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IN QUEST OF CONSTITUTIONAL PRINCIPLES OF "NEUROLAW"

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SUMMARY

IN QUEST OF CONSTITUTIONAL PRINCIPLES OF "NEUROLAW"

The growing use of brain imaging technology and the developing of cognitive neuroscience pose unaccustomed challenges to legal systems.
Until now, the fields of Law much affected are the civil and criminal law and procedure, but the constitutional dimension of "neurolaw" cannot be easily underestimated.
As the capacity to investigate and to trace brain mechanisms and functional neural activities increases, it becomes urgent the recognition and definition of the unalienable rights and fundamental values in respect of this new techno-scientific power, that must be protected and safeguard at "constitutional level" of norms such as: human dignity, personal identity, authenticity and the pursuit of individual "happiness".
As the same as for the law regulating research and experimentation on human genome adopted in the past years, one may also argue if the above mentioned fundamental principles of "neurolaw" must be fixed and disciplined also at European and International level.

Key words: Cognitive Neuroscience – Functional Magnetic Resounance Imaging and other neurotechnologies – Bioethics – Neurolaw – Human rights – Constitutional principles – International and European protection of fundamental rights

Neurosciences, scientific enterprise and computer-based technology: reaching the latest frontier of human knowledge?

The development of the capabilities of neuroscience to investigate and to comprehend the functioning of one of the most complex "object" of the entire Universe – the human brain – poses to socio-behavioral disciplines, like Law, some new, very difficult, and hard to focus questions.

Furthermore, the foreseeable power to intervene on, and to enhance the neural internal mechanisms – that springs out from the wider information acquired by the same neuro-scientific research and from the artificial simulation of neural networks – profoundly challenge our highest capacities, as legal scholars, to solve a bulk of dilemmas of various types.

In some ways, this "*new frontier*", represented by the neuroscience, may be considered one of the last goals of the same "*scientific enterprise*", typical of the man, to comprehend the world and the man itself, which started not only with the scientific revolution, in modern times, but with the birth of "*techne*", in ancient history.

Looking, for example, at the *Genesis* we may notice that, at the very origin, is precisely when the man and the woman gain the free will and the aptitude to distinguish good from evil, that they "made" their first "*artifact*". It is at the same time that God banished the way to the Tree of Life, within the Garden of Eden: an astonishing allegory of the never satisfied "thirst" of consciousness and of "overcame" the boundaries, which is typical of our deep "human nature". Also in the Greek philosophy – embedded in the roots of our Western though and civilization – a quite similar allegory of the origins of "*techne*" may be found in the myth of Prometheus.

Now, after millennia passed, not only the distant stars, twinkling from the far galaxies, are under our scientific investigation[1]. Not only the smallest part, of what constitutes our physical environment, is under our theoretical and experimental scrutiny[2]. Not only we are going

even deeper in the comprehension of the DNA code, which represents the past and future of all living organisms on the Earth[3]. "Humans" themselves, indeed, are nowadays directly under the scientists' eye, and in what is their typical, and essential, "human condition": their mental constructs, moral beliefs, intentions, wills, sensations, preferences, self-knowledge, consciousness, remembrances.

Furthermore, it is not trivial to notice that our capacity to inquiry and to modify the physical world, on one side, and the human body, on the other – not excluded, nowadays, the human brain –, is even more dependent from *technical power*, as Friedrich Nietzsche first, and Martin Heidegger after, have focused in the XX century, among others philosophers.

The neuro-scientific development of knowledge's enterprise started over one century ago, with the experiments conducted by pioneers Nobel Prizes Camillo Golgi and Santiago Ramón y Cajal, but is at least a couple of decades ago, that a new giant step was gained. The astounding and fast development of recent brain's exploration is largely dependent by the advent of new "*brain-imaging*" technical instruments, such as CT scans, MEG, MRI, *f* MRI, NIRS, ERPs, not to forget the "older" EEG.

Some of these new diagnostic powerful tools were realized thanks to the advancement of the computers' technology. Therefore – quite "*curiously*" and "*significantly*", indeed – our profound representation of the human "*internal hot biological computer*", so-to-speak, or at least of its "*hardware*" (the "*brain*"), is largely dependent by that "*technical cold artificial machine*" (the *computer*) created by the human higher intellectual capacity.

Under this point of view, it is quite well known the open and wide debate on which kind of representation of phenomena is the one given by the computer powered "brain-imaging".

For example, can the "*picture*" depicted by a *f* MRI be considered effectively a "*real*" and "*true*" photography of our functional neural

activities, rather than a simply record of how some of our brain cells are working much more than others and consuming an higher amount of glucose?

One may argue that, for all its power, brain-imaging remains in early stages, and that some of the very attractive false-color images of a brain may be presented to the public without proper information, so to orient, in some way, the general opinion, or – in the courtroom – the convincement of the jurors.

A powerful "*picture*", with all its visual "impact", may be interpreted – and also, *over-interpreted*, even purely emotionally – in a very different manner, from a long, and may be "boring", text of psychological prose.

Therefore, the real concern is whether, or not, the *f* MRI can be considered as a trustable "detector" of individual psyche, and the extent to which it can reveal some useful information about our behavior, over a range of complex human circumstances. Although functional neuro-imaging is not fully ready for routine courtroom use, serious reflections and even imaginative speculations on what new brain imaging technologies can, and cannot, tell us, and of what legal use they may be in the future, seem to be essential to prepare ourselves properly for a future fulfilled with "colorful" and "compelling" images of the human brain. Indeed, the power of "images" is sometimes strong enough to shape our instinctive perception of reality, as Paul Michel Foucault has correctly said.

Anyway, moving toward a more general perspective, the "bio-machineries" applied to neuroscience may be grouped into some of the following different categories: computer supplied apparatuses that are able to "monitor"/to "scan" the human brain, while the man is still normally living, and without any sort of chirurgical operation, nor of exposure to X-rays or other dangerous chemical components; micro-tools, with the use of which a physician is able to "surgically intervene", on the brain of a patient; nanotechnologies, or today bio-

chemical "drugs" or "stimulators" (like the TMS) that may "alter" – enhance or depress – some neural functions and consequently change the individual personal responses to outside stimuli or capacity to form and recall remembrances, in a persistent or permanent way.

Possible areas of intersections and interactions between cognitive neurosciences and law.

It is not a new acquisition of the neurosciences that a modification in brain's circuits – particularly in the brain cortex and in the cortical prefrontal areas, in the limbic system and in the amygdale – may determine a dramatic mutation in individual behavior. One may remember the famous case of Phineas Gage in 1848 to say that, when brain is physically changed (because of a trauma, or of a tumor, or of other degenerative diseases) the person is mentally changed. When one experiences damages to parts of one's brain, personality can change so rapidly and so completely, that may be no meaningful vestige of the "*original*" person.

Now, neurosciences have made tremendous scientific efforts to make inroads into understanding which specific areas seem to be responsible for moral sense and civic proper behavior and for correct decision-making and planning of future actions; what other particular brain's parts appear to be involved for remembrances; and what other precise neural circuits are correlated with some psychological disturbances or mental illnesses.

At the same time, the researchers have discovered that a huge part of our neuronal activity across the different brain's areas is driven forward almost without (or below the threshold of) full consciousness. At the end of the Seventies, Benjamin Libet had demonstrated that a simple decision (like to move a finger) can be predicted almost half a second of time before the subject experiences the conscious sensation to decide. All those discoveries from neuroscience have boosted new questions, in past afforded by philosophers and psychologists, or in the realm of

religion, such as the relationship between "brain" and "mind", and between scientific physical and biological "determinism" and moral and legal "free will".

Is the human brain a highly parallel and distributed system with millions of decisions being made simultaneously, essentially and structurally dependent by the biochemical various reactions at the neurons' level? Or, otherwise, may we still continue to view the man as a "*person*", a self-motivated, morally coherent and responsible, conscious and decision-making, "agent"?

In face of the foreseeable neuroscience discoveries, what shall be the future evolution of the concepts of "responsibility", "punishment" and of "agency", on which the ethical and legal systems are usually constructed? Will the deeper "scientific" understanding of the "brain" as a mechanism, made to be possible by neuroscience, allow a sort of mitigation, or exculpation of some unmoral and unlawful behavior? Will it be heard, in the future, in a courtroom, this suggestive, but worrying, sentence pronounced by an attorney, looking to the colored results of a "brain-scan": "*it was not his fault, Your Honor, but his brain's*"?

Neuroscience, indeed cannot directly answer any ethical or legal questions, but the new questions posed by the brain-imaging, and the new discoveries and capabilities to enhance human aptitudes, made to be possible by neuroscientific enterprise, simply may not be put under silence.

After the blooming of "neuroethics" and "neuroeconomics", indeed, the contact points between neuroscience and the Law are undoubtedly increasing, and a new interdisciplinary field seems to flourish: the "neurolaw".

However, the Law needs neurosciences to evolve and neurosciences need Law. Not least because the Law has been practicing some sort of "*in vivo* experiments" on real human beings for millennia, while neurosciences are quite young as a discipline, but also because much of the wisdom and the self-portraits that have been crystallized into legal

structures can be drawn upon as a powerful guidebook on how people actually behave.

Looking briefly to some legal scholarship's thoughts, the specific arenas in which neuroscience may interact with the legal phenomenon seem to be various.

The refining of the legal concept and definition of "brain death", by using the new techniques of brain-imaging to look deeply for active cognitive signature in people who do not have communicative abilities, opening the question of a revision of the criteria normally used in order to ascertain the "brain death", on one side, and pushing towards some new and different parameters in order to define the "legal death", on the other side.

A better cognition of legal competency in civil law: developments in the neuroscience over the past decade have multiplied the dimensions that are relevant to the assessment of competency of an individual to be held responsible for the contract he/she has signed, or to be responsible for civil damages he/she has caused, or for a will he/she has written down. A better understanding of how the associative areas of the brain cortex, the hippocampus and the system of memory work may therefore increase the potentialities to fulfill the standards fixed for legal capacity.

Anyway, one of the most important areas of intersection between Law and neuroscience is criminal procedure law, criminal law and penal policies.

In the specific area of "criminal procedure law", one may ask under what conditions, and in which circumstances, a judge can admit a *f* MRI, or brain scans, as a mean of proof in a trial. How the so-called *Daubert standard*[4] shall be applied to neural fingerprints? Are they probative or prejudicial? What are the risks of an over-acceptation of "deterministic" results, furnished by the "brain-imaging" technologies? How the judge, trained in law, may decide whether to admit a scientific evidence like that? How the scientific community will

help the judge in his/her role as a "gatekeeper" to a "good" scientific expertise?

A profile of intersection between neurosciences and criminal law is the legal concept of "mens rea" – intended as the malicious will to commit the crime and to foreseen the criminal event and its consequences – and the boundaries between the "mens rea" and the "culpable behavior" – intended as an imprudent behavior, or a conduct not following or not matching rules and regulations.

If an individual knows to have a genetic predisposition, or an actual disease in his/her neural correlates of consciousness, and notwithstanding this knowledge, refuses, or fails, to go to the doctor, to do some brain-scans, or to follow pharmacological treatments, will be the same individual responsible for his/her unlawful conduct, produced by his/her cognitive functional deficit?

If it is demonstrated, by brain-imaging and neuroscience knowledge, that a malformation or a disease had determined a critical alteration of some neural circuits in the brain's areas responsible for the capacity to evaluate moral behavior, and if the individual does commit a crime related, in a certain way, to that kind of alteration, was the conduct of the same individual malicious? Alternatively, was the same conduct culpable? Alternatively, was the conduct simply under the standard of competency to be held responsible for criminal actions?

In the realm of penal policies, one may argue that a better understanding of congenital or acquired diseases in some areas of brain may push the individual towards an unmoral behavior and, at least, to commit crimes. On that basis, may, and how, we predict that a citizen will commit a certain type of unlawful action? Are we in favor of a society in which a "crime" may be not only prevented but also punished, by the judiciary system, even "*before*" it was committed, on the basis of some scientific evidences that show a precise criminal attitude[5]? What kind of overall system will emerge? Will flourish a more compassionate and human regime, or the risks are to give birth

to a future "machinery" (especially in death penalty matters) more Draconian that the one actually in force?

In any case, just today neurosciences may also give us some tips and tools in order to determine if a citizen was conscious at the time he/she committed the crime, opening a different path of questions: should that person be held exculpable for a criminal act? If some circuits – the ones responsible for moral behavior and sense of law respectfulness – are impaired, should the person be excused under the insanity doctrines as incapable of knowing right from wrong? A lot of other questions arise: what shall be the proper rehabilitation procedure for a convicted, who suffers from a "*brain/mental*" disorder that prevents him to forming an empathetic response and understanding? Shall we put him/her in a prison, or is it better to house him/her in a different kind of facility?

It is quite accepted that the U.S. Supreme Court[6], even without a direct citation to the *amicus curiae*'s briefs, has considered also neurosciences's acquisitions in order to declare that the death penalty for minors is an unusual and cruel punishment, and therefore, that is unconstitutional under the VIII Amendment of U.S. Constitution, because of the structural brain's general condition of minors – in particular, their frontal lobes.

Furthermore, the overall legal decision-making – particularly in the U.S. system, where there are juries and precedents – may be relevantly affected by the new role played in the courtroom by neuroscience. Indeed, the neurosciences are pushing for a reconsideration of some very important legal decision-making mechanisms, currently operating in courtrooms. For example, neuroscience will not only share light on the criminal's brain, but also on the jurors' (and judge's) one. How the various internal brain structures (maybe responsible for bias aptitude) of the jurors interact during the "third party punishment" procedure that is practiced everyday in American, as well as in Italian, courts of justice? Will we have to select the jurors by using

their brains' tests or brains' images in order to try to find the perfect "rational" and "equalitarian" people to compose the jury?
Under the point of view of philosophy of law, because the "Law" is undoubtedly a typical product only of "men", as social animals – a Latin aphorism recites: "*ubi societas, ibi ius*" – what will be the consequence of the future discover of neural correlates of the "legal" internal "commonsense", on the image and the comprehension of the legal phenomenon itself, and on its practical use to govern the relationships between various human beings? Will this acquisition reshape our conception of what the Law "is" or "should be"? Will the neuroscience help us to increase our understanding of the functions and the scopes of Law and of its basis, and will help us to modify the institutional mechanisms by which the Law is "produced", in today complex and intertwined social structures?
In sum, two different positions may be traced. On one side, even if the neuroscience will prove a fully "brain-base causation" in almost all our various behaviors, people will continue to feel to be free individuals and the overall social systems may do not assume a different "aptitude" in response to the violation of law committed by their components. In this perspective, neuroscience will not in future overthrow the fundamental pillars of our legal systems, for example amplifying the areas of exculpation. The criteria of moral and legal responsibility were shaped by law, in general principles, and by judges in the concrete case in a purely legal perspective, and shall be maintained uniquely in the realm of legal scholarship, of courts and legislators, who may find only some "collateral help" from neuroscience. Indeed, legal responsibility is a legal construct, and does exist only within the legal framework. Therefore, neuroscience acquisitions will be no more useful than traditional psychology, for to establish the presence or absence of a "self-conscious act", a "mental state" or a "genuine affirmative defense", such as the lack or diminish of capacity[7], or the presence or absence of a "mens rea". If the rational faculties of a subject will not

result absent or seriously damaged, the individual will be simply held criminally responsible for his/her act, despite all the powerful and suggestive images depicted by a *f* MRI, a CT or a VBM.
But, on the other side, neuroscience will pose courts and legislators in face of the necessity to consider at least criminal behavior under a different light, in respect to past acquisitions. Will the rules' fully respect, pretended by the society to the individual, make some change, insofar neuroscience will have demonstrated – with a plenty of "scientific" trustable expertise – that "free will" is largely dependent on external circumstances and internal biological events in a purely deterministic view?

Looking for the "constitutional", fundamental "principles" of "neurolaw"

What was presented above, may be considered a sort of very brief summing up of the most frequents questions that "neurolaw", as a very young field of interdisciplinary research, poses to scholars, courts and legislators.
The relevance of the interactions between neuroscience and law in the arenas of civil and criminal law, criminal policy, civil and criminal procedure, philosophy of law shall by no means be underestimated. Indeed, it is foreseeable that further developments of "neurolaw" will be noticed precisely in those areas.
However, also the constitutional perspective of "neurolaw" must be taken into full account.
Indeed, the fundamental values and the general principles that rule the entire system must be grounded at the constitutional level. It is at the same level, therefore, that we have to find what constitutes the structural legal basis of all the various sectors of "neurolaw". A framework, which must govern the various actions of courts and legislators in civil and criminal matters and must drive the overall evolution of the interaction between law and neuroscience, in the next years.

The role played by constitutional law in the quest of the fundamental principles of "neurolaw" seems to be largely underestimated, in present times, at least within Italian panorama. Therefore, an overall reflection over some constitutional profiles of the new capabilities, boosted up by neuro-technologies – like the "brain-imaging", using *f* MRI, or like the "brain-enhancing", using chemical pills or technical artifacts –, must be cultivated with caution. Consequently, in the following parts, I will address just a couple of considerations, posing some related issues, looking in particular to "constitutional" pieces of law. I hereby anticipate that I have no comprehensive answers to offer, just problematic questions to ask.

Firstly, in my opinion, under a constitutional perspective, the nowadays evolution of "neurolaw" may be shaped by using the figure of a "matrix", or a "grid", or a "graph". Indeed, we have to consider some relevant and different "dimensions", or "faces" of a conceptual quite complex "prism".

One dimension is represented by the "scope" of neuroscientific techniques used. To be more precise: is this "scope" to cure someone (to restore someone's health), or not? Is the purpose of the use of neuroimaging the diagnosis and the subsequent intervention on a "illness", or it is another one? For example, is the purpose to ascertain the criminal responsibility within a trial, or to protect the general welfare from terrorists' attack, or from other malicious actions practiced by citizens, or by aliens?

Another dimension is correlated to the "nature" of neuroscientific techniques used on the individual. To be more precise: is the "neuro-instrument" applied a sort of "scanner" of the brain functions, or is a tool for the "enhancement" of the various neural capabilities?

Interwoven with the other two above, a third dimension is constituted by the specific "relationship" between the state and the individual that is underlying the "scopes" and the "nature" of neuroscientific techniques applied. To be more precise: are those techniques used

by the individual, for its own purposes, or are they used by the state, for general interests (evenly "against" the same individual's will)?
It is my aim to show that several fundamental rights, and various constitutional principles are deeply involved in each of the specific "face" of that articulated "prism" I am putting under light.
If the "*scope*" of the resort to the neuroscientific power is to practice a medical treatment to an individual for his own health, and the "nature" of the instrument applied is a "scanner" of the brain, in order to find anomalies or illnesses, the constitutional principle that seems to be applied is the so called "informed consent", as it was set by Justice Cardozo, at the beginning of XX century, in the case *Schloendorff*[8] and after refined by the Salgo decision[9]. More recently, the same principle was affirmed by the U.S. Supreme Court in the case of *Cruzan*[10], a decision pronounced in the realm of "end-of-life decision-making" and in face of states affected by dramatic brain damages, such as the persistent vegetative state.
The principle of "informed consent" derives its source directly from the constitutional right of bodily integrity and autonomy, a species of the more general right of individual liberty, and, moreover, of privacy which is paramount in the U.S. constitutional fabric and in particular in the Fifth and Fourteenth Amendments of U.S. Constitution.
Looking at the fundamental legal framework of the European Union, art. 3 of the *EU Charter of Fundamental Rights*[11] rules that "*Everyone has the right to respect for his or her physical and mental integrity*", and that, in the fields of medicine and biology, must be respected, in particular, "*the free informed consent of the person concerned, according to procedures laid down by law*". Art. 5 of the Convention for the protection of Human Rights and dignity of the human being with regard to the application of biology and medicine (*Convention on Human Rights and Biomedicine*, Oviedo, 1997) states that an intervention in the health field may only be carried out after the person concerned has given free and informed consent to it. This person shall

beforehand be given appropriate information as to the purpose and nature of the intervention as well as on its consequences and risks. The person concerned may freely withdraw consent at any time. Art. 8 of the European Convention of Human Rights protects the liberty of fundamental choices regarding own health, within the framework of the right of privacy[12]. Art. 32 and art. 13 of Italian Constitution recognize the fundamental right of accept or refuse medical treatments, that are not binding by an act of law. According to the Constitution, the law may not, under any circumstances, violate the limits imposed by respect for the human person. Recently, the Italian Constitutional Court affirmed that the principle of informed consent is of constitutional fundamental nature, and it is bulked strictly within the rights of personal liberty and human dignity[13]. The same principles is also affirmed in the art. 7 of the International Covenant on Civil and Political Rigts (U.N., 1966)

The same principle of "informed consent", in combination with the "precautionary principle", shall be applied when neuroscientific power is used for medical research purposes to "scan" the brain in order to acquire new "maps" of the neural structures and activities for the general cure of illnesses.

Art. 15 and 16 of Oviedo Convention foresee that a scientific research on a person may only be undertaken if all the following conditions are met: there is no alternative of comparable effectiveness to research on humans; the risks which may be incurred by that person are not disproportionate to the potential benefits of the research; the research project has been approved by the competent body after independent examination of its scientific merit, including assessment of the importance of the aim of the research, and multidisciplinary review of its ethical acceptability; the persons undergoing research have been informed of their rights and the safeguards prescribed by law for their protection; the necessary consent has been given expressly, specifically and is documented.

It must be respected also the right of personal data protection, considering the data related to health as "sensible", recognized not only in pieces of EU legislation (see generally, Directive n. 95/46/CE), but by the art. 8 of the EU Charter of Fundamental Rights, and the art. 10 of the Oviedo Convention. Indeed, everyone has the right to respect for private life in relation to information about his or her health, and is entitled to know any information collected about his or her health. However, the wishes of individuals not to be so informed shall be observed. Only in exceptional cases, restrictions may be placed by law on the exercise of the rights in the interests of the patient.

If the "scope" of the resort to the neuroscientific power is to practice a medical treatment to an individual for others' health and welfare, and the "nature" of the instrument applied is a "scanner", the right to be applied seems to be the fundamental due process right (see Fifth and Fourteenth Amendment of U.S. Constitution)[14]. The state must demonstrate to have a compelling interest enough to overcome the fundamental right of bodily integrity and personal autonomy, and that it is using reasonable and the least restrictive means to accomplish its goal. This general principle must be applied properly and adequately, in respect of the specific state interest at stake. For example, the legal outcome will be different if the general state interest involved is the protection of other individual's health or bodily integrity or life, or if it is the ascertain of the criminal responsibility in a trial.

The same fundamental right of due process seems to be applied even if the "scope" of the resort to the neuroscientific power is to protect some state interests, and the "nature" of the instrument applied is an enhancer of the brain's mechanisms, but the overall questions posed to the system of fundamental rights become much more important, and a lot of dilemmas arise. May the state possess the power to administer drugs, or to impose interventions on a human brain, that have the consequence of a permanent or temporary modification of brain's cells?

It is important to notice that, under the constitutional framework, each modification of the "mind" response may be generated by a sort of "intrusion" into the realm of bodily integrity and liberty, both if the enhancing agent is a "drug", that must be inoculated into blood vessels, both if the enhancing agent is a sort of technical "instrument" implanted into tissues, like a stimulator.

It is also worth of consideration that the "intervention", which I am hereby referring to, is particularly the "direct manipulation" on the neural architectures, made possible by the new acquisitions of the neuroscientific "techno-power", and is not simply the "indirect" transformation on the same neural structures, that, for example, may be the outcome of the overall parents' or teachers' educative process on pupils (which, of course, creates new neurological connections and may also improve brain's abilities of children), or the goal of the even "persuasive" influence of advertisements (which may exercise an undoubted "influence" on individual behavior, but which not constitutes a proper "intervention" on the same "brain" of the person affected, who remains free to elaborate his/her mental states).

The evolution of neuro-techniques seems to affect both mental and bodily integrity equally, urging us to extend the traditional, historical, concept of "personal liberty", as purely liberty of the "corpus", to the new provinces of the protection of the "integrity" of the "mind", affected by an intrusion on the "brain".

Insofar as the enhancement of mental capabilities (by an alteration of the brain's natural functioning) affects not only the individual physical integrity, but also the mental and "moral" liberty, different fundamental constitutional rights seem to become relevant, other than the right of self-determination.

Art. 3 of European Charter of Fundamental Rights protects also the "mental" integrity of the individual, and not only the "body" integrity. Art. 10 of the same Charter recognizes and guarantees to everyone the right to "freedom of thought". Art. 21 of Italian Constitution protects

the so called "freedom of expression": anyone has the right to freely express his thoughts in speech, writing, or any other form of communication. In 1948, seems to be to our Constituent Fathers a sort of mistake or an imprecision to refer to a right of "free thought". Indeed, they believed that thoughts are purely internal mind states, that cannot be affected by any physical constriction exercised by public powers. But, nowadays, we can say that, in order to freely express a thought, I must freely form it, particularly when the alteration of my mind is the result of a "physical" intervention on the neural correlates of my consciousness and capability to think. Our Italian Constitution protects also the development of the personality of the individual as a fundamental value of our Italian Republic (art. 2). The State must guarantee the right of person to have "his/her" own personality not altered ("moral liberty"). The same interpretation seems to have been conducted on the U.S. First Amendment to the Constitution. Once, the U.S. Supreme Court has said that:

> *Where, as here, medication which is potentially mind altering is concerned, the threat to individual rights goes beyond a threat of physical intrusion and threatens an intrusion into the mind*[15].

The Fathers of the U.S. Constitution recognized the profound significance of man's "*spiritual nature, of his feelings and of his intellect*". They

> *sought to protect Americans in their beliefs, their thoughts, their emotions and their sensations. They conferred, as against the government, the right to be let alone – the most comprehensive of rights and the right most valued by civilized men*[16].

While the "First Amendment literally forbids the abridgment only of speech", the Court has "*long recognized that its protection does not end at the spoken or written word*"[17]. Freedom of thought, while not expressly guaranteed by the First Amendment of the U.S. Constitution, is one of those fundamental rights necessary to make the express guar-

antees meaningful. As Justice Benjamin Cardozo once extolled, the freedom of thought "*is the matrix, the indispensable condition, of nearly every other form of freedom. With rare aberrations a pervasive recognition of that truth can be traced in our history, political and legal*"[18]. The power of the state cannot constitutionally premise legislation on desirability of controlling a person's private thoughts[19].

May this fundamental right be set aside by some compelling state interests, in order to protect the mentally ill person and the others? In the U.S. common law, force administration of antipsychotic medication is a significant intrusion on a committed patient's bodily integrity, and, accordingly, a patient has a qualified right to refuse medical treatment[20]. The government may involuntarily administer anti-psychotic drugs to a mentally ill defendant, if the inmate is dangerous to himself or others and the treatment is in the inmate's medical interest[21].

May the same fundamental right be set aside by other kind of compelling state interests, different from the protection of the mentally ill patient and from the protection of other's welfare, for example in the administration of justice? May one be altered in his/her mind's states in order to enhance it's capability to remember a criminal episode committed by him/her or to which he/she was a testimony? Or, may the individual's mind be altered by substances affecting the brain's cells in order to maintain the legal capacity to stand in a trial? The U.S. Supreme Court has said that Fifth Amendment Due Process Clause permits the Government involuntarily to administer antipsychotic drugs to a mentally ill defendant facing serious criminal charges in order to render that defendant competent to stand trial, but only if the treatment is medically appropriate, is substantially unlikely to have side effects that may undermine the fairness of the trial, and, taking account of less intrusive alternatives, is necessary significantly to further important governmental trial-related interests[22].

Indeed, also the constitutional right to self-defence and the right to have a fair trail become relevant.

In Italy, art. 188 of Criminal Procedure Code forbid, in any way, notwithstanding the informed and peaceful consent of the person affected, the use of methods and techniques capable to influence or to alter the liberty of auto-determination of the individual, or the capacity of the same person to remember and to value facts.

Finally, if the "nature" of the neuroscientific intervention is to "enhance" some parts of the individual brain, and the "scope" of that intervention is uniquely for "private purposes" of the individual itself, without any direct state's interest involved, what should be the constitutional principle to be applied?

May we say that the principle of informed consent (with or without the principle of precaution) shall be the only one to govern that overall matter? That the respect of personal autonomy in so profound decisions is paramount? Alternative, may we say that the state retains some power to restrict the right of the individual to dispose for his/her own brain enhancement, or to alter his/her own personality (for example, by erasing his/her memory in order to throw away negative, or sad remembrances)? Putting the same question in another way, may we recognize a fundamental right of wide disposal of brain/mind for each own modification purposes, as the same as of disposal of other organs of the body?

I suggest that an interesting limit to personal autonomy may be founded in this area: it is the personal identity itself. It is what I call, improperly, the "theory" (or the "problem") of the "alien", that may be shown as following.

Let us suppose that (in a who knows how far future) an intervention on the brain of a patient may be done "routinely", due to some dramatic new acquisition in neuroscience and some new powerful neuro-instruments; let us suppose, also, that it will be possible to modify single "pieces" of an individual's brain, in order to permanently modify the same individual's mind in some specific characteristic.

Will the "person" that comes out after that kind of medical intervention be "really" the "same person" who did decide for the intervention,

prior the intervention itself? Or, otherwise, will this kind of "person" be so radically and completely different, that he/she may be considered as a "new" individual: a sort of "alien"?
Will that individual be still related, in his/her fundamental rights, to the "previous" individual, or he/she will be an individual that, due to his/her different identity, cannot be dependant in any way from the decision adopted by a different individual in the past? What about the legal protection against "discrimination" of that enhanced individual?
Art. 13 of Oviedo Convention prescribes that an intervention seeking to modify the human genome may only be undertaken for preventive, diagnostic or therapeutic purposes and only if its aim is not to introduce any modification in the genome of any descendants. This provision expresses a general, fundamental principle: that no-one may decide, directly, to modify the genome of future people, different from himself, using biotechnologies.
May we apply the same principle to the "alien", who will "birth" after the transformation of one's personality by the manipulation of neurons? Shall we forbid an intervention on each owns brain that results in the "creation" of a "different" subject?
We may also consider another aspect of the same problem, related to the previous, even if it seems to be slightly different. During our life, each of us develops a lot of "relationships" with other persons. Under this point of view, the same personal identity must be considered as a "relational" concept. Indeed, the identity of the individual is deeply and significantly constructed also by the contributions given by other individuals.
Cognitive psychologists pretend that parts of our "mind" are stored not only in our "brain", on which we may directly "dispose", but also in the several "existential relations", we set up with others (it is the so called theory of the "extended mind"), that are parts also of others' cognitive and existential spheres.
Therefore, may other subjects (e.g. parents, spouses, relatives…), be entitled of a sort of legal interest or right to consent, or to assent, to

neurological transformation, when the enhancement radically transforms the behavior, or the identity of the person, with whom the same subjects are interrelated by binding relationships, recognized by Law? Are we comfortable to sustain that the principle of individual autonomy and of respect of a deeply "personal choice" is absolutely sovereign in this field (even if the consequences of the choice at stake are a profound alteration of individual behavior)? Do we agree that the interest of somebody else, with whom the person is usually and profoundly interacting during day-by-day life, must not gain any consideration at all? On the contrary, what may be the "balance" between the paramount principle of personal autonomy and the eventually relevant interests of other persons affected by the decision of the individual who accept to go through a neural enhancement?

Those seems to be open questions, we may not simply disregard.

Moreover, we may also consider the wide field of dilemmas posed by the respect of the principle of "equality" in face of cognitive enhancement's applications. Under which conditions may the state protect the "parity" principle between its citizens in competing for the development of their personality?

In agonistic sports, the assumption of drugs (doping) in order to increase physical abilities is an illicit behavior, both because of the protection of the sanity of the same athlete, both because of the respect of the principle of fairness between the various participants to the same competition. Are we in favour to apply the same legal scheme to the assumption of drugs in order to increase mental capacities and to alter the competition among workers in the labour market, or students in scholar environment?

Let us suppose that a cognitive enhancement will improve the Q.I. of an individual, or his/her attitude to find a better job, or his/her intellectual capacities (for example, to discover a new powerful treatment against cancer…) and, consequently, will increase the general welfare of the community which belongs. Which can be the interest of

a society about this kind of intervention, and its consequently decision, adopted by the means of its democratic process and outcomes? Like the previous ones fixed just above, these questions open a wide spectrum of problems not easy to solve.

Conclusions

The U.S. Supreme Court has stated that everyone has the fundamental liberty right to define the personal "*concept of existence, of meaning, of the universe, and of the mystery of human life*", without technological interferences superimposed by the state or the society[23].

Furthermore, in the Oviedo Convention and in the EU Charter of Fundamental Rights, the values of human dignity and of personal identity are paramount and must ever prevail over the general interest of state, or of society, or of science.

I suggest that there is an interesting sort of "convergence" (so-to-speak) between the two major legal systems on the opposite shores of the Atlantic Ocean, and that this "convergence" is on a bulk of "fundamental" principles belonging to the right of autonomy and of liberty, and to the values of human dignity and of personal identity. All those fundamental legal principles shall be recognized, affirmed and protected both by "constitutional" and by "international" law.

Therefore, in the future, we may need some new shaped international provisions to regulate the field "neurolaw", such as we have needed, in the past, some international ad hoc "Declarations" in order to regulate the once new field of genomics.

In my humble opinion, the respect of the fundamental, constitutional and international recognized principles descending from the springing source of the "human dignity" in general (as a common quality of all men and women), and of each own "personal identity" (as a individual and unique characteristic of a single person) may be put at the very foundation of "neurolaw", insofar it is precisely the biological organ of our "identity" and of our "humanity"

– the brain – the one that neuroscientific powers will directly affect in the foreseeable future of the mankind.

BIBLIOGRAFIA E NOTE

General Bibliography

ANNAS, G.J., *Foreword: Imaging a New Era of Neuroimaging, Neuroethics and Neurolaw*. Am. J. Law Med. 2007; 33: 183.
ARNAUDO L., *Diritto cognitivo. Prolegomeni ad una ricerca*. Politica del diritto 2010; 1: 101.
AZZONI G., *L'arbitrarietà del corpo umano*. In: D'AGOSTINO F. (ed.), *Corpo esibito, corpo violato, corpo venduto, corpo donato: nuove forme di rilevanza giuridica del corpo umano*. Milano, Giuffrè, 2003, pp. 57-89.
BALDINI V., *Sviluppi della medicina e dialettica dei diritti costituzionali*. In: AA. VV., *Studi in onore di Gianni Ferrara*. t. I, Torino, Giappichelli, 2005, p. 240 segg.
BARTOLOMEI F., *La dignità umana come concetto e valore costituzionale*. Torino, Giappichelli, 2007.
BATTS S., *Brain Lesions and their Implications in Criminal Responsibility*. Behav. Sci. Law 2009; 23: 261-272.
CASCO C., PETROSINI L., OLIVIERI M. (trad. it. a cura di), BEAR M.F., CONNORS B.W., PARADISO M.A., *Neuroscienze. Esplorando il cervello*. III ed., Milano, Elsevier, 2007.
BEAR M.F., CONNORS, B.W. & PARADISO M.A., *Neuroscience: Exploring the Brain*. III ed., Baltimore, Lippincott Williams & Wilkins. 2007.
BIANCHI A., *Neuroscienze cognitive e diritto: spiegare di più per comprendere meglio*. Sistemi intelligenti 2010; 2: 295-312.
BILANCIA P., *Exogenus influences on the implementation and the interpretation of the Constitution*. Archiv für Rechts–und Sozialphilosophie 2008; 3.
BLACKMORE S., *Consciousness. A Very Short Introduction*. Oxford, Oxford University Press, 2005.
BOELLA L., *Neuroetica. La morale prima della morale*. Milano, Cortina, 2008.
BORSELLINO P., *Bioetica tra "morali" e diritto*. Milano, Cortina, 2009.
CARTER SNEAD O., *Neuroimaging and the "complexity" of capital punishment*. The New Atlantis: A Journal Of Technology and Society 2008; 19: 35.
CECCHERINI E. (ed.), *La tutela della dignità dell'uomo*. Napoli, Esi, 2008.
CLARK A., *Being There: Putting Brain. Body and World Together Again*. Cambridge, MIT Press. 1997.

COMMITTEE ON SCIENCE AND LAW, *Are Your Thoughts Your Own? "Neuroprivacy" and the Legal Implication of Brain Imaging*. CBA Record 2005; 60: 407 segg..
DAMASIO A.R., *Neuroscience and ethics: intersections*. American Journal of Bioethics 2007; 7: 3-7.
DEATON R.J.S., *Neuroscience and the Incorpore-ted First Amendment*. First Amendment Law Review 2006; 4:181 segg.
DI CIOMMO M., *Dignità umana e Stato costituzionale. La dignità umana nel costituzionalismo europeo, nella Costituzione italiana e nelle giurisprudenze europee*. Firenze, Passigli, 2010.
EAGELMAN D.M., *Feature: Neuroscience and the Law*. The Houston Lawyer 2008; 45: 36 segg.
EISENBERG J.B., *Schiavo on the Cutting Edge: Functional Brain Imaging and its Impact on Surrogate End-of-Life Decision-Making*. Neuroethics 2008; 1: 75-83.
FARAH M.J., HEBERLEIN A.S., *Personhood and neuro science: Naturalizing or nihilating?* American Journal of Bioethics 2007; 7: 37–48.
FARAH M.J., *Neuroethics: The practical and the philosophical*. Trends in Cognitive Science 2005; 9, 1: 34-40.
FARAHANY N. (ed.), *The impact of behavioral sciences on criminal law*. Oxford, Oxford University Press, 2009.
FORZA A., *Neuroscienze e diritto*. Rivista penale 2009; 3: 247 segg..
GALLESE V., *Embodied simulation: from neurons to phenomenal experience*. Phenomenology and the Cognitive Science 2005; 4: 23-48.
GAZZANIGA M.S., *Human. The Science Behind What Makes Us Unique*. New York, HarperCollins, 2008.
GAZZANIGA M.S., *The Ethical Brain*. Washington D.C., Dana Press, 2005.
GAZZANIGA M.S., *The Law and Neuroscience*. Neuron 2008; 60,3: 412-415.
GAZZANIGA M.S.. *The Cognitive Neuroscience III*. Cambridge, MIT Press, 2004.
GOODENOUGH R.O., *Mapping Cortical Areas Associated with Legal Reasoning and Moral Intuition*. Jurimetrics 2001; 41: 429-442.
GREELY H.T., *Prediction, Litigation, Privacy and Property: Some Possible Legal and Social Implications of Advances in Neuroscience*. In: GARLAND B. (ed.), *Neuroscience and the Law: Brain, Mind, and the Scales of Justice*. Washington D.C., Dana Press, 2004.
GREENFIELD S., *The Private Life of the Brain*. London, Penguin Books, 2000.
GREY B.J., *Neuroscience, Emotional Harm, and Emotional Distress Tort Claims*. American Journal of Bioethics-Neuroscience 2007; 7(9): 65 seg.
GROSSI P., *Dignità umana e libertà nella Carta dei diritti fondamentali dell'Unione*

europea. In: SICLARI M. (ed.), *Contributi allo studio della Carta dei diritti fondamentali dell'Unione europea*. Torino, Giappichelli, 2003, 41 segg.
INTIERI C., *Neuroscienze e diritto: una nuova teoria giuridica sulla mente*. Sistemi intelligenti 2010; 2: 255–268.
JONES O.D. (et al.), *The Neural Correlates of Third-Party Punishment*. Neuron 2008; 60: 930-940.
JONES O.D., *Law and Behavioral Biology. Journal of Law*. Cognitive Science and Artificial Intelligence 2006; 2: 28 segg.
KANDEL E.R., SCHWARTZ J.H., JESSEL T.M., *Principi di neuroscienze*. (PARRI V., SPIDALIERI G. (trad. it. a cura di), III ed., Milano, Ambrosiana, 2003.
KECKLER C.N.W., *Cross-Examining the Brain: A Legal Analysis of Neural Imaging for Credibility Impeachment*. Hastings Law Journal 2006; 57: 509 segg..
KHOSHBIN L.S., KHOSHBIN S., *Imaging the Mind, Minding the Image: An Historical Introduction to Brain Imaging and the Law*. American Journal of Law and Medicine 2007; 33: 171-192.
KNABB J.J., WELSH R.K., ZIEBELL J.G., REIMER K.S., *Neuroscience, Moral Reasoning, and the Law*. Behavioral Sciences and the Law 2009; 27: 219-236.
KOLBER A.J., *Freedom of Memory Today*. Neuroethics 2008; 1: 145-148.
KRAHN T., FENTON A., MEYNELL L., *Novel Neurotechnologies in Film – A Reading of Steven Spielberg's Minority Report*. Neuroethics 2009; 1,3: 73-88.
KULYNYCH J., *Legal and Ethical Issues in Neuroimaging Research: Human Subjects Protection, Medical Privacy, and the Public Communication of Research Results*. Brain Cogn. 2002; 50(3): 345-357.
LEKOVIC G.P., *Neuroscience and the law*. Surg. Neurol. 2008; 69: 99–101.
LETTIERI N., *Fuori da uno splendido isolamento. Le science cognitive negli orizzonti della scienza giuridica*. Sistemi intelligenti 2010; 2: 323-336.
LEVY N., *Introducing Neuroethics*. Neuroethics 2008; 1:1.
LIBET B., *Unconscious cerebral initiative and the role of conscious will in voluntary action*. Behav. Brain Sci. 1985; 8: 529-566.
LUCCHIARI C., PRAVETTONI G., *La mente umana. Un'introduzione alla scienza cognitiva*. Milano, Unicopli, 2008.
MARCUS G., *The Birth of the Mind. How a Tiny Number of Genes Creates the Complexities of Human Thought*. New York, Basic Books, 2004.
MARCUS S.J., *Neuroethics: Mapping the Field*, Conference Proceedings, 2002.
MARTELL D.A., *Neuroscience and the Law: Philosophical Differences and Practical Constraints*. Behavioral Sciences and the Law 2009; 27: 123-136.
MIESEL A., CERMINARA K.L., *The Right to Die. The Law of the End-of-life Decisionmaking*. New York, Aspen, 2008.

MONTANARI VERGALLO G., *Il rapporto medico–paziente*. Milano, Giuffrè, 2008.
MONTI M.M., COLEMAN M.R., OWEN A.M. et al., *Willful Modulation of Brain Activity in Disorders of Consciousness*. N. Eng. J. Med. 2010; 362: 579-589.
MORSE S., *New neuroscience, old problems: Legal implications of brain science*. In: GARLAND B. (ed.), *Neuroscience and the Law: Brain, Mind, and the Scales of Justice*. Washington D.C., Dana Press, 2004.
MORSE S., *Brain overclaim syndrome and criminal responsibility: a diagnostic note*. University of Pennsylvania Law School, Public Law Working Paper n. 06-35.
OCCHIOCUPO N., *Liberazione e promozione della persona umana: unità di valori nella pluralità di posizioni*. Milano, Giuffrè, 1988.
OWEN A.M., SCHIFF N.D., LAUREYS S., *A new era of coma and consciousness science*. Prog. Brain Res. 2009; 117: 399 sgg..
PARDO M.S., *Neuroscience Evidence, Legal Culture, and Criminal Procedure*. American Journal of Criminal Law 2006; 33: 301 sgg..
PELAGATTI G., *I trattamenti sanitari obbligatori*. Roma, Cisu, 1995.
PICCOLINO M. (ed.), *Neuroscienze controverse. Da Aristotele alla moderna scienza del linguaggio*. Torino, Bollati Boringhieri, 2008.
PIROZZOLI A., *Il valore costituzionale della dignità: un'introduzione*. Roma, Aracne, 2007.
POCKETT, S., *The Concept of Free Will: Philosophy, Neuroscience and the Law*. Behavioral Science and the Law 2007; 25: 281-293.
President's Council on Bioethics, *Beyond therapy: Biotechnology and the pursuit of happiness*. 2003.
PURVES D., BRANNON E.M., CABEZA R., HUETTEL S.A., LABAR K.S., PLATT M.L., WOLDORFF M.G., *Neuroscienze cognitive*. (trad. it. a cura di ZANI A.), Bologna, Zanichelli, 2009.
RODOTÀ S., *New Technologies and Human Rights. Facts, interpretations, perspectives*. Astrid Rassegna, 2010, vol. 109 s.g.–4 s.a., 23/2/2010.
ROSE S., *The future of the Brain: the Promise and Perils of Tomorrow's Neuroscience*. Oxford, Oxford University Press, 2006.
SANTOSUOSSO A., BOTTALICO B., *Neuroscience, accountability and individual boundaries*. Frontiers in Human Neuroscience 2009; 3, 45: 1.
SAVULESCU J., BOSTROM N., *Human Enhancement*. Oxford, Oxford University Press, 2009.
SCHICK A., *Neuroexecptionalism?* Am. J. Bioeth. 2005; 5: 36-38.
SEAMAN J.A., *Black Boxes*. Emory Law Journal 2008; 58: 428 sgg.
SINNOTT-ARMSTRONG W., GRAFTON S., GAZZANIGA M. & GAZZANIGA S., *Brain Scans Go Legal*. Scientific American Mind 2006/2007; 30.

SKENE L., WILKINSON D., KAHANE G., SAVULESCU J., *Neuroimaging and the Withdrawal of Life–Sustaining Treatment from Patients in Vegetative State*. Med. Law Review 2009; 17,2 : 245-261.
TANCREDI L.R., *Neuroscience, Developments and the Law*. In: GARLAND B. (ed.), *Neuroscience and the Law: Brain, Mind, and the Scales of Justice*. Washington D.C., Dana Press, 2004.
TANCREDI L.R., *The Neuroscience of "Free Will"*. Behav. Sci. and the Law 2007; 25: 295-308.
TOVINO S.A., *Imaging Body Structure and Mapping the Brain Function: A Historical Approach*. Am. J. Law Med. 2007; 33: 193-228.
VERONESI P., *Il corpo e la Costituzione. Concretezza dei "casi" e astrattezza della norma*. Milano, Giuffrè, 2007.
ZEKI S. e GOODENOUGH O. (ed.), *Law and the Brain*. Philosophical Transactions of the Royal Society, Oxford, Oxford University Press, 2006.
ZEKI S., *Splendors and Miseries of the Brain*. Chirchester, Wiley–Blackwell, 2009.

1. One may remember that 2009 was the U.N. International Year of Astronomy, as to mark the 400th anniversary of the first use of an astronomical telescope by Galileo Galilei.
2. One may think at the LHC in Geneva.
3. One may recall in memory the Genoma's Project.
4. *Daubert v. Merrell Dow Pharmaceuticals*, 509 U.S. 579 (1993).
5. Like in the movie "*Minority Report*" as observed by KRAHN T., FENTON A., MEYNELL L., *Novel Neurotechnologies in Film – A Reading of Steven Spielberg's Minority Report*. Neuroethics 2009; 1,3: 73-88.
6. In *Roper v. Simmons*, 551 U.S. (2005).
7. In the Italian case law, see Court of Assise of Appeal of Trieste, judgment, September 18, 2009, *Bayout*.
8. *Schloendorff v. Society of New York Hospital*, 211 N.Y. 125, 105 N.E. 92 (1914).
9. *Salgo v. Leland Stanford etc. Bd. Trustees*, 154 Cal. App. 2d 560 (1957).
10. *Cruzan v. Missouri, Department of Health*, 497 U.S. 261 (1990).
11. Nice, 2000; Strasbourg, 2007, which possess an equal legal force in comparison with the European Treaties, according to article 6 of the E.U. Treaty as amended by the Treaty of Lisbon, 2007
12. See the European Court of Human Rights, in the case of *Diane Pretty v. United Kingdom*, 2002.

13. See judgment n. 438/2008.
14. *In re Atul R.*, 890 N.E. 2d 695, Ill. App. 4. Dist., 2008.
15. *United States v. Charters,* 829 F.2d 479, 492 (4th Cir. 1987).
16. *Stanley v. Georgia,* 394 U.S. 557, 564 (1969), quoting *Olmstead v. United States,* 277 U.S. 438, 478 (1928) (Brandeis, J., dissenting).
17. *Texas v. Johnson*, 491 U.S. 397, 404 (1989); see also *Globe Newspaper Co. v. Superior Court,* 457 U.S. 596, 604 (1982).
18. *Palko v. Connecticut,* 302 U.S. 319, 326-327 (1937).
19. *Stanley v. Georgia*, 394 U.S. 557 (1969).
20. *People ex rel. Ofengand*, 183 P.3d 688, Colo. App., 2008.
21. *U.S. v. Payne*, 539 F.3d 505, C.A.6.Tenn., 2008.
22. *Sell v. United States*, 539 U.S. 166 (2003).
23. In the seminal case of *Planned Parenthood of Southeastern Pennsylvania v. Casey*, 505 U.S. 833, 851 (1992).

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