Research on the Impact of the Brain-Computer Interface on the "Duty of Care" in Negligent Criminal Law

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Abstract

With the rapid advancements of the artificial intelligence technology field, the Brain-Computer Interface (BCI) technology has gradually expanded its applications into the realm of cognitive enhancement, and this transition itself, which triggers a fundamental challenge to the theory of "the duty of care" in the criminal negligence. The traditional determination of liability for negligence relies on the standard of "rational ordinary people", but the cognitive enhancement function of the BCI technology disrupt this foundational assumption, making the cognitive abilities and cognitive boundaries of some actors far exceed those of ordinary individuals. Consequently, this intensifies the risk of imbalance in the negligence liability determination and necessitates a higher standard for the obligation to evade harmful outcomes of those actors to be raised. Given the significant individual differences caused by the cognitive enhancement effect of the BCI technology, the current legal standards of determination of liability for negligent crimes in the criminal law have systematic deficiencies in addressing cognitive disparities. To deal with this situation, a new liability determination framework which is compatible with the cognitive enhancement function of the BCI technology must be established. This framework should integrate technical reliability assessments and the actual cognitive ability of actors to construct a stepped standard of duty of care. By implementing such a hierarchical mechanism, the boundaries of negligence liability can be refined, avoiding excessive legal scrutiny or omissions stemming from over-reliance technology.

Keywords: Brain-Computer Interface; Cognitive Enhancement; Duty of care; Criminal Negligence

Introduction

The technical specification conflicts caused by the Brain-Computer Interface (BCI) technology have gradually extended from the simple dimension of scientific ethics to the core area of the doctrine of criminal law. By intervening in brain neural signals to enhance the cognitive abilities of actors, this specialized function of the BCI has directly challenges the longstanding duty of care system for negligent crimes, which is predicated on the "rational ordinary people" standard. The crux of this challenge lies in that the BCI technology enhances the cognitive ability of the actor, and directly shakes the two major foundations that make the negligence crime under the Criminal Law established, which are the anticipation possibilities and the outcomes avoidance possibilities. Historically, criminal law assumes a uniform cognitive baseline among individuals. However, the BCI breaks the "cognitive" state where the cognitive abilities of all actors are at the same level, creating a cognitive hierarchy where some actors possess superior perceptual and analytical abilities. So, it poses a substantive challenge to the basic rule of the duty of care in negligent crimes. When development of technology leads to the differentiated distribution of the cognitive abilities of the actors, the traditional standard of duty of care can neither reasonably define the boundary of the anticipate possibilities of the users, nor cope with the requirements of their special outcome avoidance obligations. It highlights the mismatch between the paradigm of criminal law dogmatics and the reality of technological development, and it is urgent to establish a new theoretical framework of duty of care through reconstructing the criminal law dogmatics.

In the era of the BCI-driven cognitive transformation. The legal criteria for determining the duty of care in cases of criminal negligence face unprecedented challenges due to technological advances. Based on the judicial determination predicament of the duty of care caused by the cognitive enhancement effect of the BCI technology, and combined with the case law principles of relevant technologies in the field of artificial intelligence, which is aiming to construct a differentiated duty of care framework suitable for the BCI users, so that the criteria of the duty of care for negligent crimes can keep abreast of the significant changes in the era of cognitive enhancement.

I. Challenges of the BCI Technology to the Duty of Care Theory in Negligent Crimes

(1) The Failure of the Traditional "Rational Ordinary People" Standard

Under traditional criminal law, negligence liability is assessed using the “rational ordinary people” benchmark, which assumes uniform cognitive abilities across individuals, for instance: German criminal law theory emphasizes that the duty of care should be judged based on "social proportionality" assumption, which is, whether the actor constitutes a negligent crime depends on whether he or she can foresee and avoid the occurrence of the harm result. In Japan, the law has proposed the “new negligence theory”, which argues that the duty of foresee consequences should shift toward an obligation to avoid harm outcomes. However, this theory assumes that all actors share the same baseline of physiological cognitive ability. Chinese criminal law has absorbed the doctrines of the criminal laws of both Germany and Japan; Article 15 of the Criminal Law of China stipulates that the core of the duty of care in negligent crimes is the possibility of the actor foresees the occurrence of harm and the possibility of the actor avoiding the occurrence of harmful results. Just like the Germany and Japan, the criminal law of China also requires that the judgment standard for negligent crimes should follow the assumption of "rational ordinary people".

By intervening in cranial nerves, the BCI technology has realized the enhancement of the ability to obtain information of the actors as the main subject in the criminal law, making some individuals cognitive ability significantly beyond other ordinary persons.[3] Especially, users of the BCI can notice some information that is not noticed by ordinary people through this technology, such as information that is temporarily hidden in the mind due to the defect and interference of ordinary people's attention, which will lead to a separation between the subjective predictive ability of the actor and the objective duty of care of the actor. If the assumption of "rational ordinary people" in traditional criminal law theory is still used as the judgment criterion for the duty of care in negligent crimes, which will trigger two extreme consequences: On the one hand, users of the BCI will bear the full obligation of anticipation, just because

[3] Wu Xuyang, "Analysis of the Legal Rights System under the Background of the New Development of Brain-Computer Interfaces", Political and Legal Forum, no. 2 (2025), pp. 121-33.

the cognitive enhancement function of the BCI has improved their cognitive ability, which will overly compressed the application space of "failure to anticipate what was foreseeable" as stipulated in criminal law provisions, even makes those provisions lost their applicable scenarios. On the other hand, users of non-Brain-Computer Interface can even claim that there is an insurmountable gap between their cognitive abilities and those of technology users, and they should be completely exempted from obligation. This binary opposition situation not only challenges the principle of fairness in the application of traditional criminal law theory, but is also likely to vacillate the social application basis of negligent crimes.

(2) Systematic Failure of the Foreseeability Obligation

With the continuous breakthroughs in the BCI technology, in the fields like transportation, it is possible to develop a risk early warning system based on cognitive enhancement function of the BCI technology, in addition to the motion control assistance type. Take the driving scenario as an example, the BCI devices can provide dynamic risk warnings to their users. If an actor fulfills the duty of care to check after receiving the risk warning and then drives a car, resulting in a crushing accident. Based on the current traditional criminal law theory, it is advisable for the actor to claim that he or she has fulfilled the due duty of care. However, in the process of the development of the BCI technology, whether the inspection behavior carried out by the actor based on the early warning of the BCI device is sufficient to eliminate the actor's duty of care needs to be discussed on a case-by-case basis: in a low risk situation, such early warning is unlikely to increase the actor's duty of care, while in medium and high risk situations, it will become the standard to enhance the actor's duty of care.

In the BCI device shows that low risk early warning situation, the actor puts forward the defense has the rationality of criminal law. The low risk warning itself is sufficient to indicate that the probability of the occurrence of such risk is very low. The actor subjectively does not reach the degree of "clearly know" which specific risks are about to occur. Therefore, it cannot be directly presumed that the actor has foreseen the harm result. Based on the reminder of the device and the experience of daily life, the actor's choice to ignore the such early warning was consistent with what is the thinking logic and behavioral patterns of the ordinary people. And also, the actor’s judging that the probability of such risks occurring is minimal conforms to the standard of social correspondence. At this point, the actor's duty of care only needs to

reach the level of the general duty of care of an ordinary person who has not used the BCI. There is no need to demand that the actor fulfill a higher duty of care due to cognitive enhancement function of the BCI.

When the actor, which is the user of the BCI receives the medium risk early warning of the BCI, the user should assume the responsibility of higher than the average person a duty of care, and the criteria for the validity of the defense claimed by them will also change accordingly. A medium risk warning indicates that the possibility of a hazard occurring has reached a level that cannot be ignored. At this time, if the actor as a user of the BCI, merely conducts a formal and simple inspection, such as getting off the vehicle to patrol without taking any practical measures, resulting in an accident, in fact, the actor subjectively underestimates the medium risk warning. It is the negligence with undue assumption to believe that a simple inspection can prevent an accident.

And when the actor received warning with a high risk, The criteria for determining the duty of care of the actor will be more stringent. At this point, the actor claims the accident to its defense space will be considerably narrowed. A high-risk warning means that the actor has the highest duty of care. If the actor chooses to continue driving and causes an accident, there is at least gross negligence subjectively, and they may even further reach the boundary of indirect intent due to their reckless indifference towards the fact that certain legitimate interests have been infringed.

(3) The Intensification of the Outcome Avoidance Obligations

The cognitive enhancement function of the BCI technology does indeed bring about an increase in the obligation of anticipation. However, it also cannot be ignored that the increase in the obligation of anticipation will also lead to its expansion. The BCI technology, through its related functions of data analysis and risk early warning, may transform originally imperceptible risks into foreseeable ones. For example, in the medical field, if a doctor who uses the BCI technology as his or her assistant, the doctor finds that a patient's vital signs are in an abnormal range through such technology and fails to intervene in time, resulting in damage, the doctor should bear corresponding liability for negligence.

Through direct intervention of the cranial nerves, the BCI technology has greatly improved the user's decision-making speed and accuracy, and may even make the optimal decision probability of reaching one hundred percent. However, the cognitive enhancement effect of this technology should not be misunderstood as "absolutely error-free decision-making ability", otherwise it will lead to excessive criticism of the obligation to avoid the results borne by the user. Similarly, with the unceasing development and maturation of the technology, in the future, this kind of technology may demonstrate its reliability and accuracy which are nearly perfect. And based on these two characteristics of this technology, the BCI technology is highly likely to dominate a certain industry without industry compulsion, put it another way, the BCI will shape the whole industry and become the new technical standard of the certain field. At this point, for personnel who are engaged in the related industries have not been equipped with the BCI devices and also without meeting the same standards of the BCI technology users, it is very likely that they will be identified as negligent.

In addition to avoid some of the harm results happened, the most important thing is making the right choice in a reasonable amount of time. Within the "Reasonable Time" range, the BCI technology enables the actor to no longer be in the repetitive dilemma of thinking and acting. However, if the BCI technology provides too many choices, causing the actor to procrastinate decision-makings and resulting in harmful consequences, how the responsibility should be determined? Within the scope of the concept of "Correct Choice", as humans with sound physiological functions, the BCI technology can only be a mechanical auxiliary tool, it cannot play a role in making decisions on behalf of the actor himself or herself.[4] Just as in the Tesla case, although the Apollo self-driving system had some flaws, the court still held the perpetrator accountable for the negligence of relying too much on technology and failing to take over the vehicle in time. Therefore, the actor must independently decide and undertake the obligation to avoid the outcomes based on his or her social experience or professional abilities.[5]

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[4] Chen Bing and Liu Yongji, "Science and Technology Ethics and Legal Response: The Safe Development of Autonomous Driving", Learning and Practice, no. 2 (2025), pp. 45-52, doi:10.19624/j.cnki.cn42-1005/c.2025.02.008.

[5] L'Enfant Plaza Sw, 'Collision Between a Sport Utility Vehicle Operating With Partial Driving Automation and a Crash Attenuator, Mountain View, California, March 23, 2018'.

II. The Judicial Determination dilemma of duty of Care Caused by the Brain-Computer Interface Technology

(1) Obstacles to Fact-Determining Caused by the Black Box Nature of the Technology

The judicial determination predicament of the BCI technology essentially stems from the conflict between technical rationality and legal rationality. When algorithms of the BCI have predicted risks at an extremely fast speed, the criminal law however, requires the actor to recall the subjective cognitive state of the reaction at that time. And all of these just create a sense of disorientation and also simultaneously lead to difficulties in the application of the law, which are as follows: the BCI technology expands the cognitive boundaries of human beings, but at the same time affects the logical basis of liability determination in law. Furthermore, the risk early warning data provided by the BCI technology is neither purely objective data nor purely subjective psychological states, but rather based on a paradigm of "human-computer hybrid cognition" between those two situations. And this cognitive form actually creates a brand-new subject in the criminal law.[6] Further speaking, after the underlying logic of technological development becomes black-boxed and complex,[7] judges will have to be in an awkward situation. Because they cannot understand the process of algorithmic decision-making in the same way as they evaluate human behaviors, but they still have to make judgments on the legal consequences of algorithmic decision-makings. And this leads to deviations in judicial judgments. Either the judges overly rely on the evidence of the BCI technology and directly equate the algorithm's "foresight" with the actor's already foresight.[8] Or they just fall into the complete conservative side, directly deny the impact of technological development on human cognition, and still use the traditional standard of "ordinary rational person". All of these will cause the ambiguity of judicial judgment standards and further result in

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[6] Sheng Haojie, "The Challenges of Brain-Computer Interfaces to Criminal Law and Their Responses", Journal of Southwest University of Political Science and Law, 26.2 (2024), pp. 138-51.

[7] Liu Xianquan, "The Evolution of Criminal Responsibility in the Era of Artificial Intelligence: Yesterday, Today, and Tomorrow", Law, no. 1 (2019), pp. 79-93.

[8] Swati Aggarwal and Nupur Chugh, 'Ethical Implications of Closed Loop Brain Device: 10-Year Review', *Minds and Machines*, 30.1 (2020), pp. 145–70, doi:10.1007/s11023-020-09518-7.

inconsistent judicial judgments.

(2) The absence of legal evaluation criteria resulting from technical unreliability

At present, the BCI technology is still at the early stage of commercialization, and the problem of its unreliability is particularly prominent. On the one hand, there is a lack of unified technical evaluation standards for this kind of technology. Especially at the legal level, technical norms for the key technical standards of cognitive enhancement functions have not yet been established. On the other hand, the development of the BCI technology is highly black-boxed, which has intensified the difficulty of verifying the reliability of the technology. Manufacturers refuse to disclose the underlying logic of the core algorithms on the grounds of trade secrets. Even if it is disclosed, the unexplainable nature of algorithms based on autonomous learning may lead to the technology manufacturers themselves being unable to understand its logic.[9] And this has forced relevant judicial decisions to rely highly on expert opinions, further introducing new subjective risks. Compared with the mature supervision and management system of medical devices, at present, there is a lack of benchmark test norms for cognitive enhancement functions and also doesn't establish the relevant regulatory standards for neural data security. This not only provides space for technology manufacturers to evade legal responsibilities under the pretext of "experimental use", but also may lead to the further arbitrariness of judicial decisions due to the unreliability of the technology.

(3) The vacuum in responsibility allocation caused by the non-attribution of technology

The non-imputability of the BCI technology has led to a systematic collapse of the legal responsibility allocation system, leaving the responsibility allocation in a vacuum state. If the impact of the BCI technology on the duty of care is not regulated separately, the current legal framework will face three risks in responsibility allocation: Firstly, users bear excessive responsibility. Based on the principle of "he who asserts must prove", the BCI users have to bear an excessive burden of proof for their defense that the device has failed to fulfill the corresponding risk avoidance obligations, which has caused considerable difficulties in safeguarding their own

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[9] Liu Xianquan, "The Impact of the Iterative Development of Artificial Intelligence on Criminal Responsibility for Property Crimes", Journal of the National Prosecutors College, 33.2 (2025), pp. 33-44.

rights. Secondly, the technology manufacturers bear disproportionate responsibility. The court may impose excessive responsibility on the technology manufacturers. Due to the difficulty of the burden of proof, the court may avoid the difficulty in making judgments and rigidly attribute the responsibility solely to the "technical defect", which leads to the BCI technology manufacturers bearing excessive responsibility and also hinders the technological innovation and development, just because the technology manufacturers are afraid to take excessive responsibilities. Thirdly, there is a possibility of a complete liability vacuum where neither the users nor the manufacturers bear responsibility. If the users can prove that they have fulfilled their due duty of care, then the liability for harm results should be borne by the technology manufacturers. However, if the technology manufacturers also prove that they have fulfilled their legal obligations, such as making the algorithm transparent and regular reviews, then the technology manufacturers should not bear liability for harm results either. Those will lead the party involved into a predicament where there is no way to obtain legal redresses.

III. Legal Construction of Differentiated Duty of Care under the Challenges of the Brain-Computer Interface Technology

(1) Define the Normative Boundaries Between Technical Defects and User Faults

To adapt to the development characteristics of the BCI technology, the traditional standard for determining the duty of care in negligent crimes in criminal law, "rational ordinary people", should be shifted to a hierarchical and categorized standard for negligent determination, achieving the following things:

Adhere to humanism.[10] Research on the BCI technology should integrate findings from multiple scientific fields to establish minimum safety standards for such devices. This will ensure legal compliance and enable reasonable evaluations within the feasible scope of the technology. Secondly, it is necessary to be able to make a dynamic legal evaluation of the actions carried out by the actor, that is, to define the scope of the actor's duty of care by combining the objective actions specifically carried out by the actor and the subjective cognitive possibilities, avoiding excessive reliance on technical assumptions or ignoring the cognitive limitations of human beings. Finally, it is also necessary to establish the principle of accountability for technology-assisted decision-making to address the predicament where users of the BCI overly rely on technological development which caused them to abandon their subject status legally. This predicament should be attributed to the failure of the actor to fulfill the due duty of care rather than to the technology itself.

Don't have overly high expectations of users of the BCI technology. Due to the technical possibility of cognitive enhancement in the BCI technology, which is, in judicial decisions, it is easy to generate a perception that users of the BCI technology will inevitably reach the "perfect rational" state. Nonetheless, in fact, the BCI should be regarded as a technical auxiliary means rather than a matter-of-course legal basis for accountability reinforcement. The use of this technology by the actor in itself does not automatically enhance his or her duty of care. But in judicial practice, the

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[10] Lu Hui and Wang Zhijia, "Reflecting on the Ethical Dilemma and Solution of 'Brain-Computer Interface' Technology Based on Existentalism", Research in Dialectics of Nature, 39.8 (2023), pp. 69-75, doi:10.19484/j.cnki.1000-8934.2023.08.011.

objective behaviors and subjective purposes of the actor should not be ignored. The judges cannot mechanically presume that the actor "had fully foreseen the possible harm results based on cognitive enhancement of the technology and had the optimal decision-making ability, but did not take corresponding actions", or even merely criticized the actor on the grounds of "imperfect decision-making", thereby inappropriate expanding the scope of determining negligent crimes. As mentioned in the previous driving case, the low-risk warning of the BCI should not be automatically converted into the perpetrator's obligation to foresee; otherwise, it may lead to the abuse of the BCI technology and the risk of the perpetrator's liability limit being overly expanded. Or, due to technological uncertainty, the changes brought about by the BCI technology and the intersection of subjective cognitions and objective behaviors of the actor are completely denied, resulting in criminal law provisions lagging behind the development of real technology. Therefore, criminal law evaluation must strictly distinguish the cognitive enhancement effects of technological tools and the subjective aspects of the actor to prevent the traditional principle of liability attribution from being undermined due to technological intervention.

(2) Introduce the Stepped Application Standards for "Reasonable Users"

The criteria for reconstructing the duty of care in negligent crimes can have more intuitive application measures in terms of technology, that is, classifying and managing the BCI devices and adjusting the degree of commercial investment in the market. Incorporate the factor of cognitive enhancement into the judgment criteria of the duty of care, and establish corresponding risk levels based on the degree of cognitive enhancement of the BCI technology users and the degree of intervention of the BCI technology and the social harmfulness. Differentiate the application of the duty of care. Apply different standards to different BCI users according to different levels and types to avoid the arbitrary and rigid one-size-fits-all phenomenon in judicial practice and achieve the coordinated development of judicial and technological development.

(3) Add Special Liability Provisions for the Application of the Brain-Computer Interface technology

Due to the existence of the BCI, both the human behaviors as the subject of the criminal law and the object behaviors of the auxiliary tools are manifested through the human behaviors as the subject, confusing the boundary between human behaviors

and technological behaviors. The criminal law should add relevant provisions to avoid subverting the basis of criminal law regulation.

Users of the BCI technology bear increased responsibilities. Based on the characteristics of the BCI technology, its users are bound to have stronger cognitive abilities compared to the ordinary people, and therefore they will also bear a higher duty of care. However, if the person who actively uses the BCI technology causes harmful results due to its cognitive enhancement effect, they shall bear increased responsibility. Joint liability for technical defects. manufacturers of the BCI devices who are aware that the devices have defects but still put them into commercial use shall bear corresponding responsibilities. If the user of the equipment has reached the due duty of care and the harmful result occurs only due to the defect of the technical equipment, the users may claim exemption from liability to the corresponding extent and scope. The complete immunity of the user under special circumstances. Since the BCI technology eliminates the closed nature of the human brain,[11] which also means that this kind of technology is at risk of being hijacked by hackers.[12] When similar sudden situations occur and the user is unable to foresee or avoid the occurrence of harmful consequences, the user himself or herself shall be completely exempted from criminal responsibility by reference to force majeure. And for the vacuum of responsibility allocation caused by the non-imputability of the technology, corresponding rules should be established legally.

The top of the priority is to hold enterprises accountable for algorithm traceability, requiring the BCI technology manufacturers to establish traceability methods for the logic and data of their equipment's underlying algorithms and core algorithms, so when accidents happened, it will much easier to do the traceable check. And for the core algorithm, the number of regular checks should be stipulated. Secondly, a risk liability clause should be introduced. That is, if the manufacturer cannot prove that the harm results occurred due to improper operation by the user or external reasons, it

[11]Li Xiaoyong, "Logical Justification and Institutional Conception of the Right to Mental Integrity in the Context of Brain-Computer Interface Technology," Journal of Political Science and Law, no. 3 (2024), pp. 45-57.

[12] Marcello Ienca and Pim Haselager, 'Hacking the Brain: Brain–Computer Interfacing Technology and the Ethics of Neurosecurity', *Ethics and Information Technology*, 18.2 (2016), pp. 117–29, doi:10.1007/s10676-016-9398-9.

should be presumed that there is a causal relationship between the harm results and the actions taken by the technology, and the manufacturer shall be held responsible for this. If the manufacturer has fulfilled the corresponding compliance obligations, its liability can be mitigated, but the manufacturer still should bear the corresponding compensation liability. Finally, a neutral third-party detection mechanism should be introduced to connect with the stepped application standards of "reasonable users", and a corresponding stepwise proof method should be constructed. The BCI users should bear the initial burden of proof, while relevant enterprises should bear the responsibility of providing algorithms and data. For the part of the evidence involving neural data information in the BCI, the burden of proof should be transferred to a neutral third party designated by the court, just to avoid evidence bias and privacy leakage caused by enterprises' independent proof. At the same time, institutions bearing the burden of proof should also be regulated. They cannot use the right of proof granted by law to collect, sell or even tamper with the BCI data of diverse actors. Ensure that the law is not abused as an excuse for crimes.

Conclusion

Through the systematic deconstruction of the changes brought about by the cognitive enhancement effect of the BCI technology on the duty of care in negligent crimes, the dual impact of this technology on the duty of care in negligent crimes is revealed. At the normative level, the development of the BCI technology objectively raises the cognitive boundaries of actors, thereby enhancing the judgment criteria for the possibility of anticipation. At the subject level, if the duty of care of technology users is simply and mechanically expanded, it will fall into the fallacy of attribution of "omniscience presumption", which not only ignores the cognitive limitations of human beings as the subject of the criminal law, but also deviates from the basic position of criminal law humanism. In response to this theoretical predicament, by adopting a framework of hierarchical division of duty of care for the BCI users, in the dimension of foreseeable possibilities, establish a dual judgment criterion that combines the achievable scope of technology with the actual cognitive level of individuals. BCI technology should be regarded as a tool to assist human decision-making, so as to ensure human subjectivity and initiative while acknowledging the enhancement effect that technology brings to human cognition. In terms of the obligation of results avoidance, the objective criterion of "reasonable user" is proposed, by introducing technical norms and industry standards from science, neuro-philosophy and other sciences. Differentiated judgments based on individual cognitive abilities can truly achieve specific analysis of specific cases, reaching the objectivity of judgments and the fairness of liability attribution. Finally, in judicial practice, the judiciary authority should be vigilant against mechanical judgments, and use the rough applications standards just for pursuit the efficiency, avoiding to fall into the trap of the analogy. Only by improving the regulatory framework for emerging technologies can diminish the rigidity risks of criminal law stagnation caused by technological fear and risks of subject virtualization caused by technological radicalism, so that the safeguarding and promoting functions of criminal law norms can still play a part in the development process of emerging technologies. And further, provide corresponding regulatory basis for responding to the criminal law challenges brought by emerging technologies. It also provides a theoretical basis for formulating the legal regulatory framework of the BCI technology in the future.

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