SCIENCE NEWS

Tissue-engineered Colon from Human Cells Develop Different Types of Neurons

A study carried out by scientists at the Children's Hospital Los Angeles (CHLA) has shown that tissue-engineered colon derived from human cells is able to develop many specialised nerves required for function, mimicking the neuronal population found in native colon. These specialised neurons, localised in the gut, form the enteric nervous system, which regulate digestive tract mobility, secretion, absorption and gastrointestinal blood flow. In addition, in a condition called Hirschsprung's disease or aganglionosis, where those neurons are not present, the team was able to replace them.

The study — the first report on the enteric nervous system in human-derived tissue-engineered colon — was published online ahead of print in the journal, *Tissue Engineering, Part A,* on September 28.

In healthy intestines, food passes trough the digestive tract through peristalsis — a series of wave-like contractions. Special nerve cells called ganglion cells are required for this movement, but there is also a rich mixture of other types of nerve cells. In children with Hirschsprung's disease, these cells are missing. Without these, the intestine becomes blocked and surgical removal of the affected segment of colon is required.

To help children suffering from intestinal diseases that may require surgical removal of all or part of their intestines, the CHLA team—led by principal investigator Tracy C. Grikscheit, MD, a paediatric surgeon and researcher at the Saban Research Institute of CHLA — is developing tissue-engineered options.

One objective of growing tissue-engineered organs is to generate new tissues from a patient's cells. Grikscheit and her team first needed to determine what parts of the enteric nervous system were present in tissue-

engineered colon when it is grown from normal human cells.

"The diversity of neuron types that grew within the human tissue-engineered colon was a revelation to our team because, previously, we had only documented that some ganglia were present," said Grikscheit, who is also a tenured associate professor of surgery at the Keck School of Medicine at the University of Southern California. "The next step was to determine if these neuronal elements could be supplied to tissue-engineered colon that was missing neurons — like in Hirschsprung's disease," Grikscheit added.

The scientists initially grew cells from patients with Hirschsprung's disease and from mice with a genetic mutation that causes aganglionosis. In both the cases, the tissue-engineered colon derived from these cells did not have all-important components of the intestinal nervous system. In a second set of experiments, again testing both mouse and human cells, the investigators added neurospheres, which are clusters of purified neural progenitor cells. The cells had been stained with green fluorescence, so the scientists could readily visualise where the nerve cells ended up in the tissue-engineered colon, as well as determine the source of the nerve cells.

"After growing the colon for four weeks, we saw that the green nerve cells had been incorporated into the colon engineered from human tissue derived from a patient lacking those elements and that the different nerve subtypes were present," said first author on the study, Minna Wieck, MD, an investigator and surgical resident at CHLA.

New colon cancer culprit found in gut microbiome

Changes in the gut bacteria of colon cancer patients indicate that some virulent bacteria could be linked to the progression of the disease, according to a research published in the open access journal *Genome Medicine*. The findings could eventually be used to identify a virulence signature in these cancers and help doctors predict how bacterial changes in patients' guts could affect their prognosis.

The human gut microbiome, a collection of microorganisms, their genomes and habitat that contributes to maintaining a healthy intestine, is thought to play an active role in colon cancer progression. Previous studies have shown that changes in the bacterial community occur in the gut microbiome of colon cancer patients, with tumours harbouring increased bacterial diversity and an abundance of pathogenic bacteria compared to surrounding healthy tissues.

Although researchers have uncovered a variety of potentially pathogenic bacteria associated with colon cancer, little work has been done to determine if there is a single signature that might unify their findings.

Lead author Michael Burns from the University of Minnesota, USA, said, "It was surprising that the results were so clear. We were able to clearly identify the presence of two virulent strains of bacteria, including the discovery of a new potential culprit, Providencia."

"This has obvious implications for colon cancer patients and by analysing the similarities among these pathogens, we have uncovered a single signature of colon cancer

when analysing the gut microbiome that might help researchers identify these cancers in future."

This was the first study to focus on the pathogenic potential of the bacterial genes present in the colon cancer 'tumour microenvironment', the environment of surrounding blood vessels, immune cells and other cells. The genes of the gut microbiomes were predicted in 44 primary tumor and 44 patients-matched normal colon tissues to analyse the general microbial function.

The team in Ran Blekhman's lab noted changes in the abundances of helpful, harmless and pathogenic bacteria, including Fusobacterium and Providencia. Fusobacterium has previously been implicated as a cancer-causing group of bacteria, but this is the first time that Providencia has been linked to colon cancer.

Analysing the major changes that take place in the gut microbiome could help researchers categorise the role a particular bacterium plays and identify the key players.

Additionally, by showing that the microbial genes which are predicted to be present in colon cancer tissue, are enriched for virulence functions. Clinicians could use this signature to uncover what bacterial changes in the gut mean for a patient's health.

At this stage, the research cannot determine a definite causal link between Providencia species and colon cancer. While the study's methods are robust for analysing human gut samples, more research will be needed to assess the interactions between gut bacteria and the progression and development of colon cancer.

Medical Nanoparticles: Local Treatment of Lung Cancer

Nanoparticles can function as carriers of medicines to combat lung cancer. Working in a joint project at the NIM (Nanosystems Initiative Munich) Excellence Cluster, scientists from the Helmholtz Zentrum München (HMGU) and the Ludwig-Maximilians-Universität (LMU) in Munich have developed nanocarriers that site-selectively release medicines/drugs at the tumour site in human and mouse lungs. In the journal, *ACS Nano*, the scientists reported that this approach led to a significant increase in the effectiveness of current cancer medicines in lung tumour tissue.

Nanoparticles are extremely small particles that can be modified for a variety of uses in the medical field. For example, nanoparticles can be engineered to be able to transport medicines, specifically to the disease site while not interfering with the healthy body parts.

Selective drug transport verified in human tissue for the first time

The Munich scientists have developed nanocarriers that only release the carried drugs in lung tumour areas. The team headed by Silke Meiners, Oliver Eickelberg and Sabine van Rijt from the Comprehensive Pneumology Center (HMGU), working with colleagues from the Chemistry Department (LMU) headed by Thomas Bein, was able to show nanoparticles' selective drug release to human lung tumour tissue for the first time.

Tumour-specific proteins were used to release drugs from nanocarriers

Tumour tissues in the lung contains high concentrations of certain proteases, which are enzymes that break down and cut specific proteins. The scientists took advantage of this by modifying the nanocarriers with a protective layer that only these proteases can break down, a process that then releases the drug. Protease concentrations in healthy lung tissues are too low to leave this protective layer and so the medicines stay protected in the nanocarrier.

"Using these nanocarriers, we can very selectively release a drug, such as a chemotherapeutic agent specifically at the lung tumour," reports research group leader Meiners. "We observed that the drug's effectiveness in the tumour tissue was 10 to 25 times greater compared to when the drugs were used on their own. At the same time, this approach also makes it possible to decrease the total dose of medicines and consequently to reduce undesirable effects," the research group's leader added.

Further studies will be directed to examine the safety of the nanocarriers in vivo and verify the clinical efficacy in an advanced lung tumour mouse model.

Engineered Cardiac Tissue Model Developed to Study Human Heart

When it comes to finding cures for heart diseases scientists are working to their own beat. That's because they may have finally developed a tissue model for the human heart that can bridge the gap between animal models and human patients. These models exist for other organs, but for the heart, this has been elusive. Specifically, the researchers generated the tissue from human embryonic stem cells with the resulting muscle having significant similarities with human heart muscle. This research was published in the February 2014 issue of *The FASEB Journal*.

"We hope that our human engineered cardiac tissues will serve as a platform for developing reliable models of the human heart for routine laboratory use," said Kevin D. Costa, PhD and a researcher involved in the work from the Cardiovascular Cell and Tissue Engineering Laboratory, Cardiovascular Research Center, Icahn School of Medicine at Mt. Sinai, in New York."This could help revolutionise cardiology research by improving the ability to efficiently discover, design, develop and deliver new therapies for the treatment of heart disease, and by providing more efficient screening tools to identify and prevent cardiac side-effects, ultimately leading to safer and more effective treatment of patients suffering from heart disease,"he said.

To make this advance, Costa and colleagues cultured human engineered cardiac tissue, or hECTs, for 7–10 days and they self-assembled into a long thin heart muscle strip that pulled on the end-posts and caused them to bend with each heart beat, effectively exercising the tissue throughout the culture process.

These hECTs displayed spontaneous contractile activity in a rhythmic pattern of 70 beats per minute on an average, similar to the human heart. They also responded to electrical stimulation. During functional analysis, some of the responses known to occur in the natural adult human heart were also elicited in hECTs through electrical and pharmacological interventions, while some paradoxical responses of hECTs more closely mimicked the immature or newborn human heart. They also found that these human engineered heart tissues were able to incorporate new genetic information carried by adeno virus.

What Molecules you Leave on your Phone Reveal about your Lifestyle

Molecular traces left on cell phones allowed UC San Diego researchers to construct lifestyle sketches of each phone's owner.

We leave behind trace chemicals, molecules and microbes on every object we touch. By sampling the molecules on cell phones, researchers at University of California San Diego School of Medicine and Skaggs School of Pharmacy and Pharmaceutical Sciences were able to construct lifestyle sketches for each phone owner, including diet, preferred hygiene products, health status and locations visited. This proof-of-concept study, published on November 14 by the Proceedings of the National Academy of Sciences could have a number of applications, including criminal profiling, airport screening, medication adherence monitoring, clinical trial participant stratification and environmental exposure studies.

You can imagine a scenario where a crime scene investigator comes across a personal object, like a phone, pen or key, without fingerprints or DNA, or with prints or DNA not found in the database. They would have nothing to go on to determine who that belongs to," said senior author Pieter Dorrestein, PhD, *Professor* in UC San Diego School of Medicine and Skaggs School of Pharmacy and Pharmaceutical Sciences. "So we thought — what if we take advantage of left-behind skin chemistry to tell us what kind of lifestyle this person has?"

In a 2015 study, Dorrestein's team constructed 3D models to illustrate the molecules and microbes found at hundreds of locations on the bodies of two healthy adult volunteers. Despite a three-day moratorium on personal hygiene products before the samples were collected, the researchers were surprised to find that the most abundant molecular features in the skin swabs still came from hygiene and beauty products, like sunscreen.

"All of these chemical traces on our bodies can transfer to objects," Dorrestein said. "So we realised we could probably come up with a profile of a person's lifestyle based on chemistries we can detect on objects they frequently use," he added.

Thirty-nine healthy adult volunteers participated in Dorrestein's latest study. The team swabbed four spots on each person's cell phone — an object we tend to spend a lot of time touching — and eight spots on each person's right hand, for a total of nearly 500 samples. Then, they used a technique called mass spectrometry to detect molecules from the samples. They identified as many

molecules as possible by comparing them to reference structures in the GNPS database, a crowdsourced mass spectrometry knowledge repository and annotation website developed by Dorrestein and *co-author* Nuno Bandeira, PhD, *Associate Professor* at the Jacobs School of Engineering and Skaggs School of Pharmacy and Pharmaceutical Sciences, UC San Diego.

With this information, the researchers developed a personalised lifestyle "read-out" from each phone. Some of the medications they detected on phones included anti-inflammatory and anti-fungal skin creams, hair loss treatments, anti-depressants and eye drops. Food molecules included citrus, caffeine, herbs and spices. Sunscreen ingredients and DEET mosquito repellant were detected on phones even months after they had last been used by the phone owners, suggesting that these objects can provide long-term composite lifestyle sketches.

"By analysing the molecules they've left behind on their phones, we could tell if a person is likely a female, uses high-end cosmetics, dyes her hair, drinks coffee, prefers beer over wine, likes spicy food, is being treated for depression, wears sunscreen and bug spray — and therefore, likely spends a lot of time outdoors — all kinds of things," said first author Amina Bouslimani, PhD, Assistant Project Scientist in Dorrestein's lab. "This is the kind of information that could help an investigator narrow down the search for an object's owner," she added.

There are limitations, Dorrestein said. First of all, these molecular read-outs provide a general profile of person's lifestyle, but they are not meant to be a one-to-one match, like fingerprints. To develop more precise profiles and for this method to be more useful, he said more molecules are needed in the reference database, particularly for the most common foods people eat, clothing materials, carpets, wall paints and anything else they come in contact with. He would like to see a trace molecule database on the scale of the fingerprint database, but it's a large-scale effort that no single lab will be able to do alone.

Moving forward, Dorrestein and Bouslimani have already begun extending their study with an additional 80 people and samples from other personal objects, such as wallets and keys. They also hope to soon begin gathering another layer of information from each sample — identities of the many bacteria and other microbes that cover our skin and objects. In a 2010 study, their collaborator and co-author, Rob Knight, PhD, *Professor* in the UC San Diego School of Medicine and Jacobs School of Engineering and director of the Center for Microbiome Innovation at UC San Diego, contributed to a study, in which his team found they could usually match a computer keyboard to its owner just based on the unique populations of microbes the person has left on it. At that time, they could make the match with a fair amount of accuracy, though not precise enough for use in an investigation.

Beyond forensics, Dorrestein and Bouslimani imagine that trace molecular read-outs could also be used in medical and environmental studies. For example, perhaps one day physicians could assess how well a patient is sticking with a medication regimen by monitoring metabolites on his /her skin.

Similarly, patients participating in a clinical trial could be divided into sub-groups based on how they metabolise the medication under investigation, as revealed by skin metabolites — then the medication could be given only to those who can metabolise it appropriately. Skin molecule read-outs might also provide useful information about a person's exposure to environmental pollutants and chemical hazards, such as in a high-risk workplace or a community living near a potential pollution source.

Heavy Cell Phone use linked to Oxidative Stress

A new study finds a strong link between heavy cell phone users and higher oxidative stress to all aspects of a human cell, including DNA. Uniquely based on examinations of the saliva of cell phone users, the research provides evidence of a connection between cell phone use and cancer risk.

To further explore the relationship between cancer rates and cell phone use, Dr. Yaniv Hamzany of Tel Aviv University's Sackler Faculty of Medicine and the Otolaryngology Head and Neck Surgery Department at the Rabin Medical Center, looked for clues in the saliva of cell phone users. Since the cell phone is placed close to the salivary gland when in use, he and his fellow researchers, including departmental colleagues progessors. Professors Raphael Feinmesser, Thomas Shpitzer, Dr. Gideon Bahar, Rafi Nagler and Dr. Moshe Gavish of the Technion in Haifa, hypothesised that salivary content could reveal whether there was a connection with developing cancer.

Comparing heavy mobile phone users to non-users, they found that the saliva of heavy users showed indications of higher oxidative stress—a process that damages all aspects of a human cell, including DNA—through the development of toxic peroxide and free radicals. More importantly, it is considered a major risk factor for cancer.

The findings have been reported in the journal, *Antioxidants and Redox Signaling*.

Putting stress on tissues and glands

The researchers examined the saliva content of 20 heavy-user patients, defined as speaking on their phones for a minimum of eight hours a month. Most participants speak much more, Dr. Hamzany says, as much as 30 – 40 hours a month. Their salivary content was compared to that of a control group, which consisted of deaf patients who either do not use a cell phone, or use the device exclusively for sending text messages and other non-verbal functions.

Compared to the control group, heavy cell phone users had a significant increase in all salivary oxidative stress measurements studied.

"This suggests that there is considerable oxidative stress on the tissue and glands which are close to the cell phone when in use," he says. The damage caused by oxidative stress is linked to cellular and genetic mutations which cause the development of tumours.

Making the connection

This field of research reflects long-standing concerns about the impact of cell phone use, specifically the effects of radio frequency non-ionising electromagnetic radiation on

human tissues located near the ear, say the researchers. And although these results don't uncover a conclusive "cause and effect" relationship between cellular phone use and cancer, they add to the building evidence that cell phone use may be harmful in the long term, and point to a new direction for further research.

One potential avenue of future research would be to analyse a person's saliva prior to exposure to a cell phone, and then again after several minutes of exposure. This will allow researchers to see if there is an immediate response, such as a rise in molecules that indicate oxidative stress, Dr. Hamzany says.

Study examines Role of Vegetable Food Pairings in School Plate Waste

School meals paired with popular vegetables are less likely to wind up in garbage bins, research has shown. A research team measured food waste in three elementary schools in Bryan and Dallas.

A study, led by a team of Texas A&M AgriLife Research and the Institute for Obesity Research and Program Evaluation, researchers found that school meals paired with popular vegetables are less likely to end in garbage bins.

The schools are participants in the U.S. Department of Agriculture National School Lunch Program both in pre- and post-implementation of the new standards.

The study was funded by the Alliance for Potato Research and Education and is published in the journal, *Food and Nutrition Sciences*.

"Our research team looked at whether there is a relationship between consumption of certain entrees and vegetables that would lead to plate waste," said Dr. Oral Capps Jr., an AgriLife Research Economist in College Station. "We found that popular entrees such as burgers and chicken nuggets contributed to greater waste of less popular vegetables," Capps added.

"Conversely, entrees paired with potatoes — served as tatoer tots, oven-baked French fries, and wedges — experienced the least amount of overall waste," Capps said.

"Our study shows that optimising entree-vegetable pairings in school meals has the potential to positively impact vegetable consumption, which is especially important for those students relying on school meals for their energy and nutrient needs," Capps said.

The data were collected by a team of 'plate waste warriors', Texas A&M students who were paid by the hour, Capps said. Each wore a different coloured apron that is associated with the assigned waste bin in which the entree is discarded. A minimum of eight workers were needed at each school during the lunch periods, which were typically from 10:45 a.m. through 1 p.m. The A&M students gathered the trays containing leftover portions.

Leftovers were separated into different waste bags and each bag was weighed on a scale for plate-waste measurement. When the students went through the lunch line, a sticker was placed on the food tray to identify the vegetable and entree chosen. Students on the free lunch programme were also evaluated for plate waste. The tray with the corresponding sticker was weighed and

recorded to help calculate the overall food waste.

Growing interest: School-grown vegetables increase salad selection

If children grow vegetables, they are more likely to eat them. A new study shows that when garden grown vegetables were slipped into school salads, children were over four times more likely to eat salad.

"This is a small study, but it suggests gardens can help children's diets — even in the snow belt," said lead author Brian Wansink, PhD, *Director* of the Cornell Food and Brand Lab and author of *Slim by Design*.

This pilot study, conducted in upstate New York, measured the change in vegetable selection and plate waste when school grown salad greens were incorporated in the cafeteria school-lunch. The researchers measured the selections and plate waste of a total of 370 enrolled high school students for over three days.

When the salad bar contained produce grown by the students, the percentage of those who selected salad with their meals increased and on an average, students ate two-thirds of their salad. Unfortunately, in addition to increased salad selection, the amount of plate waste also increased. The overall salad consumption for the entire student body increased from approximately 5 to 12 servings per day.

This study implies the larger potential benefits of school garden programmes. "We see great promise with this research. The first hurdle in increasing vegetable consumption is simply getting children to put them on their plate," concluded *co-author* Drew Hanks of the Ohio State University.

The recess swap: Getting kids to eat their veggies at school

Many schools have reported that fruits and vegetables are feeding trash cans rather than students. This new study published in *Preventive Medicine* shows that one simple no-cost change, holding recess before lunchtime, can increase fruit and vegetable consumption by 54 per cent.

Students participating in the National School Lunch Programme are required to select a fruit and a vegetable side. This regulation is intended to get students to eat more fruits and vegetables; however, just because an apple and green beans made it on to the tray doesn't mean that they will be eaten. Many schools have reported that fruits and vegetables are feeding trash cans rather than students."Recess is often held after lunch so children hurry to 'finish' so that they can go play — this results in wasted fruits and vegetables," explains co-author David Just, PhD of Cornell University. "However, we found that if recess is held before lunch, students come to lunch with a healthy appetite and less urgency and are more likely to eat their fruits and vegetables."

Lead author Joseph Price, PhD, Brigham Young University and Dr. Just conducted their study in a school district in Orem, Utah. Seven schools within the district (grades 1–6) participated in the study, three of which switched recess to before lunch and the rest continued to hold recess after lunch. For four days in the spring of 2011 and nine days in the fall of 2011 the researchers measured fruit and vegetable waste by standing next to

the trash cans and recording the number of servings of fruits and vegetables that each student consumed or threw away. They also measured whether or not each student ate at least one serving of fruits or vegetables.

After analysing a total of 22,939 observations, the researchers concluded that in the schools that switched recess to before lunch children ate 54 per cent more fruits and vegetables. There was also a 45 per cent increase in those eating at least one serving of fruits and vegetables. During the same time period, the consumption of fruits and vegetables actually decreased in the schools that didn't switch.

Not getting a balanced meal can leave children feeling hungry for the rest of the day in school leading to decreased academic performance and excessive snacking when they reach home. The researchers note that, "increased fruit and vegetable consumption in young children can have positive long-term health effects. Additionally, decreasing waste of fruits and vegetables is important for schools and districts that are faced with high costs of offering healthier food choices." Because moving recess is a no-cost way to make kids healthier and make the school meal programme more successful, Price and Just recommend that every school makes the switch.

Seven Reasons to Eat Insects

Eating bugs may not seem appetising, but according to John Coupland, PhD, CFS, *Professor* of Food Science at Penn State University, and *spokesperson* for the Institute of Food Technologists (IFT), insects are a sustainable alternative protein source with nutritional benefits that can't be ignored.

1. **High in protein:** A cricket has 65 per cent protein has whereas beef has about 50 per cent.
2. **High in other nutrients:** Insect protein contains a good range of amino acids and they also contain vitamins, minerals, unsaturated fatty acids and polyunsaturated fatty acids.
3. **Low in fat:** Many insect species have less than 5 grams of fat per serving.
4. **Good for the environment:** Insect farming can be a more sustainable practice because insects don't need much space, can live under all sorts of conditions and are easy to feed.
5. **Can be eaten in a variety of ways:** Insects can be pan-fried, boiled, sautéed, roasted, or baked with a bit of oil and salt. They can also be made into flour and used for bars, breads, crackers and cookies.
6. **Abundant:** Some parts of the world have over 300 species of insects. Something for everyone!
7. **Taste great:** People describe the taste of insects as nutty with a similar flavour to shrimp and chicken. Grasshoppers, ant eggs and wasps are considered a delicacy in several countries.

Around 40 per cent Diabetic Women more likely to suffer Severe Heart Problems than Diabetic Men

A systematic review and meta-analysis of 19 studies, containing almost 11 million patients shows that diabetic women are around

40 per cent more likely to suffer from acute coronary syndromes (heart attack or angina) than diabetic men. The study has been conducted by Dr Xue Dong, the Affiliated ZhongDa Hospital of Southeast University, Nanjing, China, and colleagues, and is presented at this year's annual meeting of the European Association for the Study of Diabetes (EASD) in Stockholm.

'Survival' Protein a Target in Drug-resistant non-Hodgkin Lymphomas

Targeting a cell 'survival' protein could help treat some lymphomas, including cancers with genetic defects that make them resistant to many existing therapies, researchers have discovered. T-cell and B-cell lymphomas are types of white blood cell cancer known as non-Hodgkin lymphomas. T-cell lymphomas account for approximately 20 per cent of non-Hodgkin lymphomas.

How Green Tea could help improve MRIs

Green tea's popularity has grown in recent years. people can drink it, enjoy its flavour in their ice cream and slather it on their skin with lotions infused with it. Now, the tea could have a new, unexpected role — to improve the image quality of MRIs. Scientists report that they successfully used compounds from green tea to help image cancer tumours in mice.

Sanjay Mathur and colleagues note that a recent research has revealed the potential usefulness of nanoparticles — iron oxide, in particular — to make biomedical imaging better. But the nanoparticles have their disadvantages. They tend to cluster together easily and need help getting to their destinations in the body. To address these issues, researchers have recently tried attaching natural nutrients to the nanoparticles. Mathur's team wanted to see if compounds from green tea, which research suggests has anticancer and anti-inflammatory properties, could play this role.

Using a simple, one-step process, the researchers coated iron-oxide nanoparticles with green tea compounds called catechins and administered them to mice with cancer. MRIs demonstrated that the novel imaging agents gathered in tumour cells and showed a strong contrast from surrounding non-tumour cells. The researchers conclude that the catechin-coated nanoparticles are promising candidates for use in MRIs and related applications.

The authors acknowledge funding from the University of Cologne and the EU Project Nanommune.

Humans can empathise with Robots

Researchers have presented the first neuro-physiological evidence of humans' ability to empathise with a robot in perceived pain. Event-related brain potentials in human observers, reflecting empathy with humanoid robots in perceived pain, were similar to those for other humans in pain, except at the beginning of the top-down process of empathy. This difference may be caused by humans' difficulty in taking a robot's perspective.

Empathy is the basic human ability. We often feel empathy towards others in distress and console them. Is it possible for us to emphasise with humanoid robots? Since robots are becoming increasingly popular and common in our daily lives, it is necessary to understand our interaction with robots in social situations.

However, it is not clear how the human brain responds to robots in empathic situations.

Now, researchers at the Department of Information Science and Engineering, Toyohashi University of Technology, in collaboration with researchers at the Department of Psychology, Kyoto University, have found the first neuro-physiological evidence of humans' ability to empathise with robots in perceived pain and highlighted the difference in human empathy towards other humans and robots.

They performed electroencephalography (EEG) in 15 healthy adults, who were observing pictures of either a human or robotic hand in painful or non-painful situations, like a finger being cut by a knife. Event-related brain potentials for empathy towards humanoid robots in perceived pain were similar to those for empathy towards humans in pain. However, the beginning of the top-down process of empathy was weaker in empathy toward robots than toward humans.

"The ascending phase of P3 (350-500 ms after the stimulus presentation) showed a positive shift in the observer for a human in pain in comparison with the no-pain condition, but not for a robot in perceived pain. Then, the difference between empathy towards humans and robots disappeared in the descending phase of P3 (500-650 ms)," explains *Associate Professor* Michiteru Kitazaki. "The positive shift of P3 is considered as reflecting the top-down process of empathy. Its beginning phase seems related to the process of perspective taking, as was shown in a previous study,"says kitazaki."

These results suggest that we empathise with humanoid robots in a similar fashion as we do with other humans. However, the beginning of the top-down process of empathy is weaker for empathy towards robots than towards humans. It may be caused by humans' inability in taking a robot's perspective.

It is reasonable that we cannot take the perspective of robots because their structure is very different from ours. The researchers are trying to manipulate humans' perspective of robots in a further study. This study will contribute to the development of human-friendly robots whom we feel sympathy for and are comfortable with.