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Neural Data and Space Law: Navigating the Legal Frontiers of Brain-Computer Interfaces in Astronaut Training

INTERVIEW WITH MARIUSZ T. KŁODA, MIKOŁAJ RESZKOWSKI AND MICHAŁ NOSOWSKI

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Alexandra Sarban: As space missions become more complex, technologies like Brain-Computer Interfaces (BCIs) and Electromyography (EMGs) are transforming astronaut training by monitoring cognitive function and optimizing performance. However, the legal status of neural data collected through these methods remains uncertain, raising questions about privacy, jurisdiction, and regulatory compliance in an international context. This interview explores how existing and emerging legal frameworks can address these challenges and ensure governance of neural data in space exploration.

Given your involvement in drafting space activities legislation, how do you think current frameworks could address the collection and use of neural data derived from technologies like BCIs and EMGs in training centres?

Mariusz T. Kłoda: The question is very broadly (globally) formulated, therefore, I will consider only the European context (*scil.* European Union and European Space Agency). In my opinion, the current legal framework for protecting personal data that is in force in the EU (GDPR¹ mainly) is sufficient. This thesis is accurate on the condition that the neural data of astronauts and astronaut candidates (derived from technologies like BCIs and EMGs in astronaut training centres) meet the characteristics of “personal data”. This issue appears to be simple only *prima facie*. Quite recently, the European Data Protection Supervisor and the Agencia Española de Protección de Datos analyzed the issue of neural data and published a report titled: TechDispatch. Neurodata². In the comments on this report, it is indicated that: *Neural data is, at least in some cases, personal data*³. I agree with these comments; moreover, the discussed neural data of astronauts and astronaut candidates could be examples of such cases, in my opinion. When it comes to classifying aforementioned neural data as personal data, we should primarily consider the terms: “data concerning health” or, alternatively, “biometric data”⁴. Such data are subject to the regulations of the GDPR⁵. Neural data are not *expressis verbis* regulated in the GDPR, as is widely known.

The legal framework adopted by ESA also appears to be sufficient within the discussed scope, which is important in view of the functioning of the European Astronaut Centre (EAC) within this intergovernmental organization. According to the ESA website: *the European Space Agency collects and/or processes personal data concerning various individuals, in particular – but not only – ESA Staff members and personnel engaged by ESA contractors and their subcontractors. The Agency is subject to a Personal Data Protection framework composed of the following elements: 1. the Principles of Personal Data Protection adopted by ESA Council on 13 June 2017; 2. the Rules of Procedure for the Data Protection Supervisory Authority adopted by ESA Council on 13 June 2017; 3. the Policy on Personal Data Protection (including its Annex “Governance Scheme of the Agency’s Personal Data Protection”) adopted by Director General of ESA on 1 March 2022*⁶. ESA has developed its own regulations because, generally, the GDPR does not apply to ESA. This is primarily a consequence of ESA’s immunity (*the Agency shall have immunity from jurisdiction and execution, except (...), according to the Article IV of the Annex*⁷). Nonetheless, ESA’s internal regulations align with the values underpinning the European Union’s personal data protection system.

It should be assumed that the discussed neural data of astronauts and astronaut candidates could meet, under the internal regulations of ESA, the characteristics of “Personal Data”⁸, and more precisely “Health-related Sensitive Personal Data” (which means *Personal Data relating to the physical or mental health of the Data Subject*), or, alternatively, “biometric data” (a type of “Sensitive Personal Data”⁹).

Alexandra Sarban: Are there specific challenges in aligning such frameworks with GDPR and other data protection regulations, especially given the extraterritorial nature of space operations?

Mariusz T. Kłoda: It would be advisable if countries that are not members of the EU or ESA, but participate in international space operations (missions), provided at least the same level of protection for the neural data of astronauts and astronaut candidates (derived from technologies like BCIs and EMGs in astronaut training centres) as is required by the personal data regulations of the EU or ESA. This expectation is

based on the assumption that the discussed neural data of astronauts and astronaut candidates could meet the characteristics of “personal data”. Of course, individual countries may follow a different *modus operandi*, particularly on the terminological level. In this regard, the Colorado Privacy Act (CPA), which distinguishes a category for neural data, serves as a case in point. According to the Section 6-1-1303 (Definitions) of the Colorado Revised Statutes¹⁰, “Biological data” *means data generated by the technological processing, measurement, or analysis of an individual's biological, genetic, biochemical, physiological, or neural properties, compositions, or activities or of an individual's body or bodily functions, which data is used or intended to be used, singly or in combination with other personal data, for identification purposes. Biological data includes neural data* (2.2). “Neural data” *means information that is generated by the measurement of the activity of an individual's central or peripheral nervous systems and that can be processed by or with the assistance of a device* (16.7).

When it comes to space operations (missions) *sensu stricto* (i.e. those conducted in outer space), the issue of jurisdiction becomes crucial. According to the Article VIII of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (so called Outer Space Treaty – OST), *A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body*. However, what is the status of intergovernmental organizations, such as the European Space Agency, or supranational organizations like the European Union, in this context?

According to the Article VII of the Convention on Registration of Objects Launched into Outer Space¹¹, *In this Convention, with the exception of articles VIII to XII inclusive, references to States shall be deemed to apply to any international intergovernmental organization which conducts space activities if the organization declares its acceptance of the rights and obligations provided for in this Convention and if a majority of the States members of the organization are States Parties to this Convention and to the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies. States members of any such organization which are States Parties to this Convention shall take all appropriate steps to ensure that the organization makes a declaration in accordance with paragraph 1 of this article*.

The EU has not made a Declaration of Acceptance under the aforementioned Convention¹², while the ESA has¹³. The European Space Agency is key in this context, as it is ESA, not the EU, that possesses the astronaut corps.

Alexandra Sarban: Are there existing or proposed legal mechanisms to ensure data sovereignty, especially when neural data is processed and shared across borders for the purposes of innovation between organizations (ex. ESA and NASA)?

Mikołaj Reszkowski, Michał Nosowski: The issue of data sovereignty is, in our understanding, related to applicability of laws in a given country to data stored in that country. In essence, GDPR does relate to data sovereignty – where a given entity carries out their activities on territory of the EU, GDPR applies, as per Article 3. As such,

in the EU, there are legal mechanisms to ensure data sovereignty, although without any specific regulations connected with neural data.

The main framework that regulates the data transfers between USA and EU, is the EU – US Data Privacy Framework. However, it is applied only in relation to US commercial organizations who applied to the framework and ensured their compliance with its requirements. It is not a perfect mechanism but it does create a legal basis for data transfers between EU and USA, which has always been a troubling matter. Whether Data Privacy Framework is here to stay is uncertain, as previous, similar mechanisms were deemed to not be appropriate safeguards, as per CJEU rulings¹⁴.

However, the Data Privacy Framework may not be applied to personal data transfers commenced between NASA and ESA. NASA is not eligible to join the framework as an US governmental organization. What is more, as an international organization ESA is not a subject to the GDPR. Even though ESA adopted its own rules for the protection of personal data, which are similar to the requirements arising from the GDPR, it formally does not apply the GDPR to its operations, e.g. in terms of legal basis for the protection of personal data.

If we were to apply the GDPR to processing of personal data related to the effects of use of technologies like BCI or EMG, it would require us to choose an appropriate legal basis for the processing of personal data. Considering the fact that data of this kind may constitute information about the health of an individual, they fall into the definition of “special categories of personal data”. Processing such data requires additional legal basis, as stated in the article 9 (2) of the GDPR. One of these additional legal basis covers the possibility to process personal data (including health data) for the purpose of scientific research purposes, provided that such activities are based on Union or Member State law which shall be proportionate to the aim pursued, respect the essence of the right to data protection and provide for suitable and specific measures to safeguard the fundamental rights and the interests of the data subject. Alternatively, the health data may be also processed based on a consent of an individual, which meets requirements specified in Article 4 (1) of the GDPR and an additional condition of being “explicit consent”. In this case, the consent cannot be presumed to have been granted, it must be clear and direct.

However, please have in mind that personal data always refers to a specific individual. Therefore, if the data collected for the research purposes were to be anonymized, they would not constitute personal data anymore, and consequently, no requirements arising from the GDPR would have to be applied. Anonymization is a situation when data cannot be attributed to a specific individual.

Nevertheless, potential data transfers between ESA and NASA will not fall into the scope of the GDPR, as neither of these organisations is subject to regulations of the GDPR. However, if certain other EU-based entities (e.g. University or research facility) were to process this kind of data, they would have to do so in accordance with the GDPR.

The purpose of “innovation” does not, in its own, constitute a separate legal basis for data processing, nor does it justify processing personal data outside of scope of regulations like GDPR. As such, some specific, research-related regulations might

be useful for the purpose of moving science forward. Such legal frameworks may already exist in given EU countries, but unfortunately, no unified EU-level legal act has been created in regard to neural data research.

Alexandra Sarban: How might blockchain or distributed ledger technologies be used to ensure transparency, accountability, and security in managing neural and biometric data collected when preparing for and during space missions?

Mariusz Kłoda: DLT, including blockchain, may be useful in the indicated scope, among other reasons, due to the characteristics of this technology mentioned above. However, given the sensitivity of the personal data in question, it cannot be a public system; rather, it should be private in nature.

Alexandra Sarban: Could these technologies address gaps in current space-related data protection policies?

Mariusz Kłoda: DLT, including blockchain, may be one of the technologies useful in the area under discussion. This issue is discussed in the literature¹⁵. However, its significance could change unfavorably, for example, with the development of quantum technologies offering substantial computational power or AI.

Alexandra Sarban: How do you see the role of legal frameworks in ensuring that neurotechnologies used prior to (in space centres when testing new technology e.g., BCIs and EMGs) and in space missions do not infringe on fundamental rights such as privacy and cognitive liberty?

Mikołaj Reszkowski: Of course, they can prove to be a valuable tool. It is important to highlight that many legal frameworks establish consent-based approach to various medical experiments, including those related to analyzing neural data and collecting such data – regardless of legal bases when it comes to processing personal data. Such consent-centered way of developing neurotechnologies must be maintained in existing regulations and implemented in upcoming ones.

Various legal frameworks could create other legal instruments of significant importance, especially by establishing the necessity of ethical approach, respecting participant's privacy and wishes, as well as ensuring the ability to withdraw from experiments/research, together with the option to completely erase collected data upon request. The concept of "neurorights" comes to mind – a set of specific virtues which must be kept in mind when we deal with analyzing neurological data, for example "mental privacy", being freedom to conceal our mental information, or "cognitive liberty", being our right to decide which brain activities could be recorded at a time¹⁶.

Alexandra Sarban: Space exploration often requires innovation at the edge of existing legal and ethical frameworks. How should lawmakers balance fostering innovation in neural data applications with protecting the privacy and autonomy of astronauts?

Mikołaj Reszkowski: Striking the balance between "not killing innovation" and ensuring we don't devolve into absolute lack of control over our sensitive data is always a difficult task – that much is given. It is the case in many areas of law, not only data

protection – intellectual property comes to mind especially (e.g., balancing the rights of creators and those who interact with their creations). A risk-based approach, present in the GDPR is something that works, to an extent, as it should. Entities responsible for specific activities (in this case – data controllers) are responsible for analyzing their own goals and adjusting security measures appropriately. In case of research involving neural data, entities conducting such activities must take into account sensitivity of processed information (especially in regard to data security) and appropriately manage what information is stored (by anonymizing data when possible). On-going discussion and analyses are of great value, especially in such dynamically changing fields as those related to neurotechnologies.

Alexandra Sarban: Considering the international nature of space missions, how can EU regulations like GDPR be harmonized with other countries' privacy laws to ensure a consistent approach to protecting neural and biometric data?

Mikołaj Reszkowski, Michał Nosowski: GDPR had an effect of bringing the issue of data protection into the “mainstream”. In other words, more people became aware of the need for such laws when GDPR became “a real thing”, and many countries followed the EU’s example, leading to implementation of their own data protection regulations. In some cases, the regulations are noticeably similar to their European counterpart, to the point where they create legal grounds for the European Commission (EC) to issue “adequacy decisions”. Under these decisions, EC decides that a third country (that is, a country outside the European Economic Area) creates a regime which ensures safety on a level equal to the GDPR, thus legalizing transfers of data to these countries. Such harmonization is a suitable tool, considering that GDPR is in itself, already a decently functioning regulation, albeit not perfect, of course.

Therefore, many other countries, such as Australia, Japan, South Korea, Canada, UK or Brazil adopted national data protection laws, often similar to the GDPR.

As to whether neural data is going to be considered personal data (at least in the eyes of GDPR) is a whole different issue. It is not always going to be entirely certain – health related information is usually strongly protected but we still need some identifiability. There is a lot of discussion among researchers as to what kind of criteria we should apply when labeling something personal data. One way of thinking is very restrictive and revolves around the following way of thinking: “only information that is not possible to be identified by anyone, with any method, can be considered to not be personal data”. While the other approach is focused on a more subjective (realistic) way of thinking – we should take into account whether identification of a data subject is actually plausible with a given set of information. Whether neural data is protected should be analyzed case by case, taking into account the specific data processing activities.

Alexandra Sarban: In your opinion should there be a unified international treaty governing neural data collected in space, or are existing space law treaties sufficient?

Mikołaj Reszkowski: Existing laws do not regulate that matter. A unified regulation would most certainly be helpful, assuming it is created in a manner that is exercisable and does not constitute “empty declarations” (e.g., creates actual obligations

that space organizations are going to follow). Something that I would consider important to implement in these kinds of regulations is a risk-based approach, actual, clearly defined obligations and some official bodies overseeing the practice.

Alexandra Sarban: How should legal frameworks evolve to address the potential misuse of neural data, such as for behavioral prediction or manipulation?

Mikołaj Reszkowski: First, a specific regulation could be useful, although considering that neural data does not have very clear legal status, it would always be difficult to create very strict principles, which could be followed to the letter. Implementing legal mechanisms akin to those we have in regard to medical experiments would be useful – participation should be voluntary, everyone should be able to withdraw at any moment, and a person participating should have the option to manage their data. For instance, this matter was subject of judgement made by Chile's Supreme Court of Justice in August of 2023 – a person (plaintiff) who acquired a device related to neurotechnology sought deletion of neural data stored by device's provider, as the data has been subject to further resale¹⁷. The court has agreed with the plaintiff and demanded deletion of above mentioned data.

Unfortunately, very often, a possibility of incurring serious financial consequences is the tipping point in encouraging organizations to follow specific rules, especially in developing fields of law like personal data protection. In other words, general principles, declarations, and unspecified guidelines, rarely achieve their goal in satisfactory scope, as lack of established practice, legal precedents and know-how of official authorities make application of just mentioned principles unlikely.

As such, financial consequences are one possible solution. The other one that comes to mind is previously mentioned implementation of risk-based approach and actual, practical guidelines prepared by authorities having knowledge on the topic – for example, something akin to the European Data Protection Board with the Guidelines it creates.

Alexandra Sarban: Many thanks for sharing your insights in this interview.

- ¹ Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation).
- ² See https://www.edps.europa.eu/system/files/2024-06/techdispatch_neurodata_en.pdf (last accessed March 9, 2025), DOI: 10.2804/770800.
- ³ See A. van der Wolk, C. Martinez, It's All in Your Head? Not Anymore: EU Data Protection Authorities Report on Applying Data Protection Law to Consumer Neurotechnologies that Process Brain Data, <https://www.mofo.com/resources/insights/240722-it-s-all-in-your-head-not-anymore-eu-data-protection> (last accessed March 9, 2025).
- ⁴ See TechDispatch. Neurodata, p. 15.
- ⁵ "Data concerning health" means personal data related to the physical or mental health of a natural person, including the provision of health care services, which reveal information about his or her health status. "Biometric data" means personal data resulting from specific technical processing relating to the physical, physiological or behavioural characteristics of a natural person, which allow or confirm the unique identification of that natural person, such as facial images or dactyloscopic data (article 4 points 14–15 of the GDPR).
- ⁶ See https://www.esa.int/About_US/Law_at_ESA/Highlights_of_ESA_rules_and_regulations (last accessed March 9, 2025).
- ⁷ Annex I to the Convention on the Establishment of the European Space Agency.
- ⁸ According to the Policy on Personal Data Protection, "Personal Data" means any information concerning an identified or identifiable Data Subject, in this latter case provided that identification of the said Data Subject may be done without unreasonable efforts directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that Data Subject.
- ⁹ According to the Policy on Personal Data Protection, "Sensitive Personal Data" means Personal Data that can reveal without unreasonable efforts the racial or ethnic origins, political opinions, trade union membership, religious or philosophical beliefs, health or sexual life, genetic or biometric data, or criminal convictions of a Data Subject.
- ¹⁰ See <https://leg.colorado.gov/colorado-revised-statutes> (last accessed March 9, 2025).
- ¹¹ This Convention further develops the aforementioned OST regulation.
- ¹² The EU has not done so with respect to either the Convention on International Liability for Damage Caused by Space Objects or the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space. See F.G. von der Dunk, The European Union and Space – Space for Competition?, DigitalCommons@University of Nebraska – Lincoln, 2018, p. 4–6, <https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1107&context=spacelaw> (last accessed March 9, 2025) and P.M.J. Mendes De Leon, Responsibility and Liability of the EU under International Air and Space Law, *Ordine internazionale e diritti umani*, 2018, p. 87–88, <https://scholarlypublications.universiteitleiden.nl/access/item%3A2970546/view> (last accessed March 9, 2025).
- ¹³ See Status and application of the five United Nations treaties on outer space, and way and means, including capacity-building, to promote their implementation, April 15, 2024, A/AC.105/C.2/2024/CRP.3, https://www.unoosa.org/res/oosadoc/data/documents/2024/aac_105c_22024crp/aac_105c_22024crp_3_0_html/AC105_C2_2024_CRP03E.pdf (last accessed March 9, 2025).
- ¹⁴ See CJEU ruling regarding "EU-U.S. Safe Harbour" mechanism in "Schrems I Case" (C-362/14) and CJEU ruling regarding "EU-U.S. Privacy Shield" in "Schrems II case" (C-311/18).
- ¹⁵ See e.g. M.N.O. Sadiku, P.A. Adekunle, J.O. Sadiku, Blockchain in Space Exploration, *International Journal of Trend in Scientific Research and Development*, 2024, Volume 8, Issue 5, p. 1151–1160, <https://www.ijtsrd.com/papers/ijtsrd70521.pdf> (last accessed March 9, 2025), DOI: 10.2804/770800.
- ¹⁶ See footnote no. 2.
- ¹⁷ See A. Cossu, Protecting the Right to Neural Privacy Within the United States, February 4th 2025, https://www.hofstrajibl.org/2025/02/protecting-the-right-to-neural-privacy-within-the-united-states/#_edn41 (last accessed March 11, 2025).