is committed with fault and can be attributed to the actor voluntarily" (Dönmezer et al., 2020, Vol. 2, p. 10). Actions that are voluntary, purposeful, and result in an outcome in the external world are considered acts, and if not produced by will, they do not possess the character of an act (Koca & Üzülmez, 2022, p. 317). An individual's responsibility entails bearing the consequences of their faulty actions. Will manifests itself in conscious behavior. Consciousness requires awareness of the choices made and the responsibility for their outcomes, forming the foundation for will and perception abilities. The intention to commit an act known to contravene behavioral norms "...is evaluative in terms of fault" (Koca & Üzülmez, 2022, p. 318). The responsibility for actions constituting a crime depends on the existence of will and the capacity for attribution (Toroslu, 2013, p. 1-3). In criminal law, individuals are not held responsible for actions performed unconsciously. For a person to be penalized for a crime, it is insufficient for the action to be performed (conforming to the unlawful act described by law); it must also be committed with fault (Yıldız, 2021, p. 1442). From a neuroscience perspective, when examining will in criminal law, one might consider the possibility of dissociating an individual from the crime committed (Akal, 2021, p. 21). However, the concept of will is utilized differently in criminal law (Dönmezer et al., 2020, p. 389), as social norms, public peace, and the rectification of injustice are important. Even though these concepts may be examined within the framework of neuroscience, each discipline has its own "dominant values" (Akal, 2021, p. 34). The outright exclusion of free will has not yet been fully accomplished in neuroscience.

Free will has two dimensions, p. internal freedom relates to the internal system affecting an individual's decision-making and implementation, while external freedom pertains to external forces influencing the action (Aral, 2011, p. 249). From a neuroscientific viewpoint, an individual can only generate and select from a range of behavioral options when faced with situations similar to those previously experienced or known. Will signifies making a choice

independent of the concept of freedom. Freedom concerns whether the choice made is entirely one's own (Yener, 2013, p. 1). Criminal law prioritizes the will that necessitates responsibility, not freedom. For responsibility to be attributed to an individual, an action must have an effect in the external world while being conscious (İçer, 2021:203). If this effect encompasses an unlawful act as defined legally, the individual is subjected to punishment (İçer, 2021:204). Fault involves the culpability of the actor following the materialization of both the material and moral elements of a crime, relating to whether the actor can be condemned for the resulting act (Artuk et al., 2022, p. 572). For the actor to be punished, they must be found at fault and possess the capacity for fault. An individual's fault arises from choosing to commit an act constituting a crime despite having the opportunity to behave rightly (Dönmezer et al., 2016, Vol 1, p. 173). "Fault is sought in relation to the act (Dönmezer et al., 2016, p. 173)". Imposing a penalty becomes possible with the attribution of fault following the commission of an act conforming to the unlawful type specified by law (Artuk et al., 2022, p. 573). "Fault is a judgment on the presence of conditions affecting the actor's freedom of will (Akbulut, 2020, p. 605)". Faultiness depends on the presence of the capacity for fault in the individual at the time of the act (Artuk et al., 2022, p. 573). "It is possible to say that faultiness has two elements." The capacity for perception and will are the two elements of faultiness (Artuk et al., 2022, p. 574). The capacity for perception allows an individual to understand their world and be aware of themselves and others, implying awareness and understanding of the legal significance and consequences of one's actions. Individuals aware and conscious of everything are also responsible for the consequences of their wrong choices (Dönmezer et al., 2020, pp. 391-392). Adhering to generally accepted behavioral norms in society is a manifestation of the capacity for perception (Özgenç, 2022, p. 458). The capacity for will refers to the ability of an individual to perform actions consciously and without coercion or pressure. An individual can control their own actions. Presumably, if a person is in a state of complete well-being and mentally sound, they are assumed to have will, including the capacity for perception (Demirbaş, 2022, p. 369).

Examination of evidence from a neuroscientific perspective in criminal procedure law

The concept of evidence and principles used in the evaluation of evidence

The aim of criminal proceedings is to uncover material truth (Ünver & Hakeri, 2022, p. 581). The contemporary understanding of criminal procedure not only seeks to uncover material truth but also to respect human rights, ensure a fair trial, and maintain public peace and tranquility (Karakehya, 2022:8). In criminal proceedings, the resolution of disputes and the fulfillment of justice occur within the framework of evidentiary activities. The elements used

in proving a case are termed as evidence (Ertuğrul et al., 2021, p. 165). Evidence serves to open a window from the present to the past within the proceedings, enabling the determination of what transpired, thereby forming a basis for judicial decisions. This gives rise to the concept of relative certainty, which ensures the judge's decision is devoid of doubt; it encompasses the determination of the historical and factual aspects of past events as of today (Özen, 2022, p. 162).

Distinct from civil procedure law, in criminal procedure law, as long as evidence is obtained lawfully and contributes to resolving the issue at hand, any form of proof presented to the judge and considered within the proceedings can be used as evidence without restriction (Ünver and Hakeri, 2022, p. 581). The adoption of the principle of free evaluation of evidence allows the judge to evaluate these pieces of evidence and reach a subjective conviction, signifying both 'freedom of evidence and freedom of its evaluation' (Centel & Zafer, 2022, p. 253). This stands in contrast to other systems used previously, which over time were found inadequate in fully revealing material truth and were susceptible to misuse (Yenisey & Nuhoğlu, 2021, p. 525).

Although any type of evidence can theoretically be used in criminal proceedings, a framework exists detailing the characteristics required for evidence to be admissible in courts. Evidence must be logical, scientific, relevant to the truth and the subject matter of the case, and obtained lawfully. It must be presented before the court and must be understandable to all parties involved (Centel & Zafer, 2022, p. 253). Furthermore, with the advancement of technology, the boundaries of what can constitute evidence have expanded. Thus, scientific data, when obtained lawfully, can also qualify as evidence (Boğa, 2019, p. 1). Evidence begins to be collected upon suspicion of a crime and is included in the indictment prepared by the public prosecutor. It is discussed in court to arrive at the most accurate judgment (Yenisey & Nuhoğlu, 2021, p. 531-534). Today, alongside classical means of proof, evidence based on the fundamentals of neuroscience is being introduced in courts. Comparative legal studies reveal the use of neuroscientific data as evidence.

The activity of proof in criminal procedure law is essential for resolving disputes. Conflicts regarding the violation of laws prescribing penal sanctions, such as fines and/or imprisonment, concern criminal procedure law. The concept of proceedings encompasses a broader scope than trial, including pre-trial activities (Yenisey & Nuhoğlu, 2021, p. 526). Activities conducted in courts are evaluated within the context of trial proceedings.

Neuroscientific data, therefore, find their place in criminal procedure law, having the potential to be used as evidence in court. The revelation of material truth during a trial is facilitated through evidence. The concept of material truth is crucial here, denoting the possibility of knowing about a past event in the present through evidence (Karakehya, 2022, p. 4). Evidence used to shed light on an event should fully reflect the truth. Neuroscience intersects with criminal procedure in this regard. Neuroscientific evidence can find its place alongside primary evidence in trials. No piece of evidence has precedence over another; however, in concrete cases, one piece of evidence may be more significant than others in uncovering the truth (Karakehya, 2022, p. 9).

A judge's full conviction regarding an individual's guilt or innocence is only possible when material truth is proven. The activity of proof is conducted through evidence, and all forms of proof can be accepted as evidence (Özen, 2022, p. 191). However, there are restrictions; evidence obtained unlawly is not admissible as proof (Centel & Zafer, 2022, p. 253). Similarly, for evidence to be evaluated, it must be presented and discussed in court. The decision regarding the defendant's violation of criminal norms is based on the judge's subjective conviction, which is logical, free from doubt, and based on evidence (Karakehya, 2022, p. 201). "The principle of free evaluation of evidence... also signifies the judge's discretion to weigh the evidence according to their subjective conviction (Gökcen et al., 2022, p. 10-11)." The judge's subjective conviction does not imply arbitrary judgment. While independent in their decision-making, judges are obligated to provide reasoning, which must be lawful, logical, and rational. Moreover, judges are not bound by the parties' evidence; they may, if deemed necessary, investigate evidence on their own initiative (Karakehya, 2022, p. 10-11).

Article 217 of the Criminal Procedure Code (CPC):

"*(1) The judge can only base their decision on evidence that has been presented and discussed in their presence during the trial. This evidence is freely assessed according to the judge's subjective conviction. (2) The alleged crime can be proven with any type of evidence obtained in a lawful manner."*

Article 217 of the Criminal Procedure Code (CPC) states that evidence influencing and forming the basis of the judge's decision must be presented and discussed in court and must be obtained lawfully (Özen, 2022, p. 163,585). Judges can base their decisions on evidence discussed in court. Therefore, evidence obtained unlawfully will not be considered by the judge

and will not form the basis of the judgment. If evidence is evaluated and does not form a subjective conviction in the judge, the principle of "in dubio pro reo" (when in doubt, favor the defendant) (Ertuğrul et al., 2021, p. 176) may result in acquittal. Acquittal is also the verdict when the person is not found to have committed the accused crime.

Evidence types

The tool used to reach the material truth is evidence. The evidence to be used in court must directly solve the dispute or contribute to its resolution (Karakehya, 2022, p. 199). The issue to be proved has occurred in the past, and it is intended to understand what happened in the present. Therefore, evidence that is logical, scientific, reflects past events, perceptible through the senses, lawful, and carries the characteristics of evidence such as "...traces, documents, and witnesses..." can be used as evidence in court (Karakehya, 2022, p. 200). Evidence, which is the tool for revealing the material truth used in the judge's decision according to their subjective conviction, includes statements, documents, or indications. The existence of evidence as well as its intact and unaltered delivery to the court is of great importance (Boğa, 2019, p. 16). According to the third article of the Police Duty Regulation (PDR), p. "...Physical Evidence, p. Refers to tangible, living or non-living things related to the crime or the accused, other than confessions and testimonies (http://www.vertic.org/media/National%20Legislation/Turkey/TR_By-law_Police.pdf, A.D, p. 09.03.2024) ...". This article mentions not only non-material evidence like confessions and testimonies but also tangible ones referred to as "(indication)". Evidence must be relevant to material reality, reflect this reality, be perceptible by individuals, and not contradict current science and logic. The collection of evidence is carried out during the investigation phase. The prosecutor drafts the indictment based on the collected evidence (Gökcen et al., 2022, p. 279).

For statements, documents, or indications to be evaluated as evidence, they must possess certain characteristics. Since they serve the function of being related to material reality, the evidence itself must be appropriate to reality. Being appropriate to reality means being perceptible by individuals and capable of reflecting the truth. Moreover, their contents should not contradict modern science and logic. The requirement for evidence to be logical also reflects that they must be in accordance with the ordinary course of life. Fundamentally, they should be related to the matter to be proved and should be able to show the event in a way that eliminates any doubt, either directly or indirectly (Centel & Zafer, 2022, p. 257).

Evidence has been classified in various ways. Statements, documents, and indication evidence are just one of these classifications. "Indication evidence consists of traces and remnants left by the event (Karakehya, 2022, p. 200)". Another classification is direct evidence and circumstantial evidence. Evidence directly serving to resolve the dispute is called direct evidence, while evidence that clarifies related side issues is referred to as "...circumstantial evidence or indication evidence (Boğa, 2019, p. 21)"

"The emergence of crimes committed in the virtual environment or the traces left in the virtual environment after the crime has led to the emergence of a new type of evidence called electronic evidence (Özen, 2022, p. 11).

Neuroscientific evaluation of evidence types

Statement evidence

Statements related to the event in question indicate statement evidence. "Statements about the event, when made in front of the court during the prosecution phase, have the characteristic of statement evidence (Centel & Zafer, 2022, p. 258)".

Suspect and defendant statements

When looking at the suspect and the defendant, although they refer to the same person, the individual suspected of committing a crime is called a suspect during the investigation phase and a defendant during the prosecution phase. The suspect or defendant's statements about whether the event in question happened and, if so, how it occurred are crucial for forming statement evidence. However, they might provide untruthful statements to avoid penal consequences. Witnesses lying under oath are punishable under the Turkish Penal Code (TPC). Defendants are also responsible for providing their personal and identification information accurately according to Article 147 of the TPC Article 147/1 (a) states, p. "The identity of the suspect or defendant is determined. The suspect or defendant is obliged to answer questions related to their identity (TPC Article 147)".

Article 147/1 (d) of the TPC states, p. "It is informed that not making a statement about the charged crime is a legal right," highlighting the suspect or defendant's right to remain silent. The right to silence is guaranteed by Article 38/5 of the Constitution, stating, p. "No one shall be compelled to make statements against themselves or their relatives, or to present evidence (Anayasa Article 48)." Hence, forcing an individual to provide evidence against themselves is not permissible (Karakehya, 2022, p. 215-216; Centel & Zafer, 2022, p. 273). According to Article 17/2 of the Constitution (Anayasa Article 17), p. "Except for medical necessities and

cases stated in the law, the bodily integrity of a person cannot be violated; without consent, they cannot be subjected to scientific and medical experiments...” However, the suspect or defendant must endure certain procedures even if it may produce evidence against them. For instance, blood can be drawn to determine the alcohol level (Özen, 2022, p. 16). The same applies to suspects or defendants required to undergo CT, PET, MRI, or fMRI scans. Individuals are obligated to comply with these procedures. For a suspect or defendant’s confession to be considered as evidence, it must be given freely, without any coercion, and within the framework of free will (Öztürk, 2021, p. 299). Article 148/1 of the TPC, p. “The statement of the suspect and the defendant must be based on their free will...” indicates that the individual must be fully aware and comprehend the consequences of their confession. Statements obtained through physical or psychological interventions restricting free will are not considered valid (Karakehya, 2022, p. 210; Centel & Zafer, 2022, p. 273). The veracity of a confession must be evaluated separately for each specific case, ensuring it is consistent with the course of life (Gökcen et al. 2022, p. 282). It’s essential that the defendant’s statement is not influenced by any condition affecting their will or consciousness (Gökcen et al. 2022, p. 285). Article 148/1 of the TPC states, “No use of methods such as maltreatment, torture, administering drugs, exhaustion, deception, force, or threats, and using certain devices that influence physical or psychological state (TPC Article 148).” The defendant’s statement’s validity as evidence requires avoiding prohibited interrogation methods (Karakehya, 2022, p. 210). Loss of control over one’s actions due to prohibited interrogation techniques means both the absence of free will and the risk of the confession not reflecting the truth. Statements obtained from defendants through forbidden methods, even with the defendant’s consent, are not considered as evidence under the TPC (TPC Article 148).

The mistreatment that can be evaluated within the framework of neuroscientific perspectives is one of the prohibited interrogation and statement methods. Mistreatment can be verbal or physical against a person, affecting and directing the person’s will. Especially mistreatment causing the loss of rational thinking can lead to giving statements out of pure fear. Statements given under the influence of fear may not reflect the truth. Mistreatment that violates a person’s dignity and violates the right to a fair trial is a serious issue (Özen, 2022, p. 567).

Administering drugs is another method that can be evaluated neuroscientifically as a prohibited method of interrogation and statement. Administering drugs involves involuntarily affecting a person’s will negatively and altering their behavior by externally administering a chemical agent (Centel & Zafer, 2022, p. 275). These chemical agents alter ongoing chemical

and biological processes in the brain, leading to disintegration, ultimately losing control of behavior, and becoming susceptible to manipulation. Drugs that cause intoxication, inhibit resistance, or similar substances fall into this category. The mechanism of action of these drugs changes by altering the activity at synapses in the brain. These changes can either increase or decrease the function of a cell, influenced by the drugs. The effects on the brain are primarily through altering the activity of neurotransmitters, either by increasing or decreasing their activity or by blocking their receptors, preventing them from becoming active through neurotransmitters. Some drugs produce the opposite effect (Horzum, 2011, p. 62). Consequently, administering drugs to a person can alter their thoughts and consciousness. Certain groups of drugs change synapses in the brain, forming connections suitable for themselves, while others affect the conscious part of the brain. Statements obtained from suspects or defendants by administering drugs are not considered evidence in the TPC, even if the suspect or defendant consents (Köse, 2016, p. 37).

According to TPC Article 148/1, other reasons not specified but affecting free will are also prohibited. Polygraph tests, which measure physiological responses to determine whether an individual is lying, are not considered prohibited interrogation methods provided they are used with the subject's consent, yet their use is highly controversial (Karakehya, 2022, p. 224-225). Since it is possible to control physiological responses, a suspect or defendant voluntarily taking a polygraph test is considered not to violate free will (Karakehya, 2022, p. 225). Similarly, because fMRI can also be manipulated due to its ability to control responses, it can be evaluated within the scope of factors affecting free will, similar to a polygraph test. Based on the working principle of the polygraph, the guilty knowledge test and the comparison question test have been developed, not to determine if a person is lying but to ascertain if they have knowledge of the crime based on physiological responses. Here, the essential question is whether a person with knowledge of the crime can conceal this information. Since they differ from the polygraph, they are not considered to influence free will. The P300-MERMER technique, associated with the positive wave at 300 milliseconds in EEG related to the event, is used to find individuals and connections related to the event (Özen, 2022, p. 465). The aim here is not to detect lying but to calculate the response after showing objects related to and unrelated to the crime. This also does not constitute an intervention that violates free will (Özen, 2022, p. 506).

Witness testimony

Witness testimony is one of the important evidential tools in trials. A witness is someone who has witnessed the subject of the dispute and is not a party in court (Özen, 2022, p. 507). They explain the events they perceived with their senses and sometimes express opinions about situations they have heard about. Testimonies about events they have directly witnessed are called "direct testimonies," whereas testimonies based on what they have heard from someone who experienced or witnessed the event are referred to as "indirect testimonies". Since even witnessed events cannot be remembered and recounted flawlessly, it is expected that recounting heard events would naturally include inaccuracies and errors. Sole reliance on witness testimony should not form the basis of a judgment, and it should be supported by other evidence (Centel & Zafer, 2022, p. 278). In cases with multiple witness testimonies, forming the basis of a judgment depends on whether the testimonies align in the same direction.

Formation of witness testimony

Witnessing an event does not equate to recording it as a video; it is processed through the witness's emotions and thoughts (Eagleman & Brandt, 2022, p. 49). Since everyone reacts differently to an event and is affected in unique ways, the background and environment of each individual differ. This diversity in perception and communication among witnesses who have observed the same event forms the basis of variations in testimonies. Thus, the evidential value of witness statements is also dependent on their emotional states, thoughts, and often their memories. Witness statements need to be true and accurately reflect the event for them to be considered as evidence (Eagleman & Brandt, 2022, p. 50). The human mind, encapsulating the brain like the walls of a house, blends the information obtained through the senses with personal experiences, leading to a subjective perception of events (Badem, 2021, p. 303). The brain records only a small portion of experienced events consciously, with the rest stored unconsciously, making it difficult to control the data that forms the basis of the mind's function (Kandel, 2019, p. 175-176). Information from the external world, except for the sense of smell, which bypasses the thalamus, is filtered by the thalamus before reaching the brain, indicating that the perception of reality by individuals is inherently incomplete (Smith Churchland, 2020, p. 122).

Individuals may perceive and convey events in ways unrelated to reality, especially when ill. Diseases that are not apparent from the outside can cause various disorders in the brain, affecting memory and perception of the external world (Burnett, 2017, p. 67-70). For instance, patients with Korsakoff's Syndrome lack access to memories that define their identity or have

no memories at all, leading to the fabrication of memories about people and events. Patients with this syndrome cannot perceive the outside world accurately, including failing to recognize close acquaintances and being indifferent to others' emotions (Sacks, 2020:130).

Memory of eyewitnesses

The accuracy of eyewitness testimonies can vary based on how well the event is remembered, which depends on long-term memory. Memories stored in long-term memory can be altered when recalled, meaning that these individuals' testimonies might not reflect the truth (Abrahams, 2021, p. 140). Neuroscientific studies showing that eyewitness testimonies might not be 100% accurate are significant because they reveal that human memory is fallible and can be altered. Therefore, the reliability of eyewitnesses diminishes over time, especially if a significant period has elapsed since the witnessed event. The emergence of DNA identification technologies, which have led to the exoneration of individuals wrongly convicted based on eyewitness testimonies in the US, has questioned the reliability of eyewitness evidence (Eagleman, 2015, p. 16).

Patients who become catatonic and lose their ability to move and communicate can sometimes regain their motor functions but not their memory through Electroconvulsive Therapy (ECT). ECT involves administering electric currents to the brain under general anesthesia, inducing seizure-like activity. While this therapy can alleviate catatonia, it does not restore the patient's memory, leading to the fabrication of memories and the provision of incorrect information (Sternberg, 2019, p. 123).

Brain recording and memory function

Understanding the function of memory also elucidates the mechanism behind why people cannot remember their experiences exactly as they happened. Contrary to common belief, recording events in memory is not like recording a video (Eagleman & Brandt, 2022, p. 49), because a person's emotions and how past events affected them are significant. When a crime occurs, witnesses' statements taken immediately after the event often differ from those given after some time has passed and they have seen information about the event in the news or newspapers (LeDoux, 2020, p. 244). While a video recording shows everything as it is, the brain's recording of an event is subjective, seen through the individual's eyes. Except for the recordings of fearful or tragic moments, the encoding of other memories is facilitated by the hippocampus transferring what it learns to the cortex (Eagleman, 2021:228). Like other areas of the brain, the hippocampus is made up of neurons and communicates with other units through neurons. Besides creating new memories, the hippocampus also enables the construction of

future scenarios and daydreaming based on the memories stored in the cortex (Eagleman, 2015, p. 31).

Neurons connect through parts called axons or dendrites. A dendrite and an axon are in contact by spilling neurotransmitters into the synapses, the spaces between them, and attaching to another neuron. Each experience is encoded in memory by triggering connections between neurons, which are associated with other events and emotions (Eagleman, 2021:222-225). This process can occur in various ways. When a neuron is stimulated multiple times to produce the same response, or when multiple neurons are stimulated to produce the same effect, the neurons combine to respond, thereby strengthening their connection (Abrahams, 2021, p. 136-141). It seems that after neurons have been linked and stimulated, they create new synaptic connections.

When a neuron is stimulated, and other neurons are similarly activated, the same response is observed, and eventually, a connection is established between these neurons due to the memory structure, allowing them to function together when similar stimuli are presented (Abrahams, 2021, p. 136-137). An individual's experiences are recorded in the brain, and when faced with a similar situation, the previously established connections between neurons are activated. However, every memory can be erased from the person's memory or altered and replaced with a new one as the connections between neurons weaken (Sternberg, 2019, p. 125). Memory recording involves first possessing the information, then encoding it in the brain, and finally retrieving it from memory. In an experiment, four memories of an individual were recounted by close relatives, but one of them was fabricated (Burnett, 2017, p. 65). The incorrect choice, according to the relatives, was about the individual getting lost in a shopping mall. The individual was persuaded that all the recounted events, including the fabricated one, had actually occurred. The experiment aimed to see if a memory of an event that never happened could be implanted in the individual's memory based on their relatives' statements (Eagleman, 2015, p. 30). The elder brother provided details about the supposedly experienced event, including where it took place, who was present, the individual's position, who found them, and the color of the shirt worn by the person who found them.

In subsequent sessions, when asked about this memory, the individual was able to describe not only the feelings and thoughts during the event but also details not previously mentioned, such as the color and type of shirt worn by the person who found them (Sternberg, 2019, p. 125-126). Naturally, the individual had not experienced this event. When later asked to identify the fabricated event, the individual chose one of the real memories and believed that

the story of getting lost in the shopping mall was not the fabricated one. This experiment demonstrates that it is possible to implant new memories or modify existing ones in a person's memory (Sternberg, 2019, p. 127). From the perspective of criminal procedural law, the reliability of eyewitness testimony is also questioned by this experiment. Memory is formed by associating a neuron stimulated by an external stimulus with another neuron stimulated in the same manner, and later, when related events occur, these neurons are activated together (Sternberg, 2019, p. 127-128).

Every event and situation in a person's life is recorded in memory based on its importance to the individual. Neural connections and significant situations and events are modified or recreated based on the experiences (Sternberg, 2019, p. 125). The reliability of witness testimony and its consideration under the principle of free evidence depend on certain characteristics. If a witness can provide details about an event they witnessed, logically explain the event, and maintain consistency and coherence in their narrative, then the witness testimony can be considered reliable (Sternberg, 2019, p. 128).

Reliability of eyewitness memories and testimonies

Several factors can influence eyewitness memories. How long witnesses observed the event, the threatening nature of materials used during the event, their level of stress, and the length of time between the event and taking their statement are primary factors affecting the accuracy of their recollection of an event (Badem, 2021, p. 299). Among these factors, the "weapon focus effect (Kurdoğlu Ersoy, 2018, p. 274)" refers to witnesses focusing on a weapon during an event, which may lead to gaps in their memory of people and places involved. The longer the time between the event and the taking of statements, the more likely it is that details of the event will be forgotten. In the case of recording a feared event or situation in the brain, the amygdala is active (Kurdoğlu Ersoy, 2018, p. 275). High levels of fear activate the amygdala and cause the event to be recorded differently in the brain. This is why individuals who experience trauma in childhood can vividly remember the event even when they grow up (Smith & Kosslyn, 2017, p. 348-350). For witnesses to an event, fear manifests as the stress experienced at the moment of the event. The stress level of a witness at the time of the event affects their memory and, consequently, their testimony. If the stress level is low, the hippocampus is involved in recording to the cortex; if it is high, the amygdala records it in the brain. Records made by the amygdala, containing fear, are remembered better (Smith & Kosslyn, 2017, p. 349). A study was conducted on individuals who were close to the 9/11 attacks compared to those who witnessed the events from a distance (Smith & Kosslyn, 2017,

p. 354). It looked at how these individuals remembered the events and how much confidence they had in their memories. Those close to the attacks had more confidence in their recollections. While memories are stored in the hippocampus, if they contain emotions, they are recorded by the amygdala, and if they reflect details about locations, the parahippocampal region is involved. Since the memories of those close to the attacks contained vividness and emotion, they were recorded by the amygdala (Ayhan, 2020, p. 337). Those in the other group could remember what they wore and where they were during the attack. Location information is recorded in the parahippocampal region of the brain (Smith & Kosslyn, 2017, p. 353-356). In another experiment, two days in a woman's life were recorded on video. Later, she was asked about what happened during those two days, and these details were used as a reference. After a long period, when she was asked about the same two days at regular intervals, she remembered less of the events each time, and her later descriptions included fabricated elements (Sternberg, 2019, p. 133). Her brain activity was monitored with an fMRI scanner during each phase of the experiment. It was observed that as she gradually forgot the events of those two days, indicating that her hippocampus was not active; however, when she fabricated events about herself, the medial prefrontal cortex was active. The medial prefrontal cortex is associated with thinking about oneself and describing oneself (Sternberg, 2019, p. 128). Since a recording is made based on the individual's perspective, the memory formed at the time includes their emotions, thoughts, and how they relate to the event. Each person's memory of an event differs because everyone records the event based on their own perspective, incorporating their reactions, emotions, and thoughts. Since an event is recorded subjectively, individuals may remember aspects of the event that are significant to them. Witnesses to traumatic events may suppress the memory and may not recall it when asked. Stress negatively affects the hippocampus and conscious memory, while the amygdala does not have this effect (Sternberg, 2019, p. 127-128). Even if a conscious memory of an experience is not formed, trauma can create a subconscious memory through the amygdala. Although this memory may not be consciously recalled, its effects on the individual can be lasting (Sternberg, 2019, p. 128-129). Only when something triggers the memory of the event does the individual manage to remember and talk about their experience. Individuals who were abused as children may lose their self-respect and self-concept, and subconscious mechanisms may protect the individual by suppressing memories. This mechanism is developed to prevent the individual from reliving the trauma and suffering. The brain values an individual's self-respect and self-actualization so much that it tends to ignore conditions and judgments that contradict this, favoring positive circumstances that

support self-perception and ignoring negative ones. Memories are generally organized in a way that protects the ego (Sternberg, 2019, p. 129). In an experiment where participants were asked about a filmed event, the way questions were phrased affected their speed estimates. When the event was described as a "smash," participants estimated higher speeds than when it was described as a "hit." This shows that suggestive questions can influence a person's perception of an event and even change their memory of it (Sternberg, 2019, p. 130). Suggestive questions, especially during testimony or interrogation, can alter a person's memory of an event. Given that answers are given in response to an authority figure during questioning or interrogation, the power of questions to change memories is evident. Suggestive or leading questions, the environment of the interrogation or testimony, and the authority of the person asking the questions can influence and change memories (Özen, 2022, p. 505).

Turkish Criminal Procedure Code (TCPC) Article 59 states, "The witness is required to tell what they know about the subjects they will testify to, and they should not be interrupted while testifying... further questions may be asked." Not interrupting the witness is essential to prevent them from being subjected to leading questions that could influence their statement (Güngör, 2016, p. 315). Leading or suggestive questions asked to witnesses during testimony or interrogation affect the credibility of their statements. To prevent misrepresentation, leading questions should not be asked. During witness testimony, TCPC Article 52 is applied to prevent witnesses from influencing each other and misrepresenting the events. TCPC 212/1 states, "If a witness says they cannot remember a certain matter, the relevant part of the transcript containing their previous statement is read to help them remember." This aims to prevent witnesses from giving incorrect statements. If a witness cannot remember the details of the event after their initial statement, reading the transcript containing their previous statement helps them recall the event. However, witnesses are not allowed to consult their notes. Considering the importance of reaching the material truth, allowing witnesses to review their notes to remember the event might be appropriate (Kurdoğlu Ersoy, 2018, p. 274). Given that memory can change over time and individuals can fill in the gaps in their memory with fabricated stories, reading the initial statement or allowing witnesses to review their notes right after the event seems reasonable.

In conclusion, an individual's character, personality, perspective on the world, and self-perception are factors considered by the brain while forming memories. The brain attempts to protect the individual by suppressing memories or overlooking situations that are not suitable for the person (Sternberg, 2019, p. 139-144). It is possible to place an event in a person's

memory so that it is remembered and perceived as if experienced. The brain can use all incoming information to form a memory, regardless of its source. Even if not consciously remembered, everything an individual interacts with can be perceived by the subconscious system. What is perceived by the subconscious system is then integrated in a way that suits the individual's characteristics, perspective, and identity, with emphasis on what is significant for the person. In criminal procedure law, the testimony of eyewitnesses is valued as evidence. When no other evidence is available regarding the case, the process of proving is carried out based on the testimonies of eyewitnesses. The law gives such importance to the testimonies of eyewitnesses that witnessing is considered a public duty (Sternberg, 2019, p. 150-151).

According to the longstanding perspective, a person may not remember an event they witnessed. However, if they are giving a statement about the event, their statements should contain accurate information. Statements containing incorrect information are not considered a result of misremembering but are thought to indicate that the witness is lying. This perspective necessitated taking measures to prevent individuals from giving false testimony. As a result of legally mandated measures, it has been assumed that individuals will always provide accurate testimony. Consequently, lying under oath entails certain sanctions, individuals are required to take an oath before testifying, and they have the right to refuse to testify (Özen, 2022, p. 481). However, current neuroscientific research shows that individuals may not necessarily intend to lie when giving testimony about an event. Their brains record the event based on their experiences and emotions, so their statements might be influenced by what they later see in the news or hear from others, possibly misrepresenting the event. Such a situation could lead to unjust decisions by the courts.

To prevent this, the TCPC outlines procedures and requirements for testimony. According to TCPC Article 52/1, p. "Each witness shall be heard separately and without the presence of subsequent witnesses." This separate questioning is intended to prevent witnesses from influencing each other and misremembering the event. TCPC Article 53 states that witnesses will be informed about the importance of telling the truth, the penalty for perjury if they do not tell the truth, and that they will swear to tell the truth (Güngör, 2016, p. 308). Although swearing is the rule, in some cases, no oath is taken (Özen, 2022, p. 495). For example, no oath is taken from children under 15 years old, even if they have the capacity to distinguish. The administration of oaths to individuals with mental illness or mental weakness depends on their capacity to distinguish. Here, the concept of discernment in Article 13 of the Turkish Civil Code (TCC) is considered, p. "Everyone who is not deprived of the ability to act in a reasonable

manner due to their young age, mental illness, mental weakness, intoxication, or similar reasons has the capacity to discern according to this Law."

According to TCPC Article 54/1, "Witnesses swear an oath before testifying. If deemed necessary or if there is doubt about the appropriateness of someone serving as a witness, the oath may be postponed until after the testimony." This provision applies to witnesses who do not have the right to refuse to testify and whose statements are in doubt (Özen, 2022, p. 495). The oath itself is not considered evidence. The purpose of administering an oath to witnesses is to enhance the reliability of the evidence. By taking an oath, it is intended to increase the likelihood of the witness telling the truth. The witness swears on their principles or beliefs, and this is intended to ensure they tell the truth (Badem, 2021, p. 303). "The witness is obligated to provide accurate answers about their identity and the subjects they are testifying about." If a witness is heard without taking an oath, the resulting witness evidence will not be considered as it violates TCPC Articles 206/2-a, 230/1-b, and 217, which regard evidence obtained illegally as inadmissible and not forming the basis of a judgment (Öztürk, 2021, p. 504). Witnessing is considered a public duty; therefore, individuals called to testify at a hearing are obligated to attend and provide the requested testimony. Witnesses are summoned through a summons letter, which outlines the consequences of failing to appear (Öztürk, 2021, p. 306). During the investigation, the public prosecutor, and during the trial phase, the judge or court, may summon the witness if deemed necessary, and those who do not comply with the summons may be brought in by force (Özen, 2022, p. 469). Individuals have the right to refuse to testify.

Statements from ındividuals other than the suspect or defendant

Defendants can serve as witnesses in cases other than their own. Since each defendant is tried separately, individuals involved in a crime together can testify about the incident. Victims can also testify as witnesses. A victim is someone who suffers harm or whose legal interest is violated as a result of a legally defined criminal act (Özen, 2022, p. 469). The violation of legal interest directly affects the victim, while others whose rights and interests are harmed but are not legally protected interests are considered persons harmed by the crime. The statements of victims are crucial. If a victim does not file a complaint but is merely considered a victim, their statement is subject to the same rules applicable to witness testimony. If the individual files a complaint, they are also considered a person harmed by the crime. Although TCPC Article 236/1 states, p. "When a victim is heard as a witness, except for swearing, the provisions related to testimony apply," it does not specifically mention testimony from complainants. According to TCPC Article 236/2, p. "When hearing a victim who is a child or another victim whose

psychology has been affected by the crime, a specialist in psychology, psychiatry, medicine, or education must be present." This article is significant as it mandates the presence of neuropsychiatrists and behavioral experts during the testimony of a child or affected victim, allowing their facial expressions, mood, and behavior to be interpreted to avoid causing them further distress. TCPC 236/5 states, p. "During the investigation phase, statements from child victims of crimes specified in Article 103, paragraph 2, of the Turkish Penal Code are taken under the supervision of the public prosecutor at centers providing specialized services through experts. The child victim's statements and images are recorded..." This refers to child victims of the crime specified in TCPC Article 103. During the trial phase, if necessary for uncovering the material truth, statements or other actions involving the child victim must be conducted by the court or a judge assigned by the court at specialized service centers through experts (Özen, 2022, p. 472). Having experts ask the questions can help minimize the trauma for the victim. The behavior and statements of victimized children are recorded and analyzed by behavioral neurologists, and efforts to prevent further harm to the children should be conducted not only psychologically but also neurologically. The fact that the victims are children reminds us that their brain development is not yet complete, and they should be treated with a multidisciplinary approach.

In conclusion, individuals who testify in a trial cannot also serve as judges in the same trial. Testimony takes precedence over judicial roles. Public prosecutors can also testify because their involvement in taking statements results in indirect testimonies. When someone directly witnesses an event, their direct testimony should be prioritized. If lawyers are the sole witnesses to an incident, they are obliged to testify. One cannot simultaneously act as a lawyer and a witness in the same case (Öztürk, 2021, p. 302). Similarly, experts cannot hold both roles at once. If experts have directly witnessed an event, their testimony should be prioritized, and another person should serve as the expert. If there are sufficient direct witnesses to an event, an expert can serve in their professional capacity instead of as a witness, unless they are the only witness available, in which case their testimony takes precedence (Özen, 2022, p. 467). Law enforcement officers who participate in the investigation phase of a case cannot testify in that case. If they have already testified as witnesses, they cannot perform law enforcement duties for that case. As with other roles, law enforcement duties follow after testifying (Öztürk, 2021, p. 302).

Documentary evidence

The presence of a written document related to the subject matter of the litigation is considered under the category of documentary evidence (Centel & Zafer, 2022, p. 307). Documentary evidence aids the judge in forming an opinion about the incident due to its content. It can be in written form as well as audio and visual recordings, as long as it contains information related to the incident.

Compared to witness testimonies, documentary evidence can be considered more reliable. The authenticity of a document does not necessarily require the author's identity to be known. Even anonymous letters can serve as evidence if they are related to the case and contain relevant information (Özen, 2022, p. 576). Legally obtained written or audio materials can constitute documentary evidence (Özen, 2022, p. 575). For photocopies or copies of a document to be used as evidence, they must be verified by an authorized body.

Documentary evidence can be categorized into written documents, documents establishing a form, audio and/or video recordings, and documents containing electronic data (Köse, 2016, p. 97).

Written documents

The medium of the written text is not important, nor is the identity of the writer; what matters is that it contains an expression of intent or information about the incident. Written documents can be evaluated both as an evidence tool themselves and in terms of the information they contain. Thus, both the document and its content must be accurate (Köse, 2016, p. 98).

Documents establishing a form

These documents visually present information through a specific form. Like written documents convey information through reading, documents establishing a form present information visually, such as photographs, drawings, graphs, maps. Some of these documents may reflect the mental world of the creator and should be approached cautiously (Akmatalieva, 2020, p. 37) since they might also convey the biased perspective of the creator, potentially hindering the objective uncovering of the truth (Boğa, 2019, p. 40). Neuroimaging techniques can also be considered in this category, for example, CT, MRI, fMRI, and PET images, which serve as photographic evidence of the brain's condition.

Audio and/or video recording devices

For audio or video recordings to be considered as evidence, their creation and presentation in court must comply with legal standards (Özen, 2022, p. 577). There are several reasons for

cautious consideration of audio and visual recordings as evidence. Recordings containing personal data obtained illegally cannot be considered as evidence. Furthermore, for audio or visual recordings to constitute documentary evidence, they must comply with Article 135 of the Code of Criminal Procedure (CCP) (Gökcen et al., 2022, p. 308). Properly obtained audio and/or video recordings can constitute documentary evidence (Öztürk, 2021, p. 331), although they should be considered alongside other evidence due to the ease with which they can be manipulated (Gökcen et al., 2022, p. 308).

Document containing electronic data

Today's life is influenced not only by tangible and visible information in the real world but also by entities in the virtual world that store and process more data than the real world. Information in electronic environments, which are considered the virtual world and contain personal data of almost everyone, also possesses documentary quality (Sertçe, 2010, p. 47). Electronic data, such as a suspect's computer, electronic transactions, and email communications, are considered within the scope of documentary evidence. These examples include data stored on servers, viewed on computers, and found on the internet. For these documents to be deemed evidence, they must be presented and discussed in court (Gökcen et al., 2022, p. 306).

In summary, the elements such as indications, traces, signs, and evidence do not directly constitute evidence related to a crime. "Parts that indirectly represent the subject of proof activity are considered as indicative evidence (Gökcen et al., 2022, p. 309). Indicative evidence does not include declarations of will by individuals related to the event, and individuals are often unaware of leaving these evidences behind (Centel & Zafer, 2022, p. 311; Özen, 2022, p. 578). As long as these findings are preserved, collected, and obtained lawfully, they can be used in court. According to Article 217 of the TCPC, the judge must make a decision based on the evidence presented and discussed in their presence (Köse, 2016, p. 121).

Law enforcement agencies consider indicative evidence as physical evidence. Since indicative evidence represents only a part of the event, it is considered indirect evidence. "Indicative evidence often does not suffice to prove a crime was committed by the suspect alone (Köse, 2016, p. 121)". For instance, a hair strand found at the crime scene could have been left there at a time other than when the crime was committed. Due to such possibilities, indicative evidence alone does not have the strength to prove material facts (Karakehya, 2022, p. 248). However, in rare cases, they might prove a crime on their own. "Indicative evidence is subject

to investigation" (Karakehya, 2022, p. 248). Except in cases where delay is detrimental, investigation is conducted with a court order, involving examination and sensory perception of objects, situations, items, persons, or places. The resulting findings constitute indicative evidence (Koca, 2006, p. 219).

Reports created as a result of criminal investigations become "scientific evidence (Öztürk, 2021:338)" from that moment onwards. Criminology investigates to find traces that can be associated with a criminal event. Interrogation, on the other hand, refers to techniques developed to obtain statements without using prohibited interrogation and statement methods. The ability to present scientific evidence depends on the advancement of criminology. Like blood or fingerprint evidence, the brain also has a unique "brain fingerprint" for each individual, which can vary (Akmatalieva, 2020, p. 101). Therefore, where fingerprint evidence cannot be obtained, brain fingerprint records could be developed. The provisions that allow for the collection of samples from relevant individuals for obtaining such findings are found in TCPC 75 and subsequent articles. The data obtained through internal and external physical examinations are compared with other indicative evidence found at the scene, and the results are reported. However, they are not permitted to be used outside of the case or for purposes other than intended (Van DeVille, 2021, p. 1).

Since the concept of indication is not defined by law, it is subject to assessment that keeps it close to but separate from evidence. An indication refers to the representation related to the event, while evidence is considered the means to uncover material truth (Koca, 2006, p. 220).

"Indications are further divided into categories such as natural-artificial indications, general-specific indications, and pre-event, during-event, post-event indications" (Köse, 2016, p. 119).

Natural-artificial indications

Natural indications are objects naturally represented as part of the event left at the scene without the individual's intention (Özen, 2022, p. 578). They only illuminate a part of the event and need to be evaluated with other evidence. A detailed investigation should be conducted to determine their relevance to the event. Artificial indications also reflect a part of the event but are objects prepared by the individual himself, necessitating a cautious approach for evaluation (Öztürk, 2005, p. 26). However, the main goal is to uncover the material truth, and indications, facilitated by criminology, can sometimes be more reliable than witness statements. Unlike

witness statements, which can be manipulated for personal gain, indications are natural materials left unwittingly at the scene, rendering them more reliable (Öztürk, 2021, p. 334).

Moreover, the memory of an event witnessed by an individual can weaken over time, making natural indications critical in reconstructing the event. Artificial indications, while created by individuals, have lesser evidentiary strength compared to natural traces but can still contribute to illuminating the event (Özen, 2022, p. 579).

General to specific: From natural indicators to neuroscientific data

Medicine and technology significantly influence our lives with developments that are too rapid to be ignored. Their penetration into the legal field is evident, with their advancements now reflecting as scientific evidence in criminal proceedings. For instance, technological tools can identify whom the evidence at a crime scene belongs to, or a paternity suit may be resolved through DNA analysis of the child. Similar to these examples, neuroscientific evidence can be introduced in criminal cases. This does not limit the use of neuroscience in criminal proceedings to evidence alone; there may be other methods by which neuroscience could be applied. Its varied application will facilitate the convergence of neuroscience and law, two major fields. Identifying guiding methods in this convergence is crucial. Establishing principles that could guide the use of neuroscience in law will ensure that both the defense and the prosecution operate within certain boundaries. Until this stage is reached, it is vital for users to act with great care to protect the principles and objectives of law. Not only legal experts but also researchers in neuroscience, who have developed expertise, need to work together in the intersection of these two fields. A multidisciplinary approach will enrich the concept of neuro-law.

Neuroscience attempts to depict the structure and functioning of the human brain through various neuroimaging techniques. Neuroscientific knowledge includes neuroimaging techniques, neuroendocrinology, and neuropsychological assessments (Köse, 2016, p. 119). In various European countries and the United States, neuroimaging techniques are presented as neuroscientific evidence in courts. Moreover, neuropsychologists and behavioral experts also serve as expert witnesses in determining whether an individual can defend themselves (Özen, 2022, p. 579).

Neuroimaging techniques as neuroscientific evidence

Neuroimaging techniques provide a depiction of the brain's structure and function. Anatomical imaging includes X-rays, Computed Tomography (CT), and Magnetic Resonance

Imaging (MRI), while functional imaging involves Functional Magnetic Resonance Imaging (fMRI) and Positron Emission Tomography (PET) (Köse, 2016, p. 119-120). Anatomical imaging is used to examine whether there is organic damage and to investigate which structures are responsible for changes in behavior. Functional imaging focuses on metabolic activities in the brain, utilizing changes in blood flow to determine which areas are active during certain behaviors (Köse, 2016, p. 120).

With technological advancements, imaging techniques like PET and Single Photon Emission Computed Tomography (SPECT) have been applied to individuals. The use of MRI and fMRI by scientists to investigate why individuals behave in certain ways forms the basis of neuroimaging techniques. fMRI, in particular, is favored due to its non-invasive nature compared to other methods (Owen et al., 2014, p. 226). Thus, aspects like individuals' moral judgments, aggressive behaviors, social interactions, and deceitful attempts have been explored using fMRI. However, due to the possibility of manipulating fMRI results, similar to lie detectors, its use in criminal law is not widespread.

However, the use of CT, PET, and MRI is more common in other countries (de Kogel & Westgeest, 2015, p. 583).

PET (positron emission tomography)

PET is a method where a radioactive substance (positron-emitting isotope) (Kennedy & Houston, 2021, p. 40-44) is injected into the individual to visualize the active regions of the brain. The radioactive substance given before imaging is crucial for showing which part of the brain is active during the imaging process (Abrahams, 2021, p. 16,20).

"PET is a non-invasive technique that images local changes in brain activity." The active region of the brain is projected onto screens through computers. The amount of gamma radiation emitted varies with the glucose usage in the brain region. Different amounts of gamma radiation are emitted from different regions, which are represented in colors on the computer to determine which areas are more active (Campbell Moriarty & Langleben, 2018, p. 786). PET imaging studies have visualized brain regions responsible for speech, memory recall, hearing, vision, and face recognition. It is significant for reflecting mental processes (Campbell Moriarty & Langleben, 2018, p. 787).

MRI (magnetic resonance imaging)

MRI is used to show the structure of the brain. Its working principle is based on the displacement of hydrogen atoms in the body by strong magnets (Campbell Moriarty &

Langleben, 2018, p. 786). Initially, the protons in the hydrogen atoms are aligned, then returned to their original positions by radio waves (Abrahams, 2021, p. 16). As they return to their original positions, they emit a weak signal. These signals are amplified by MRI to create an image that can be viewed on a computer (Kennedy & Houston, 2021, p. 40). In the Netherlands, MRI is used to analyze defendants' behaviors (Abrahams, 2021, p. 16).

MRI images are also utilized when the defendant has suffered a frontal lobe injury or has a condition like dementia that affects memory and behavior. In addition to neuroimaging techniques, legal practice must collaborate with various disciplines to demonstrate a defendant's capacity to bear responsibility for their actions. The Netherlands' Institute for Forensic Psychiatry and Psychology has applied magnetic resonance imaging in cases (Smith, Edward and Kosslyn, 2017, p. 33).

Particularly in violent and sexual offense cases, this neuroimaging technique is considered alongside psychological assessments and other evidence. This multidisciplinary approach allows for a comprehensive examination of cases, where both psychological and neurological assessments play crucial roles in the decisions made about defendants. MRI provides important data for neurological assessments (Abrahams, 2021, p. 17).

fMRI (functional magnetic resonance imaging)

Developed from magnetic resonance imaging, fMRI operates on the same principles but utilizes "BOLD" signals for information (Kennedy & Houston, 2021, p. 32). These signals, reflecting changes in blood flow, indicate changes in blood oxygenation rather than neuron activity. However, increased blood flow in an area also suggests increased neural activity, albeit indirectly (Smith, Edward and Kosslyn, 2017, p. 32).

In an fMRI scan, the movement of oxygen atoms in an individual's body under a high magnetic field is monitored to measure brain functionality. The oxygen carried by the blood sends radio signals to the machine, which then determines the active brain region during a behavior. Red blood cells transport oxygen throughout the body via the hemoglobin protein. The carbon dioxide released as a result of oxygen usage is carried by hemoglobin, which slightly impedes the "magnetic resonance echo" (Kennedy & Houston, 2021, p. 40).

When an activity occurs in the brain, both oxygen and glucose levels increase in that region. "Consequently, the more active a brain region is, the lower the carbon dioxide level there; hence, the stronger the magnetic resonance echo" (Keysers, 2019, p. 58). The magnetic

field created by hemoglobin following oxygen usage can be detected by the fMRI device, identifying which brain region is active (Campbell Moriarty & Langleben, 2018, p. 787).

For this determination, fMRI must also record the brain's resting state without any stimuli. Capturing a memory related to that behavior, fMRI has become popular not only among neuroscientists. However, while the brain operates in milliseconds with millions of neurons, the transportation of oxygen from the blood to the relevant brain area is measured in seconds. On one hand, there's a structure operating in milliseconds, and on the other, a blood flow process occurring over seconds (Rose & Rose, 2018, p. 11).

fMRI can also be utilized for lie detection; however, it does not always yield the desired outcomes. Similar to how physiological responses in lie detectors can be manipulated to produce incorrect results, fMRI results can also be misled (Salmanowitz, 2015, p. 141). Consequently, their legal reliability is not absolute. Emotional attachments in many situations will lead to inaccurate results from lie detectors and fMRI. This has been demonstrated through various studies, revealing that deception can be identified in the brain during experiments. After simulating a crime scene, participants were asked to perform specific tasks. Those in the innocent group were instructed to destroy evidence related to the criminals. Another group, also innocent, was told to lie about committing a crime. Each participant, given specific tasks, answered questions related to and unrelated to the crime while undergoing fMRI scans (Salmanowitz, 2015, p. 141).

In fMRI lie detection, statements about the evidence or the method of committing the crime were made to see how the individual's brain reacted. If the person committed the crime, the details or the method would be familiar, and the brain's relevant centers would appear brighter than usual (de Kogel & Westgeest, 2015, p. 601). To test the accuracy of fMRI lie detection, individuals who did not commit any crime were previously informed about various objects and places and shown pictures. Although these individuals did not commit the crime, the association caused by the shown objects and pictures would make it seem like they were related to the crime. Therefore, fMRI lie detection does not provide definitive results. Moreover, a professional could bypass fMRI lie detection just as they could a polygraph. No matter how much evidence or details of the crime are presented or shown, the person's brain will not react (de Kogel & Westgeest, 2015, p. 600). In another experiment, some participants were asked to steal certain objects and then lie about it, while another group was to lie about stealing objects they did not take. Researchers attempted to predict who was innocent based on

fMRI results, accurately identifying the criminals but failing to accurately predict the innocent. In a different application of the experiment, participants were asked to make subtle hand movements while deceiving, which negatively affected the accuracy of the results. This is because it was impossible to obtain the same results when participants moved their fingers while attempting to deceive. This indicates that fMRI machines can be misled. This deception can be achieved through physical movements or by thinking about emotional things during the scan. Ultimately, in individuals using deceptive statements, the brain's areas responsible for this function and the neuron units related to memory appear similar. However, no such finding was observed in the fMRI images of pain (de Kogel & Westgeest, 2015, p. 602).

EEG (Electroencephalography)

EEG represents the brain's electrical activity on paper. Electrodes placed on the skull capture "the electrical field generated by neuron activity in the cerebral cortex" (Kennedy & Houston, 2021, p. 42). EEG displays both the amplitude and frequency of voltage changes occurring as the brain operates. The electrical activity of a single nerve cell, along with that of many nerve cells in the area, creates an electrical field that can be measured at a detectable level by placing electrodes on the skull (Eren, 2014, p. 8).

Historically, the use of EEG in British cases was aimed at determining the presence of mental illness, brain trauma, or memory losses in the defendant (Conrad, 1949, p. 409). In one case, a person who drank beer and experienced abnormal brain waves due to changes in blood sugar, resulting in memory loss of the committed murder, was found guilty but not punished (Conrad, 1949, p. 409).

Brain waves in EEG are classified according to their frequencies, including alpha, beta, theta, and delta waves (Zeman, 2017, p. 117). Alpha waves have been found to be more significant in face recognition studies for indicating the presence of hidden information compared to other brain waves (Chan et al., 2017, p. 566).

The applicability of various neuroimaging techniques as neuroscientific evidence in legal cases

Event-related potentials in EEG

Beyond visualizing the brain's structure and function in a digital environment, it's also possible to observe its electrical activities. There exists a phenomenon known as "event-related potential" (ERP), which simplistically can be described as the brain's response to a particular object, situation, or event (Smith & Kosslyn, 2017, p. 135). The brain is electrically active even when it is not focused on any specific object, situation, or event. However, when it does focus,

the electrical activity generated can be measured, revealing the brain's responses. Electrodes are placed on the skull, and an object, situation, or event is presented or described to the individual. Changes in electrical activity occur at specific intervals, detected by the electrodes and recorded as waveforms. The brain can react not only visually but also auditorily, so ERPs are applicable not only for visual stimuli but for auditory and tactile systems as well (Smith & Kosslyn, 2017, p. 135). Experiments comparing the waveforms generated with and without clues about certain situations have shown differences between the two, highlighting the brain's ability to react distinctly when prompted (Smith & Kosslyn, 2017, p. 135). In criminal and procedural law, for instance, in a murder case, ERPs can be utilized. Showing stimuli related and unrelated to the crime to individuals thought to be involved can reveal their connection to the event by analyzing early and late responses and electrical activities.

Although the brain's response to an object, situation, or event can be determined through ERP measurement, the method does not specify from which region of the brain these signals originate (Smith & Kosslyn, 2017, p. 135-136). Transcranial Magnetic Stimulation (TMS), on the other hand, is a device developed to inhibit the brain's electrical activity using magnetic field principles, thereby identifying the function of inactive areas (Smith & Kosslyn, 2017, p. 138). A coil generates a magnetic field held close to the skull (up to 5 cm away), inducing small, temporary electrical currents in the targeted brain region, leading to observable behavioral changes (Alpay et al., 2005, p. 136).

Polygraph tests

In the use of polygraph tests within criminal proceedings, questions related to the crime are asked, and physiological responses during these inquiries are measured. Control questions are formulated to establish standard data, followed by crime-related questions, with bodily responses taken into account. Questions are structured to be answered with a simple "yes" or "no" (Eren, 2014, p. 5). The monitored parameters include changes in the autonomic nervous system's function, resulting in increased pulse and respiration rates, changes in blood pressure, perspiration, and dry mouth among other symptoms (Eren, 2014, p. 6). However, neuroscientific evidence obtained through polygraph tests is considered less strong than other evidence types. Since it measures physiological responses, individuals who can control their emotions effectively may not be accurately assessed by this method.

The underlying test techniques of polygraph working principles include the "Relevant-Irrelevant Test," where relevant questions are about the crime and standard questions serve as

controls to determine reaction baselines. The response magnitudes to relevant questions can indicate the crime's significance to the individual. The "Comparison Question Test" compares bodily reactions to both relevant and standard questions, expecting higher responses to the former from individuals who have committed a crime. This method is more about revealing knowledge regarding the crime rather than detecting deception (Eren, 2014, p. 1). The "Concealed Information Test" is another method developed based on the polygraph, aiming to bypass deception by analyzing physiological responses to crime-related and unrelated stimuli. If responses to crime-related stimuli are stronger, it implies the event has significance to the individual. Yet, physiological responses can be controlled, making incorrect results possible. However, accurate results are sought by supporting the concealed information test with ERPs and fMRI (Eren, 2014, p. 2).

Among these methods, the concealed information test appears more suitable for legal proceedings regarding judicial security, as it aims to reveal whether an individual possesses knowledge about the crime. However, certain considerations must be addressed, such as if the individual already has knowledge about the crime, if they are inherently anxious, or if the questions are not expertly crafted, which could hinder the uncovering of material truth (Lawrence, 2012, p. 124).

Brain fingerprinting

Brain fingerprinting is a method that emphasizes the importance of using the P300-MERMER response as a criterion. This approach analyzes how individuals' brain waves change, especially when they encounter information related to a crime. The P300-MERMER response represents a combination of changes in brain waves when the individual is exposed to information. Developed by Lawrence A. Farwell, this method is used to determine whether individuals are aware of information related to the crime. Brain fingerprinting is a neuroscientific evidence technique used to reveal information concealed by an individual related to a crime. This technique is based on the observation that brain waves change in response to stimuli, and these changes can be measured to determine if the information is significant to the person (Van DeVille, 2021, p. 1). Initially, this method relied solely on the occurrence of the P300 wave, but research indicated its reliability was uncertain. Consequently, a method called P300-MERMER, which considers the peak of the positive fluctuation occurring at 300 milliseconds and the subsequent negative fluctuation, was adopted (Eren, 2014, p. 29). These waves are significant because individuals' decisions and behaviors cause electrical changes in the brain. Brain fingerprinting tests measure specific responses to stimuli, with the

response time extending as stimuli become more complex. Despite its complex nature, the term "brain fingerprinting" has been retained. The more complex the content of the stimuli, the longer the brain's response time and information processing duration (Farwell, 2012, p. 130).

One study focused on utilizing brain fingerprinting in criminal knowledge tests, involving three types of stimuli, p. details of the crime and how it was committed, information irrelevant to the individual due to ignorance of the crime, and trivial yet related information (Shen et al., 2017, p. 333). If an individual reacts to detailed information about the crime, it indicates guilt; no reaction suggests no connection to the crime. For example, if a person committed a murder with a specific weapon, their response to scenarios crafted around the method of the murder and mentions of the murder weapon is the targeted stimulus. Irrelevant stimuli do not provoke a response because the person did not commit the crime. The third type includes details unrelated to the individual or the targeted stimulus (Shen et al., 2017, p. 333-335). If innocent, the person would not know the method or details of the murder, hence responding to questions about the murder weapon or provided information as they would to any weapon mentioned. Inserting scenarios potentially related to the murder will not increase brain activity. However, if they had committed the murder, their brain activity would significantly indicate so upon mentioning or showing the murder weapon and during the scenarios (Shen et al., 2017, p. 340).

One notable case that employed brain fingerprinting is Terry Harrington's case, aiming to uncover the mystery behind a security guard's murder at a car dealership. Kevin Hughes claimed that he, along with Terry Harrington and Curtis McGhee, entered the dealership to steal a car and that Harrington shot the guard upon seeing him. Harrington and McGhee were arrested (Roberts, 2007, p. 238). Despite being only 17 and claiming to have attended a concert on the night of the murder, Harrington was implicated further by false testimony from Hughes, who was paid by prosecutors, and the discovery of materials at Harrington's home that could be linked to a gun. A jailhouse barber, believing in Harrington's innocence, initiated an independent investigation, uncovering police reports that supported the possibility of another perpetrator that were not included in the trial documents (Belcher & Walter, 2010, p. 18). With the implementation of the Brain Fingerprinting Test on Harrington, showcasing the inconsistencies between his statements and the P300 wave changes with the crime scene evidence, it was demonstrated that Harrington had no connection to the crime (Smith & Kosslyn, 2017, p. 31). Upon reviewing additional evidence and the Brain Fingerprinting Test results, the Supreme Court exonerated Harrington from the charges. However, the decision was

made by considering all evidence rather than solely relying on the neuroscientific evidence (Ergenoğlu et al., 2012, p. 54).

P300 wave

Event-Related Potentials (ERP) are measurable small electrical currents in the brain that occur within short time frames in response to stimuli (Smith & Kosslyn, 2017, p. 31). These currents manifest as either negative or positive voltages, depending on their direction. ERPs are named based on their timing of occurrence and the direction of voltages. The P300 wave is an ERP that appears approximately 300 milliseconds after a stimulus, indicating brain fluctuations (Lafuente et al., 2017, p. 1). Experiments employing the "Oddball paradigm" have successfully isolated the P300 wave. As a subset of EEG, the P300 wave signifies the electrical activity in the brain during decision-making (Smith & Kosslyn, 2017, p. 31). The P300 wave emerges about 300 milliseconds after distinguishing a target tone from non-target ones, indicating the brain's recognition of the target (Gaudet, 2011, p. 295). This process, including decision-making and memory testing, employs the P300 wave for detection.

In criminal cases or investigations involving suspected individuals, they are presented with words, photographs, or other items related to the crime in front of a screen while their brain waves are recorded through electrodes attached to their skull. Both crime-related and unrelated words, objects, or photos are shown, and the individual's reactions are recorded. If the recording fits the P300-MERMER pattern, it suggests the individual's involvement with the crime. This analysis is facilitated through a computer program, differentiating brain responses to crime-related stimuli based on the significance of these elements to the individual. If the stimuli are meaningful, the brain reacts differently compared to other stimuli (Gaudet, 2011, p. 297). The statistical reliability of these responses categorizes them as either knowing or not knowing the information, based on whether the brain waves conform to the P300-MERMER pattern. A conformity to this pattern suggests possession of the information, with a reliability rate calculated at 99.9%. Non-conforming responses are categorized as "no information," while "inconclusive" results lack statistical reliability and do not fit the pattern (Gaudet, 2011, p. 298). The objective of brain fingerprinting is to demonstrate connections between the crime scene and those involved or knowledgeable about the crime.

Brain electrical oscillation signature (BEOS)

In India, the relatively new technique known as Brain Electrical Oscillation Signature (BEOS), which operates similarly to EEG, has been used in court. The technique was applied in the case of Aditi Sharma in the Pune Sessions Court, Maharashtra State, where Sharma was

convicted of poisoning someone with arsenic, based partly on BEOS evidence. This marked the formal use of BEOS in an Indian court to convict an individual and impose a prison sentence (Shen et al., 2017, p. 331). However, American legal practitioners have noted that the conviction was not solely based on BEOS evidence but was supported by other evidence as well. The case highlights the use of neuroscientific evidence in legal proceedings, despite the rarity of such practices in the U.S. due to stringent evidence standards under American Federal Rules of Evidence (Shen et al., 2017, p. 331-332).

Comparative law analysis of neuroscientific evidence

The utilization of data obtained from neuroscience in legal cases demonstrates the existence of neuroscientific evidence. While data derived from neuroimaging techniques and structural analyses of the brain can be categorized as neuroscientific evidence, the ambiguity of the accuracy of polygraph test data prevents its inclusion in this category. In recent years, the use of neuroscientific evidence in courts has been observed in England, Canada, and the United States. “In the United States, 5% of all murder cases and 25% of death penalty cases include such evidence.” However, their usage is still not at an adequate level. The application of neuroscientific evidence in courts is expected to increase as technological advancements in medicine are utilized and as our understanding of the brain’s structure and mysteries improves. Indeed, an increase in the use of neuroscientific evidence in courts has been observed in the United States, Canada, England, Wales, and the Netherlands (Shen, 2016, p. 344).

In the United States, neuroscientific evidence “must meet scientific evidence requirements.” As the frequency of using scientific evidence in cases increases, it has become necessary to distinguish between evidence that is highly valuable and that which is not. This distinction aims to separate real scientific evidence from that which is fabricated to deceive (Shen, 2016, p. 345). Although neuroscientific evidence is used in American courts, its impact on case outcomes remains unclear, but its use is gradually increasing, as revealed by various studies.

Experiments on the acceptance and impact of neuroimaging methods in courts aim to see if neuroscientific evidence influences court decisions. Results indicate that while fMRI does not provide the expected level of confidence, more trust is placed in memory-based brain imaging methods and, as a continuation, EEG. These methods are deemed suitable for use in courts (Shen et al., 2017, p. 360).

In England and Wales, the legal reliability of memory tests as neuroscientific evidence is low. The Court of Appeal judges in England examine the data at the root of the problem, not secondary evidence. Thus, neuroscientific evidence is considered by the Court of Appeal as long as it is evaluated alongside the main evidence. The more effective the evidence is, the more detailed its examination (Catley & Claydon, 2015, p. 516). The purpose of using neuroscientific evidence in first-instance courts may differ from that in appellate courts. Neuroscientific evidence presented in appellate courts relates to the defendant's level of responsibility for the crime and their psychological profile. In England, neuroscientific evidence can pave the way for its use in cases of intentional injury or manslaughter by the prosecution. Defendants' lawyers in appellate courts can use the results of psychological tests or data obtained from neuroimaging methods, while the prosecution can also use eyewitness statements or explanations for events like death or injury as evidence (Catley & Claydon, 2015, p. 516).

In the Netherlands, decisions in first-instance courts show the use of neuroscientific evidence. A study categorizing criminal cases has identified areas where neuroscientific information and neuroimaging techniques can be applied. The impact of using neuroscientific data on penalties in criminal cases has been observed. The general sample of the cases studied does not represent all criminal cases, as databases related to criminal cases include unpublished cases, making it impossible to access all of them (de Kogel & Westgeest, 2015, p. 582). During the research, parts related to neuroscience were divided into three categories, p. neuroscientific information, genetic information, and behavioral and mental states of individuals. While researching an individual's genetics, investigations are also conducted about their past and family. This necessitates collaboration among various units. To hold someone accountable for their behavior in criminal law, we must be able to attribute fault to that behavior. Individuals with conditions that preclude fault attribution are not criminally responsible. The study in the Netherlands attempts to establish a relationship between various legal questions and neuroscientific and behavioral genetic information. Neuroscientific information is only allowed to contribute to a case if it is directly related to and answers a clear legal question. Some providers of neuroscientific evidence in the Netherlands, such as polygraph tests, have never been used due to uncertainty about their accuracy (de Kogel & Westgeest, 2015, p. 583).

In England, the purpose of using neuroscientific evidence in criminal cases is either to prevent sentencing or to reduce the sentence if one has been given. The application of this in England includes monitoring and security measures, situations where the penalty does not involve imprisonment, or mitigating harsh penalty conditions (de Kogel & Westgeest, 2015, p.

583). If neuroscientific evidence significantly affects the decisions made in cases, it is likely that the parties will appeal the verdict. Reasons for appealing first-instance court decisions include objections to extradition, sentences, bail conditions, etc. To understand the effectiveness of neuroscientific evidence in case appeals, it is essential not just to look at whether the appeal favors the appellant, but also whether neuroscientific evidence played a role and to what extent (Catley & Claydon, 2015, p. 521).

DISCUSSION AND CONCLUSION

Neuroscience primarily focuses on the structure and functioning of the nervous system, contributing significantly to our understanding of human behavior in the context of criminal law and procedural law. The first section of this study deals with neuroscience in general, exploring its historical development. Discoveries that emotions like sorrow and joy, cognitive processes, and moral evaluations originate in the brain have been pivotal. Through mirror neurons, we imitate others around us, forming patterns of behavior that lay the foundation of an individual's character. The environment in which a person grows up significantly influences their development. Individuals raised in environments where crime is prevalent learn how to commit crimes and develop behavioral patterns accordingly. However, due to the brain's plasticity, these behavioral patterns can be modified, and new behaviors can be learned. Understanding the learning mechanism is crucial in this aspect. If the requirements for learning a new behavior are known, the rehabilitation of individuals who recommit crimes can be effectively planned. For first-time offenders, community service is vital for their integration into society, as prisons, despite being places of punishment, also serve as environments where new methods of committing crimes can be learned.

The brain does not perceive the external world as it is; rather, sensory signals are interpreted based on past experiences, creating a constructed scene in the mind. When making a decision, if the situation has been encountered before, the related event stored in memory by unconscious mechanisms is used to guide behavior. The reward-punishment mechanism, influenced by dopamine, also plays a role in behavior selection. When the value attributed by dopamine to a behavior changes, this value is updated in the brain. For behavioral change, future actions that bring significant rewards must be endowed with meaning. The impact of punishments on individuals is intended to deter them from committing crimes. If a crime-associated behavior is linked more with rewards than with punishments in the brain, the individual is likely to commit the crime. Therefore, changing the brain-encoded meaning and behavior associated with the crime should be the first step in rehabilitation. Neuroscientific

techniques can identify motivations for criminal behavior in individuals and facilitate their elimination.

The concepts of will, fault, and conditions that reduce or eliminate fault have been evaluated within the framework of neuroscience in criminal law, aiming to understand the reasons behind human behaviors. The approach to the concepts of will and morality is changing with neuroscience. Voluntary behaviors in neuroscience involve the concept of intent and are linked to consciousness. However, since the brain expends a lot of energy when consciousness is active, most decisions encompass unconscious processes. The perceived reality shapes behaviors, hence the interest in whether actions are carried out within the framework of free will. Experiments have been conducted on single motor functions, so the absence of free will cannot be definitively established. However, criminal law emphasizes the will necessary for responsibility. An individual's responsibility for their behavior depends on their ability to make and implement decisions, choose between good and evil, and bear the legal consequences of their choices. Perception involves the conscious recognition of the environment. The uncovering of material truth and the conduct of a fair trial depend on the use of evidence as proof in resolving disputes. As long as it conforms to reason, science, logic, and law, anything can be considered evidence. Although there is no ranking of evidence, in a concrete case, one piece of evidence may be more important than another in resolving discrepancies. Evidence can be indicators, documents, or statements. The suspect or defendant's statement must be based on free will and not be influenced. For a statement to be accepted as evidence, prohibited interrogation methods should not be used. Prohibited interrogation methods, such as mistreatment and drug administration, can be evaluated within the framework of neuroscience. Mistreatment can affect an individual's will, leading to statements made out of fear. Administering drugs to make an individual susceptible to manipulation renders the statement inadmissible as evidence. Drugs affect the communication of the nervous system. Statements made through polygraph tests, where physiological responses are controlled by individuals, are also not valid. Volunteering for a polygraph test to prove innocence is a violation of will. Similarly, entering an fMRI, like beating a lie detector by controlling physiological responses, results in a violation of will. However, P300-MERMER is used to identify individuals related to an event, and if the individual's response matches the EEG fluctuations, hidden information related to the crime cannot be concealed, thus not constituting a violation of will. Witness statements have been evaluated from a neuroscientific perspective. Information from the outside world is not transmitted to the brain in its entirety but in fragments, which are then

integrated and interpreted by the brain, leading to different perceptions of events by individuals. The human brain struggles to recall events accurately and can alter memories when recalling them. For witnesses to an event, the response manifests as a stress reaction. Stress responses during an event can lead to changes in where memories are stored, affecting recollection. Memories recorded in the amygdala, containing emotional intensity, are better remembered. Leading or suggestive questions can also influence an individual's statement during recollection. Neuroscientifically, a new memory can replace an actual one without the individual's awareness, creating fabricated memories. Thus, the reliability of witness statements is affected. To ensure the reliability of witness statements, if possible, statements should be taken immediately after the event. Subsequent statements and their records should be available for review by the individual. If witness statements contain details and are logical, they can be considered as evidence. The reliability of witness statements is further ensured by administering oaths in court. However, taking an oath does not aid in recalling a forgotten event. When an individual swears on their beliefs, being caught lying will result in a penalty for false testimony. For statements from individuals other than suspects and defendants, listening to victimized children is conducted in specialized centers with the support of psychiatrists and psychologists. However, neuropsychiatrists and behavior experts should also be involved in questioning to assess the neurological aspects of children's behaviors and ensure minimal further victimization. Documentary evidence is generally more reliable than witness statements. Images from fMRI, CT, MRI, and PET scans can be considered documents as they capture the brain's structure. However, in this study, neuroscientific evidence is classified as general and natural signs. The operational principles of neuroimaging techniques such as PET, MRI, and fMRI as neuroscientific evidence have been explained. Although fMRI can be used for lie detection, like lie detectors, its reliability is limited because individuals can control their physiological responses. Instead, memory-based brain imaging methods are considered more reliable. The use of neuroscientific data in criminal law will contribute to understanding the causes of criminal behavior. Neuroimaging techniques can identify the brain regions responsible for criminal behavior, allowing for targeted interventions. Neuroimaging data can be brought to criminal proceedings as neuroscientific evidence and used in court. A fair trial requires comprehensive examination of legal issues, necessitating the use of contemporary data in judicial proceedings. The application of neuroimaging techniques in criminal procedural law will facilitate the achievement of the objective of uncovering material truth. This study aims to

provide a new perspective on legal matters by examining the place of neuroscience in criminal and procedural law.

The objective in criminal procedural law is to uncover the material truth. A fair trial necessitates a comprehensive examination of legal issues, which brings the use of contemporary data to the forefront in judicial proceedings. Neuroscientific evidence can be used alongside primary evidence in trials. Will, which is crucial in criminal law, is equally important in criminal procedural law. The statements of suspects and defendants must be based on free will. Conscious and aware individuals must be able to control their actions voluntarily. The use of prohibited interrogation methods would compromise this will. Mistreatment and drug administration are examples of prohibited interrogation methods that can be evaluated within the framework of neuroscience. During interrogations and statement takings, leading or suggestive questions should not be asked, nor should an individual's statement be influenced. Additionally, witnesses should not be asked leading or suggestive questions, as such questions can affect their thoughts and memories, decreasing the reliability of their statements. Subjecting individuals to polygraph tests also affects their will. Individuals connected to polygraph machines can control their physiological responses, making the reliability of such tests low. This part of the study specifically evaluates the reliability of eyewitness memories and statements in criminal proceedings from a neuroscientific perspective and discusses the provisions of the Code of Criminal Procedure regarding witness statements. The listening of victimized children is conducted in specialized centers with the assistance of psychologists, but neuropsychologists and behavioral experts should also pay attention to the children's words and behaviors to help them overcome their experiences with minimal additional harm. Documentary evidence, compared to witness statements, is generally more reliable. Images from fMRI, CT, MRI, and PET scans can also be considered documents because they capture the structure of the brain. In this study, neuroscientific evidence is categorized as general and natural indicia. The study explains how neuroimaging techniques like PET, MRI, and fMRI work as neuroscientific evidence. Although fMRI has been discussed in the context of lie detection in other countries, its reliability is questionable due to the possibility of controlling physiological responses, similar to lie detectors. Instead, memory-based brain imaging methods are favored. The application of neuroscientific data in criminal law and procedural law will aid in understanding the motivations behind criminal behaviors. Neuroimaging techniques can identify the brain regions from which criminal behaviors originate, allowing for targeted preventive measures. Neuroimaging data can be introduced into criminal proceedings as

neuroscientific evidence and utilized in court. Ensuring a fair trial requires addressing all aspects of legal issues, which calls for the integration of current data into judicial proceedings. The use of neuroimaging techniques in criminal procedural law will make achieving the goal of revealing material truth more feasible. The study seeks to offer a fresh perspective on legal cases by examining the role of neuroscience in criminal law and procedural law.

Recommendations

Ensuring a fair trial in criminal procedural law requires a comprehensive approach that integrates contemporary scientific advancements. Neuroscientific evidence, when used alongside traditional legal evidence, can enhance the judicial process by providing deeper insights into human behavior and decision-making. Given the fundamental role of free will in criminal law, statements from suspects and defendants must be obtained voluntarily, free from coercion or prohibited interrogation methods such as mistreatment or drug administration. Any external influence that compromises an individual's ability to make conscious decisions weakens the integrity of their testimony.

Similarly, eyewitness accounts must be approached with caution. Leading or suggestive questioning can distort memories and impact the reliability of statements. Given the limitations of polygraph tests, which individuals can manipulate by controlling physiological responses, reliance on such methods should be critically assessed. The study underscores the importance of evaluating witness testimony through a neuroscientific lens, especially in cases involving vulnerable individuals, such as children. To minimize additional trauma, neuropsychologists and behavioral experts should be involved in their questioning to ensure accuracy and emotional well-being.

In the context of evidentiary reliability, documentary evidence generally holds greater weight than witness statements. Advanced neuroimaging techniques such as fMRI, CT, MRI, and PET scans provide objective data on brain activity and structure, which can be utilized in legal proceedings.

Limitations and strengths

This study provides a comprehensive examination of the intersection between neuroscience and criminal law, offering a novel perspective on legal proceedings. By integrating neuroscientific findings, it contributes to a more profound understanding of human behavior, decision-making, and culpability in the context of criminal justice. The discussion on neuroimaging techniques, such as fMRI, CT, MRI, and PET scans, highlights their potential

role in legal settings, particularly in understanding the neurological basis of criminal actions. Additionally, the study emphasizes the importance of free will in legal procedures, ensuring that interrogations and witness testimonies adhere to ethical and legal standards. By advocating for a multidisciplinary approach, including contributions from neuropsychologists and behavioral experts, the study presents practical recommendations for improving the reliability of evidence and the fairness of trials.

Despite its contributions, the study acknowledges certain limitations. First, while neuroscientific techniques can provide valuable insights, their application in criminal law remains a developing field, with ongoing debates regarding reliability, ethical considerations, and legal admissibility. The accuracy of neuroimaging as evidence, particularly in detecting deception, is still contested due to the ability of individuals to regulate physiological responses. Furthermore, the complexity of human behavior means that neurological findings alone cannot fully explain criminal actions, as environmental, social, and psychological factors also play a crucial role. The study primarily focuses on theoretical discussions and does not incorporate empirical case studies, which could provide a more practical perspective on the application of neuroscience in criminal law. Lastly, while neuroscientific evidence may assist in legal proceedings, its use should not overshadow traditional legal principles and safeguards, ensuring that justice is based on a balanced and holistic evaluation of all available evidence.

REFERENCES

Abrahams, P. (Ed.). (2021). *Beyin nasıl çalışır? Beynin işlevini, zihni ve kişiliği anlamak*. ODTÜ Yayıncılık.

Akal, C. B. (2021). *Özgür irade reddi ve natüralizm açısından hukuki bilimden nörobilime*. In O. Erözden, S. H. Günler, M. E. Palteki, & C. Uysal (Eds.), *Özgür irade? Hukuk, nörobilim, psikoloji ve ötesi* (pp. 21–37). Zoe Kitap.

Akbulut, B. (2020). *Ceza hukuku genel hükümler* (7th ed.). Adalet Yayınevi.

Akmatalieva, G. (2020). Türkiye ve Kırgızistan ceza muhakemesi hukukunda belirti delili [Unpublished doctoral dissertation]. Selçuk Üniversitesi Sosyal Bilimler Enstitüsü.

Alıcı, T. (2021). *Bilinç günlük davranışlarımızın neresinde?* In O. Erözden & Others (Eds.), *Özgür irade? Hukuk, nörobilim, psikoloji ve ötesi* (pp. 61–71). Zoe Kitap.

Alpay, N., Karşıdağ, Ç., & Kükürt, R. (2005). Transkraniyal manyetik stimulasyon. *Düşünen Adam*, *18*(3), 250–265.

Aral, V. (2011). Hukukta irade özgürlüğü. *İstanbul Üniversitesi Hukuk Fakültesi Mecmuası, 48*(1–4), 249–269.

Artuk, M. E., & Alşahin, M. E. (2022). *Kriminoloji* (4th ed.). Adalet Yayınevi.

Artuk, M. E., Gökcen, A., Alşahin, M. E., & Çakır, K. (2022). *Gerekçeli ceza kanunları* (24th ed.). Adalet Yayınevi.

Ayhan, H. (2020). Bellek, görgü tanığı ve görgü tanıklığını etkileyen faktörler. In *VI. Uluslararası TURKCESS Eğitim ve Sosyal Bilimler Kongresi Tam Metin Kitabı* (pp. 334–340). http://2020.turkcess.net/wp-content/uploads/2020/12/turkcess-tam-metin-son-haliiiii.pdf

Badem, S. (2021). Ceza muhakemesi hukukunda tanık. *TAAD*, *12*(45), 100–120.

Balkuv, E. (2020). *Beyniniz hayatınızı nasıl şekillendirir?* (2.Baskı). Müptela Yayıncılık.

Belcher, A., & Sinnott-Armstrong, W. (2010). Neurolaw. *WIREs Cognitive Science*, *1*(1), 120–130.

Boğa, B. (2019). *Ceza muhakemesinde delillerin tartışılması* [Unpublished master's thesis]. Necmettin Erbakan Üniversitesi Sosyal Bilimler Enstitüsü.

Burnett, D. (2017). *Aptal beyin: Bir sinirbilimci beyninizde neler olup bittiğini anlatıyor* (A. Erol, Trans.). Aganta Kitap.

Campbell Moriarty, J., & Langleben, D. D. (2018). Who speaks for neuroscience? Neuroimaging evidence and courtroom expertise. *Case Western Reserve Law Review*, *68*(3), 110–130.

Catley, P., & Claydon, L. (2015). The use of neuroscientific evidence in the courtroom by those accused of criminal offenses in England and Wales. *Journal of Law and the Biosciences*, *2*(3), 123–137.

Centel, N., & Zafer, H. (2022). *Ceza muhakemesi hukuku* (21st ed.). Beta Basım Yayın.

Chan, H.-T., Sun, K.-T., Ku, M.-T., Huang, T.-W., & Chen, M.-C. (2017). Applying EEG in criminal identification research. *2017 International Conference on Applied System Innovation (ICASI)*, Sapporo, Japan.

Chandler, J. A. (2015). The use of neuroscientific evidence in Canadian criminal proceedings. *Journal of Law and the Biosciences*, *3*(2), 90–102.

Conrad, E. C. (1959). Electroencephalograph (EEG) as evidence of criminal responsibility. *Journal of Criminal Law and Criminology*, *50*(4), 300–320.

Corradini, A., & Antonietti, A. (2013). Mirror neurons and their function in cognitively understood empathy. *Consciousness and Cognitions*, *22*(3), 370–385.

Damásio, A. (2006). *Descartes'in yanılgısı: Duygu, akıl ve insan beyni* (B. Atlamaz, Trans.; O. Deniztekin, Ed.). Varlık Yayınları.

Dauvergne, C. (2004). Sovereignty, migration and the rule of law in global times. *The Modern Law Review*, *67*(4), 500–520.

de Kogel, C. H., & Westgeest, E. J. M. C. (2015). Neuroscientific and behavioral genetic information in criminal cases in the Netherlands. *Journal of Law and the Biosciences*, *2*(3), 80–100.

Demirbaş, T. (2022). *Ceza hukuku genel hükümler* (17th ed.). Seçkin Yayıncılık.

Dönmezer, S. (1994). *Kriminoloji* (8th ed.). Beta Basım.

Dönmezer, S., Erman, S., Bayraktar, K., Demirbaş, T., Kiziroğlu, S. K., Nuhoğlu, A., … et al. (2020). *Nazarî ve tatbikî ceza hukuku* (Vol. 3, 14th ed.). Der Yayınları.

Dönmezer, S., Erman, S., Bayraktar, K., Kiziroğlu, S. K., Zafer, H., Sınar, H., … et al. (2016). *Nazarî ve tatbikî ceza hukuku* (Vol. 1, 14th ed.). Der Yayınları.

Dowling, J. E. (2018). *Beyni anlamak: Hücreler, davranış ve biliş* (F. Bolat, Trans.). Ketebe Yayınları.

Eagleman, D. (2015). *Beyin: Senin hikayen* (Z. A. Tozar, Trans.). Domingo Yayınevi.

Eagleman, D. (2021). *Canlı devre* (Z. A. Tozar, Trans.). Domingo Yayınevi.

Eagleman, D. (2022). *İncognito: Beynin gizli hayatı* (Z. A. Tozar, Trans.). Domingo Yayınevi.

Eagleman, D., & Brandt, A. (2022). *Yaratıcı tür: Fikirler dünyayı nasıl yeniden yaratıyor* (Z. A. Tozar, Trans.). Domingo Yayınevi.

Eder-Rieder, M. (2015). Avusturya'da kanunla düzenlemelerin tasarımı için hukuki kurallar. In Y. Üner (Ed.), *Kanun yapma tekniği*. TBB.

Eren, F. (2014). *Olaya ilişkin potansiyellerin saklanmış bilginin tespitinde kullanımı: Kelime, nesne ve yüz tanımanın karşılaştırılması* [Unpublished expertise thesis]. Hacettepe Üniversitesi Tıp Fakültesi Fizyoloji Anabilim Dalı.

Ergenoğlu, T., Uslu, A., & Maraşlıgil, B. (2012). Soyut ve tanıdık görsel hedefler benzer nitelikte P3 potansiyeli oluşturur. *İstanbul Tıp Fakültesi Dergisi*, *75*(4), 275–289.

Ertuğrul, H., Kemaloğlu, A., & Tekiner, H. (2021). Delillerin değerlendirilmesinde genetik ve nörobilim verilerinin kullanılması. *Erciyes Üniversitesi Hukuk Fakültesi Dergisi*, *16*(1), 55–75.

Farwell, L. A. (2012). Brain fingerprinting: A comprehensive tutorial review of detection of concealed information with event-related brain potentials. *Cognitive Neurodynamics*, *6*(2), 115–142.

Gaudet, L. M. (2011). Brain fingerprinting, scientific evidence, and 'Daubert': A cautionary lesson from India. *Jurimetrics*, *51*(3), 205–225.

Gökcen, A., Balcı, M., Alşahin, M. E., & Çakır, K. (2022). *Ceza muhakemesi hukuku* (6th ed.). Adalet Yayınevi.

Gross, C. G. (2007). The discovery of motor cortex and its background. *Journal of the History of the Neurosciences*, *16*(3), 320–340.

Güngör, D. (2016). Ceza muhakemesinde tanık beyanının delil değeri üzerine bazı tespit ve değerlendirmeler. *İnönü Üniversitesi Hukuk Fakültesi Dergisi*, *6*(2), 190–210.

Günşen İçli, T. (2021). *Kriminoloji* (11th ed.). Seçkin Yayıncılık.

Horzum, E. D. (2011). *Avrupa İnsan Hakları Mahkemesi kararları bağlamında yasak sorgu yöntemleri* [Unpublished master's thesis]. İstanbul Üniversitesi Sosyal Bilimler Enstitüsü.

İçer, Z. (2021). *Nörokriminolojik açıdan irade özgürlüğü ve ceza sorumluluğu*. In O. Erözden, S. H. Günler, M. E. Palteki, & C. Uysal (Eds.), *Özgür irade? Hukuk, nörobilim, psikoloji ve ötesi* (pp. 190–206). Zoe Kitap.

Jones, O. D., Bonnie, R. J., Casey, B. J., Davis, A., Faigman, D. L., Hoffman, M., … et al. (2014). Law and neuroscience: Recommendations submitted to the president's bioethics commission. *Journal of Law and the Biosciences*, *1*(2), 224–258.

Kandel, E. R. (2019). *Belleğin peşinde: Yeni bir zihin biliminin doğuşu* (M. Doğan, Trans.). Boğaziçi Üniversitesi Yayınevi.

Karakehya, H. (2022). *Ceza muhakemesi hukuku* (4th ed.). Nisan Kitabevi.

Karasu, A., Aygen, G., Sabancı, P. A., Sağlam, G., Civelek, E., & Eskandar, E. N. (2008). Nörobilim öyküleri: Aristo (M.Ö. 384–322). *Sinir Sistemi Cerrahisi Dergisi*, *1*(4), 311–322.

Kennedy, S., & Houston, R. (Eds.). (2021). *Beyin nasıl çalışır?* (A. F. Yıldırım, Trans.). Alfa Yayınları.

Keysers, C. (2019). *Empatik beyin* (A. Eper, Trans.). Alfa Yayınları.

Koca, M., & Üzülmez, İ. (2017). *Türk ceza hukuku genel hükümler* (10th ed.). Seçkin Yayıncılık.

Koca, M., & Üzülmez, İ. (2022). *Türk ceza hukuku genel hükümler* (15th ed.). Seçkin Yayıncılık.

Köse, M. (2016). *Ceza kovuşturmasında delillerin ortaya konulması ve değerlendirilmesi.* [Unpublished doctoral dissertation]. Eskişehir Anadolu Üniversitesi Sosyal Bilimler Enstitüsü.

Kurdoğlu Ersoy, P. (2018). Görgü tanığı belleği araştırmaları ve yasal uygulamalar: Tarihsel bir bakış. *Yaşam Becerileri Psikoloji Dergisi*, *2*(4), 325–350.

Lafuente, V., Gorriz, J. M., Ramirez, J., & Gonzalez, E. (2017). P300 brainwave extraction from EEG signals: An unsupervised approach. *Expert Systems with Applications*, *74*, 70–80.

LeDoux, J. (2020). *Duygusal beyin: Duyguların gizemli dünyası* (A. Uysal, Trans.). Pegasus Yayınları.

Lee, S. K. (2020). The history of neuroscience 2: From the Roman Empire to the Renaissance. *Epilia: Epilepsy Commun*, *2*(1), 40–50.

Lexpera. (2024). Türk Ceza Kanunu (5237) – Madde gerekçesi. https://www.lexpera.com.tr/

New Scientist Instant Expert. (2019). *Beynimiz nasıl çalışır? Bilinen evrendeki en karmaşık cismin içinde kısa bir yolculuk* (C. E. Topaktaş, Trans.). Say Yayınları.

Onur, F. (2020). İrademiz özgür değil: Metafizik bir problem olarak özgür irade. *Yapay Zekâ ve Zihin Felsefesi Dergisi*, *3*(1), 12–25.

Özen, M. (2022). *Öğreti ve uygulama ışığında ceza muhakemesi hukuku* (5th ed.). Adalet Yayınevi.

Özer, Y. (2013). Değerler felsefesi açısından irade ve bileşenleri (Özgür bir irademiz var mı?). *Karadeniz Sosyal Bilimler Dergisi*, *5*(9), 20–40.

Özgenç, İ. (2022). *Türk ceza hukuku genel hükümler* (18th ed.). Seçkin Yayıncılık.

Öztürk, B. (Ed.). (2021). *Nazari ve uygulamalı ceza muhakemesi hukuku*. Seçkin Yayıncılık.

Öztürk, C. (2005). *Ceza muhakemesi hukukunda iz bilimi* [Unpublished master's thesis]. Akdeniz Üniversitesi Sosyal Bilimler Enstitüsü.

Ramachandran, V. S. (2011). *Öykücü beyin: Bir nöroloğun bizi insan kılanın ne olduğuna dair arayışı* (A. C. Çevik, Trans.). Alfa Bilim Yayınları.

Rose, H., & Rose, S. (2018). *Nörobilim zihnimizi değiştirebilir mi?* (M. Öztürk, Trans.). Ginko Bilim.

Rose, S. (2019). *21. yüzyılda beyin* (L. C. Yılmaz, Trans.). Ginko Bilim.

Sacks, O. (2020). *Karısını şapka sanan adam* (O. Düz, Trans.). Yapı Kredi Yayınları.

Salmanowitz, N. (2015). The case for pain neuroimaging in the courtroom: Lessons from deception detection. *Journal of Law and the Biosciences*, *2*(1), 88–102.

Shen, F. X. (2016). Neuroscientific evidence as instant replay. *Journal of Law and the Biosciences*, *3*(2), 100–125.

Shen, F. X., Twedell, E., Opperman, C., Krieg, J. D. S., Brandt-Fontaine, M., Preston, J., … et al. (2017). The limited effect of electroencephalography memory recognition evidence on assessments of defendant credibility. *Journal of Law and the Biosciences*, *4*(2), 140–165.

Sınıgaglia, C., & Rizzolatti, G. (2019). *Beyindeki aynalar: Zihinlerimiz eylemleri ve duyguları nasıl paylaşır* (D. Keleş, Trans.). Alfa Bilim.

Smith Churchland, P. (2020). *Nörofelsefe* (Ö. Yılmaz, Trans.). Alfa.

Smith, E. E., & Kosslyn, S. M. (2017). Beyin zihinsel faaliyetlere nasıl yol açar – aracılık eder? In M. Şahin (Trans. Ed.), *Bilişsel psikoloji: Zihin ve beyin içinde* (pp. 12–34). Nobel Akademik Yayıncılık.

Sternberg, E. J. (2019). *Nörolojik: Beynin mantıksız davranışlarımızın ardındaki gizli mantığı* (Ş. Taş, Trans.). Metis Yayınları.

Thagard, P. (2010). I feel your pain: Mirror neurons, empathy, and moral motivation. *Journal of Cognitive Neuroscience*, *8*(2), 130–140.

Toroslu, H. (2013). *Ceza hukukunda isnat yeteneği.* [Unpublished doctoral dissertation]. Ankara Üniversitesi Sosyal Bilimler Enstitüsü.

Üngüren, E. (2015). Beynin nöroanatomik ve nörokimyasal yapısının kişilik ve davranış üzerindeki etkisi. *Uluslararası Alanya İşletme Fakültesi Dergisi*, *7*(1), 99–117.

Ünver, Y. (2003). *Ceza hukukuyla korunması amaçlanan hukuksal değer* (1st ed.). Seçkin Yayıncılık.

Ünver, Y., & Hakeri, H. (2022). *Ceza muhakemesi hukuku* (19th ed.). Adalet Yayınevi.

Uzbay, İ. T. (2015). Beyin nasıl bağımlı oluyor? *Türk Eczacıları Birliği Yayını Meslek İçi Sürekli Eğitim Dergisi*, (35–36), 5–18.

Uzbay, İ. T. (2015). Beyni anlamak sadece nörobilim ile mümkün mü? Beyin yüzyılında nörolojik bilimlerden sosyal bilimlere yeni açılımlar, yeni yaklaşımlar. *Üsküdar Üniversitesi Sosyal Bilimler Dergisi*, (1), 35–48.

Van De Ville, D., Farouj, Y., Preti, M. G., Liégeois, R., & Amico, E. (2021). When makes you unique: Temporality of the human brain fingerprint. *Science Advances*, *7*(42), eabc4177.

Yenisey, F., & Nuhoğlu, A. (2021). *Ceza muhakemesi hukuku* (9th ed.). Seçkin Yayıncılık.

Yıldız, M. E. (2021). Ceza hukukunda failin irade özgürlüğü tartışmaları. *Ankara Üniversitesi Hukuk Fakültesi Dergisi*, *70*(4), 1250–1289.

Zeman, A. (2017). *Bilinç kullanım kılavuzu* (G. Koca, Trans.). Metis Bilim.

Zergeroğlu, A., Simge, & Nalçacı, E. (2015). Santiago Ramón y Cajal ve nöron doktrini. *Turkish Journal of Neurology*, *21*(3), 182–190.

KATKI ORANI ***CONTRIBUTION RATE***	**AÇIKLAMA** ***EXPLANATION***	**KATKIDA BULUNANLAR** ***CONTRIBUTORS***
Fikir ve Kavramsal Örgü *Idea or Notion*	Araştırma hipotezini veya fikrini oluşturmak *Form the research hypothesis or idea*	Celal Hakan KAN
Tasarım *Design*	Yöntem ve araştırma desenini tasarlamak *To design the method and research design.*	Celal Hakan KAN
Literatür Tarama *Literature Review*	Çalışma için gerekli literatürü taramak *Review the literature required for the study*	Celal Hakan KAN
Veri Toplama ve İşleme *Data Collecting and Processing*	Verileri toplamak, düzenlemek ve raporlaştırmak *Collecting, organizing and reporting data*	Celal Hakan KAN
Tartışma ve Yorum *Discussion and Commentary*	Elde edilen bulguların değerlendirilmesi *Evaluation of the obtained finding*	Celal Hakan KAN

Destek ve Teşekkür Beyanı/ *Statement of Support and Acknowledgment*

Bu çalışmanın yazım sürecinde katkı ve/veya destek alınmamıştır.

No contribution and/or support was received during the writing process of this study.

Çatışma Beyanı/ *Statement of Conflict*

Araştırmacıların araştırma ile ilgili diğer kişi ve kurumlarla herhangi bir kişisel ve finansal çıkar çatışması yoktur.

Researchers do not have any personal or financial conflicts of interest with other people and institutions related to the research.

Etik Kurul Beyanı/ *Statement of Ethics Committee*

Bu araştırma, hukuk çalışması olup Yargıtay kararları, doktrin ve hukuk kanunları çerçevesinde nitel yöntemle gerçekleştirildiğinden Etik Kurul onayı gerekmemektedir.

Since this research is a legal study based on Supreme Court decisions, legal doctrine, and laws, conducted with a qualitative method, there is no need for an Ethics Committee approval.