

SCIENCE NEWS



Smartphones may decrease sedentary time, increase activity, study finds

Report calls use of prompts 'a promising strategy'

Using smartphone reminders to prompt people to get moving may help reduce sedentary behaviour, report investigators. Evidence has linked sedentary time to increased risk of breast, colorectal, ovarian, endometrial, and prostate cancers as well as weight gain, higher BMI, and obesity. Nevertheless, adults in the US spend an average of about 8 waking hours per day being sedentary.

Evidence has linked sedentary time to increased risk of breast, colorectal, ovarian, endometrial, and prostate cancers as well as weight gain, higher BMI, and obesity. Nevertheless, adults in the U.S. spend an average of about 8 waking hours per day being sedentary. Few interventions have specifically focused on decreasing and interrupting sedentary time and even less

is known about the role of mobile phone technology.

Researchers Darla E. Kendzor, PhD of the University of Oklahoma Health Sciences Center and Kerem Shuval, PhD of the American Cancer Society explored whether smartphone interventions have the potential to influence sedentary behaviour. Nearly two in three U.S. adults owned smartphones in 2015.

Participants wore accelerometers, to measure movement, and carried smartphones for seven consecutive days. Participants who reported more than two hours of sitting during the previous day or replied that they were sitting during any random smartphone assessment received a message emphasising that long uninterrupted sitting is bad for health, and encouraging them to stand up and move around more, and to sit less.

Over the seven-day study period, participants had significantly fewer minutes of daily sedentary time and more daily minutes of active time than controls. Accelerometers

recorded three percent less sedentary time than control participants, equaling about 25 minutes of time spent engaged in activity rather than in sedentary behavior on any given day.

Due to the pilot nature of the study it had inherent limitations that should be noted: it was not randomised and the duration was brief. Nonetheless, the authors say: "Overall, simple smartphone prompts appear to be a promising strategy for reducing sedentary behavior and increasing activity, though adequately-powered and well-designed studies will be needed to confirm these preliminary findings."

Small talk: Electronic media keeping kids from communicating with parents

It happens in many households. Kids are tapping on their cell phones or are preoccupied by their favorite TV show as their parents ask them a question or want them to do a chore. Unlike previous research that has relied on self-reports by parents tracking their children's media usage, a new study used enhanced audio equipment to track the home environment of preschoolers as they interacted with parents in 2010 and 2011.

It's not just teens caught up in electronic media, but also preschoolers. In fact, there is little mother-child dialogue or conversation while children ages 3 to 5 are using media, such as TV, video games and mobile devices, according to a new University of Michigan study.

Unlike previous research that has relied on self-reports by parents tracking their children's media usage, the U-M study used

enhanced audio equipment to track the home environment of preschoolers as they interacted with parents in 2010 and 2011.

For the study's 44 families, the recordings averaged nearly 10 hours daily. The recordings documented the format of media used, duration and communication between the mother and child.

The audio recording output indicated when the recording device "picked up" a media signal, which allowed researchers to code media use and transcribe media-related talk at home. Researchers also examined demographic differences in media use and mother-child communication about media.

Children of mothers with graduate degrees had less electronic media exposure than kids of mothers with high school degrees and/or some college courses, the study showed.

The kids whose moms had advanced degrees often watched educational programs. In addition, these highly educated mothers were more likely than other mothers to discuss media with their children, said Nicholas Waters, the study's lead author and survey specialist at the U-M Institute for Social Research.

"Importantly, children of mothers with less than a graduate degree were exposed to media without any dialogue related to the media content for the vast majority of the time," said co-author Sarah Domoff, a research fellow with the U-M Center for Human Growth and Development.

This is important, she said, because parents' "active mediation" of television and other types of media may mitigate risks associated with media exposure.

Waters and Domoff also collaborated on the study with Sandra Tang, a researcher in the Department of Psychology and Institute for Social Research. Future studies might include father-child interactions, they said.

Domoff will present the findings May 29 at the annual Association for Psychological Science conference in Chicago.

Restoring chemotherapy sensitivity by boosting microRNA levels

By increasing the level of a specific microRNA (miRNA) molecule, researchers have for the first time restored chemotherapy sensitivity in vitro to a line of human pancreatic cancer cells that had developed resistance to a common treatment drug.

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If the miRNA molecules can be delivered to cells in the human body — potentially with nanoparticles — the technique might one day be used to battle the chemotherapy resistance that often develops during cancer treatment. A research team at the Georgia Institute of Technology identified the miRNA used in the research with a computer algorithm that compared the ability of different miRNAs to control the more than 500 genes that were up-regulated in drug-resistant cancer cells.

The study was scheduled to be reported May 27 in the Nature Publishing Group journal *Cancer Gene Therapy*.

"We were specifically interested in what role miRNAs might play in developing drug resistance in these cancer cells," said John McDonald, a professor in Georgia Tech's School of Biology and director of its Integrated Cancer Research Center. "By increasing the levels of the miRNA governing the suite of genes we identified, we increased the cells' drug sensitivity back to what the baseline had been, essentially undoing the resistance. This would suggest that for patients developing chemotherapy resistance, we might one day be able to use miRNAs to restore the sensitivity of the cancer cells to the drugs."

MicroRNAs are small non-coding molecules that function in RNA silencing and post-transcriptional regulation of gene expression. The miRNAs operate via base-pairing with complementary sequences within messenger RNA (mRNA) molecules, silencing the mRNA molecules that control the expression of certain proteins.

Roman Mezencev, a senior research scientist in the McDonald lab, began by exposing a line of pancreatic cancer cells (BxPC3) to increasing levels of the chemotherapy drug cisplatin. After each in vitro treatment, surviving cells were allowed to proliferate before being exposed to a higher level of the drug. After approximately a year and 20 treatment cycles, the resulting cell line had a resistance to cisplatin that was 15 times greater than that of the original cancer cells.

The next step was to study the genetic changes associated with the resistance, comparing levels of more than 2,000 miRNAs in the cisplatin-resistant line to the original cell line that had not been exposed to the drug. Using a hidden Markov model (HMM)

algorithm, they found 57 miRNAs that were either up-regulated or down-regulated, and identified miR-374b as the molecule most likely to be controlling the genes that govern chemotherapy resistance.

While previous work by other researchers has shown that miRNAs can provide a mechanism for the development of drug resistance, the Georgia Tech team took the findings a step farther by increasing the expression of miR-374b. When they did, they found that the cells previously resistant to the cisplatin were again sensitive to the drug — almost back to their original levels.

Techniques to control protein expression are already being used in cancer therapy, but McDonald believes there may be benefits in targeting the activity higher up in the process — at the RNA level. Studies by the Georgia Tech team and by other researchers clearly show an association between chemotherapy resistance and changes in levels of certain miRNAs.

"Molecular evolution is a highly efficient process," McDonald said. "Our evidence suggests that many of the genes regulated by a single microRNA are involved in coordinated cellular functions — in this case, drug resistance. We believe that microRNAs might be particularly good cancer therapeutic agents because when we manipulate them, we are manipulating suites of functionally coordinated genes."

A next step will be to study the effects of manipulating miRNA levels in animal cancer models. The McDonald research team is currently pursuing this possibility by inserting the microRNAs into tumors using nanoscale

hydrogels developed by Andrew Lyon, former chair of Georgia Tech's School of Chemistry and Biochemistry.

McDonald says the study confirms the role of miR-374b in creating resistance, though he says there could be other microRNA molecules involved, as well.

"These cells have acquired resistance to the drug, and we have found a microRNA that seems to be playing a major role," he said. "We have shown that we can bring sensitivity to drugs back by restoring levels of miR374b, but there may be other miRNAs that will work equally as well. Just as there are multiple pathways to establish cancer and chemoresistance, there may be multiple pathways to restore chemosensitivity, as well."

If cancer could one day be treated using miRNAs, it's likely to be a continuing battle rather than a decisive victory, McDonald said. Cancer cells are very resourceful, and will likely find a new genetic route to resistance if one pathway is destroyed. That could require use of a different miRNA to reverse resistance.

While the miRNA research isn't likely to provide a "magic bullet" for cancer, it does show the possible role of these tiny RNA molecules in controlling a broad class of bodily processes.

"There is growing evidence that this class of small regulatory RNAs may be involved in many processes ranging from evolution to heart disease," he said. "MiRNAs are emerging as important players in cancer in general. Here, we are focusing on just one particular aspect of it."

New 'genetic barcode' technique reveals details of cell lineage

By using the gene editing tool CRISPR to create unique genetic 'barcodes,' it's possible to track the lineage of cells in a living organism, a new study reveals

By using the gene editing tool CRISPR to create unique genetic "barcodes," it's possible to track the lineage of cells in a living organism, a new study reveals.

The development could accelerate our understanding of an array of cellular processes. While several different methods exist for tracking cell lineages, each has limitations.

For example, dyes may be used to track the creation of daughter cells, but do not provide insights into the relationships between the descendant cells.

Here, Aaron McKenna and colleagues developed a lineage tracing method called Genome Editing of Synthetic Target Arrays for Lineage Tracing (GESTALT). The method introduces unique patterns of mutations into a distinct, short genetic sequence called a genomic barcode. The DNA sequence of mutated barcodes in daughter cells is then used to reconstruct cell lineage relationships.

McKenna *et al.*, demonstrate the efficacy of this technique in cell culture and live zebrafish. Upon introducing bar codes at the embryonic stage of zebrafish and analysing various tissues at the adult stage, the researchers found that just a few embryonic progenitor cells give rise to the majority of cells that make up adult organs.

For example, only 5 of the 1,138 gene variants observed in a four-month-old zebrafish gave rise to more than 98 per cent of blood cells.

The authors note that this new technique can be used in future analyses to track more complex, multicellular processes in normal development, and that it can also be used to identify the cellular origin of tumors and metastases.

New 3-D hydrogel biochips prove to be superior in detecting bowel cancer at early stages

A new method of diagnosing colorectal cancer has been developed by researchers. The scientists have created a hydrogel-based biochip to help detect bowel cancer (colorectal cancer).

Researchers from the Moscow Institute of Physics and Technology (MIPT), the Engelhardt Institute of Molecular Biology (EIMB RAS), the Institute of Bioorganic Chemistry (IBCh) and a number of other Russian research centers have developed a new method of diagnosing colorectal cancer. The results of the study have been published in Cancer Medicine.

The scientists have created a hydrogel-based biochip to help detect bowel cancer, i.e., colorectal cancer (CRC). CRC is the third most common type of cancer and it develops with minimal clinical symptoms in the early stages. Despite doctors' efforts, the 5-year survival rate does not exceed 36 per cent. Treatment is only effective, and patients only have a good chance of recovery, if the cancer is detected early.

Diagnostic methods that are currently in use are not sufficient. Analyses carried out in

vitro have low specificity and invasive studies such as colonoscopy are not only traumatic, but they are also not always suitable for an early diagnosis, as they do not give a complete picture of the development and distribution of colorectal cancer.

The method proposed by scientists from EIMB RAS, MIPT, the Russian Scientific Center of Surgery, Sechenov First Moscow State Medical University, the Institute of Bioorganic Chemistry, and Buyanov City Clinical Hospital is based on the simultaneous detection of various substances in patients' blood. These substances are autoantibodies against tumor-associated glycans, which can be found in serum at the early stages of cancer, immunoglobulins of different classes, and oncomarkers (molecules produced by tumor cells).

What?

Oncomarkers are already widely used to detect cancer. However, the combination which is used to detect CRC (carcinoembryonic antigen (CEA) with carbohydrate antigen (CA) 19-9) is not sensitive enough and is only able to detect 1 in 2 cases of the disease. To increase diagnostic sensitivity, researchers turned to glycobiology, a rapidly developing science that is focused on the most important biological molecules — glycans.

The best known glycans are amyllum, chitin and cellulose. In terms of chemistry, glycans are biopolymers consisting of a large number of monosaccharides (glucose and fructose are commonly known examples) linked glycosidically (by oxygen atoms). Besides acting as nutrients and building materials for cells, glycans are important for the contact between cells, appropriate organ growth and

much more. Tumor cells have special glycans enabling scientists to differentiate them from healthy cells, and this is the key aspect of the new study.

To detect tumor-associated glycans, scientists use autoantibodies. Antibodies are molecules produced by the immune system to attack enemy cells with high precision. They are "fine-tuned" to interact with a particular target. Antibodies against the influenza virus, for example, interact only with the protein contained in the viral particles of a certain strain, and autoantibodies against tumor-associated glycans react exclusively with glycans that are only found in CRC cells.

Antibodies are able to define target cells and initiate the process of destroying them. Any cells may become a target if they have transformed to cancer cells or become infected with a virus. Many laboratory diagnostic methods and scientific experiments are based on the unique capacity of antibodies to selectively detect other molecules.

How?

The researchers proposed looking for autoantibodies against tumor-associated glycans in serum. The method has already demonstrated its potential in the diagnosis of ovarian cancer (Swiss scientists published the corresponding paper in 2012) with biological microchips used as the primary diagnostic tools.

The idea of using microchips was first suggested in the 1980s by Andrei Mirzabekov, who was the head of the Institute of Molecular Biology and MIPT's Department of Molecular Biophysics. Today, this idea is said to be the technical basis for the biology of the 21st century. A microchip is normally a flat plate

containing samples of particular biological molecules, however in their new paper the researchers examined a new development — a three-dimensional hydrogel-based biochip.

These chips were developed at EIMB RAS. They are 3D cells made of a special gel which contains the required reagents — molecular probes. The structure of the gel provides an optimal environment for conducting tests, and the scientists were able to solve a number of problems to ensure more accurate diagnoses — e.g., they achieved equal distribution of molecular probes with a far greater sensitivity than regular "flat" systems (or "planar" systems, as specialists call them).

What were the results?

The researchers developed a model of the test-system which is able to simultaneously measure the concentration of protein-based oncomarkers, the autoantibodies-to-glycans ratio, and immunoglobulins IgG, IgA, and IgM in a patient's blood. Taking into account the fact that most protein-based markers are not specific in terms of the location and type of the tumor, scientists divided them into groups — diagnostic and prognostic signatures (combinations of protein-based oncomarkers and antibodies to glycans, etc.)

Using the model, the scientists analysed the sera of 33 patients with colorectal cancer, 69 healthy donors and 27 patients with inflammatory bowel disease. Cases like Crohn's disease and diverticulitis may in the long term lead to colorectal cancer, however, they should not be confused with one another when diagnosing the disease — the laboratory analysis system needs to not only be sensitive, but also precise.

This method surpasses all other existing methods. The model of the test-system based on diagnostic signatures was able to diagnose CRC in 95 per cent of cases, compared to 79 per cent detected by traditional methods. The sensitivity of CRC detection (in patients with Stage II-IV CRC) was 87 per cent versus 21 per cent. This increase is clearly a significant achievement. The specificity of the method is 97 per cent.

The sensitivity of a diagnostic method is its capacity to detect a disease. The higher the sensitivity, the better the results, but sensitivity on its own is not enough to make a diagnosis. The tests must also be correct in cases of another diagnosis, i.e., if there is no cancer, the results should not say that there is cancer.

The first figure of 95 per cent is the ability to accurately predict the diagnosis, which means that the disease will be diagnosed correctly for 95 patients out of 100. The sensitivity of 87 per cent tells us that the method will detect CRC in 87 out of 100 cases of patients with the disease. The traditional method of detecting CRC has a sensitivity of 21 per cent, which means that a number of patients with CRC will be declared healthy. In patients with inflammatory bowel disease, cancer will be correctly diagnosed in 97 per cent of cases.

"The method developed at EIMB RAS has great potential to be used in diagnosing gastrointestinal diseases. We hope that testing systems based on the method will soon appear in clinical laboratories in Russia," says Zhanna Zubtsova, one of the authors of the new method, Ph.D. in Physics and Mathematics, assistant professor at MIPT.

Standards to Improve Sustainable Manufacturing

A public-private team led by the National Institute of Standards and Technology (NIST) has created a new international standard that can 'map' the critically important environmental aspects of manufacturing processes, leading to significant improvements in sustainability while keeping a product's life cycle low cost and efficient.

Anyone who's ever covered a wall with sticky notes to clearly map all of the steps in a process knows how valuable that exercise can be. It can streamline workflow, increase efficiency and improve the overall quality of the end result. Now, a public-private team led by the National Institute of Standards and Technology (NIST) has created a new international standard that can "map" the critically important environmental aspects of manufacturing processes, leading to significant improvements in sustainability while keeping a product's life cycle low cost and efficient.

According to the U.S. Energy Information Administration, manufacturing accounts for one-fifth of the annual energy consumption in the United States—approximately 21 quintillion joules (20 quadrillion BTU) or equivalent to 3.6 billion barrels of crude oil. To reduce this staggering amount and improve sustainability, manufacturers need to accurately measure and evaluate consumption of energy and materials, as well as environmental impacts, at each step in the life cycles of their products.

However, making these assessments can be difficult, costly and time consuming, as many manufactured items are created in multiple and/or complex processes, and the environmental impacts of these processes

can vary widely depending on how and where the manufacturing occurs. Additionally, the data collected are often unreliable, frequently not derived through scientific methods, and do not compare well with those from other types of manufacturing processes or from processes at different locations.

These issues are beginning to be addressed through a recently approved ASTM International standard for characterising the environmental aspects of manufacturing processes (ASTM E3012-16). The guide provides manufacturers with a science based, systematic approach to capture and describe information about the environmental aspects for any production process or group of processes, and then use that data to make informed decisions on improvements. The standard is easily individualised for a company's specific needs.

"It's similar to using personal finance software at home where you have to gather income and expenditure data, 'run the numbers' and then use the results to make smart process changes—savings, cutbacks, streamlining, etc.,—that will optimise your monthly budget," said NIST systems engineer Kevin Lyons, who chaired the ASTM committee that developed the manufacturing sustainability standard.

"We designed ASTM E3012-16 to let manufacturers virtually characterise their production processes as computer models, and then, using a standardised method, 'plug and play' the environmental data for each process step to visualise impacts and identify areas for improving overall sustainability of the system," Lyons said.

For their next step, Lyons and his colleagues on the ASTM sustainability committee plan

to define key performance indicators (KPIs)—metrics of success—for manufacturing sustainability that can be fed back into the E3012-16 standard to make it even more effective.

"In the long term, we'd also like to establish a repository of process models and case studies from different manufacturing sectors so that users of the standard can compare and contrast against their production methods," Lyons said.

Through a collaboration with Oregon State University, NIST held regional industry roundtables in Boston, Chicago and Seattle to learn how best to introduce the benefits of the sustainability standard to U.S. manufacturers, especially small- and medium-size firms. A report about those meetings will be published later this year.

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Global Nitrogen Footprint Mapped for First Time

Four countries cause almost half the world's emissions, pollution from foreign demand

The first-ever global nitrogen footprint, encompassing 188 countries, has found the United States, China, India and Brazil are responsible for 46 per cent of the world's nitrogen emissions. The economic modelling, which grouped the nitrogen footprint into top-ranking bilateral trade relationships, noted a trend for increased nitrogen production and found developed nations largely responsible for emissions abroad for their own consumption. The first-ever global nitrogen footprint, encompassing 188 countries, has found the United States, China, India and Brazil are responsible for 46 per cent of the world's nitrogen emissions.

The international collaboration, led by the University of Sydney's Integrated Sustainability Analysis team in the Faculty of Science, found developing countries tend to embody large amounts of nitrogen emissions from their exports of food, textiles and clothing. Australia is one of the few wealthy nations that is a net exporter of nitrogen, because of the substantial agriculture industry.

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Ph.D. candidate Ms Arunima Malik, who co-authored the paper with University of Sydney colleagues Professor Manfred Lenzen and Dr Arne Geschke, as well as two researchers

from Yokohama National University and one from Kyushu University in Japan, said significant nitrogen net importers were almost exclusively developed economies.

"High-income nations are responsible for more than 10 times the emissions of the poorest nations," Ms Malik said. "This reflects greater consumption of animal products, highly processed foods and energy-intensive goods and services".

The vast bulk of emissions came from industries such as agriculture, transport and energy generation. Emissions from consumers-end use were mostly from sewage.

A paper on the research is published by the international journal Nature Geoscience.

Nitrogen pollution was becoming an increasingly significant problem, as countries not only consumed the naturally occurring element but were also producing greater quantities of synthetic nitrogen, Professor Lenzen said. New work by the University of Sydney looking at trends was expected to be completed soon.

"Policies are needed to integrate nitrogen supply-chains globally in order to reduce pollution, Professor Lenzen said. "We know nitrogen emissions are increasing — just as carbon emissions are increasing as populations expand.

"We are now analysing the trends, such as increased affluence and consumption, and looking at the various industries responsible for nitrogen pollution."

Findings of the research of 2010 data includes:

- Consumption in the United States, China, India and Brazil is responsible for 46 per cent of global nitrogen emissions.
- Japan and other developed nations import reactive nitrogen embodied in Chinese-made clothing as well as US and Australian meat.
- The United Kingdom, Germany, Italy, and France exchange significant amounts of nitrogen emissions embodied in food products.
- Hong Kong's nitrogen imports are primary agricultural and raw food products because it lacks land to produce its own livestock and crops.
- Developing countries such as China, India, Pakistan, and Thailand embody large amounts of nitrogen emissions into their exports of textiles and clothing.
- High-income exceptions are Australia, New Zealand, and Argentina, which export significant nitrogen embodied in livestock products.
- Per-capita nitrogen emission ranged from more than 100 kg annually for wealthy nations such as Hong Kong and Luxembourg, to less than 7 kg for developing nations such as Papua New Guinea, Côte d'Ivoire, and Liberia.
- Of the 189 teragrams of nitrogen emitted worldwide in 2010, 161 Tg was emitted from industries and agriculture and only 28 Tg was emitted by consumers.

Texting at Night affects Teens' Sleep, Academic Performance

Researcher finds that instant messaging in the dark makes a difference compared to having the lights on

The study, published in the *Journal of Child Neurology*, is the first of its kind to link nighttime instant messaging habits of American teenagers to sleep health and school performance.

"We need to be aware that teenagers are using electronic devices excessively and have a unique physiology," says study author Xue Ming, professor of neuroscience and neurology at Rutgers New Jersey Medical School. "They tend to go to sleep late and get up late. When we go against that natural rhythm, students become less efficient."

The American Academy of Pediatrics reports that media use among children of all ages is increasing exponentially; studies have found that children ages 8 to 18 use electronic devices approximately seven-and-a-half hours daily.

Ming's research is part of a small but growing body of evidence on the negative effects of electronics on sleep and school performance. But few studies, Ming says, have focused specifically on instant messaging.

"During the last few years I have noticed an increased use of smartphones by my patients with sleep problems," Ming says. "I wanted to isolate how messaging alone — especially after the lights are out — contributes to sleep-related problems and academic performance."

To conduct her study, Ming distributed surveys to three New Jersey high schools — a suburban and an urban public school and a private school — and evaluated the 1,537 responses contrasting grades, sexes, messaging duration and whether the texting occurred before or after lights out.

She found that students who turned off their devices or who messaged for less than 30 minutes after lights out performed significantly better in school than those who messaged for more than 30 minutes after lights out.

Students who texted longer in the dark also slept fewer hours and were sleepier during the day than those who stopped messaging when they went to bed. Texting before lights out did not affect academic performance, the study found.

Although females reported more messaging overall and more daytime sleepiness, they had better academic performance than males. "I attribute this to the fact that the girls texted primarily before turning off the light," Ming says.

The effects of "blue light" emitted from smartphones and tablets are intensified when viewed in a dark room, Ming says. This short wavelength light can have a strong impact on daytime sleepiness symptoms since it can delay melatonin release, making it more difficult to fall asleep — even when seen through closed eyelids.

"When we turn the lights off, it should be to make a gradual transition from wakefulness to sleep," Ming says. "If a person keeps getting text messages with alerts and light emission, that also can disrupt his circadian rhythm. Rapid Eye Movement sleep is the

period during sleep most important to learning, memory consolidation and social adjustment in adolescents. When falling asleep is delayed but rising time is not, REM sleep will be cut short, which can affect learning and memory."

Ming notes some benefits to early-evening media use, such as facilitating collaboration for school projects, providing resources for tutoring, increasing school readiness and possibly offering emotional support systems.

She suggests that educators recognise the sleep needs of teenagers and incorporate sleep education in their curriculum. "Sleep is not a luxury; it's a biological necessity. Adolescents are not receiving the optimal amount of sleep; they should be getting 8-and-a-half hours a night," says Ming. "Sleep deprivation is a strong argument in favor of later start times for high schools - like 9 a.m."

Optogenetic Technology Uses Light to Trigger Immunotherapy

"This is the first time anybody has used optogenetic techniques to stimulate the immune system, much less to fight cancer cells," said study author Gang Han, Ph.D., Assistant Professor of biochemistry and molecular pharmacology at UMass Medical School. "The advantage an optogenetic approach has over other immunotherapies, which typically activate global immune responses, is that we now have the tools to closely monitor the dose and location of the treatment to mitigate potential side effects to healthy tissues."

Neuroscientists have been using optogenetics, which combine breakthroughs in both optical technology and genetics, to

stimulate the activity of individual neurons in animals using light. Nerve cells are engineered with light-sensitive proteins that allow researchers to send or stop sending nerve impulses when they are exposed to a particular color of light. This has allowed researchers to map and decode neural circuitry in live animals.

Adapting this technology for use in other cells has proved challenging. Optogenetic technologies targeting neurons rely on the electrical impulses these cells use to quickly transmit messages. Other cells use different, and more diverse, methods of communicating, making them more difficult to turn on and off. These cells are also typically found deeper in the body where it is difficult for light to penetrate.

Dr. Han, in collaboration with Yubin Zhou, Ph.D., Assistant Professor at the Center for Translational Cancer Research at the Texas A&M Health Science Center Institute of Biosciences and Technology, approached these problems by focusing on the flow of calcium ions into cells as a potential on/off switch and using specially designed up-conversion nanoparticles to activate them. Details of the technology were published in *eLife*.

Dr. Zhou and his team genetically engineered dendritic cells with a light-sensitive calcium gate-controlling protein. When exposed to blue light, the calcium ion gates on the dendritic cell open and it is activated. (Once activated, the dendritic cells are responsible for programming T-cells that then attack infected or cancerous cells.) When the light is turned off, the gates close and the dendritic cells turn off.

To reach immune cells in a live animal, Han attached to the cells a nanoparticle he developed that converts near-infrared light into visible blue light. Unlike blue light, near-infrared light can penetrate tissue to a depth of two centimeters. When the near-infrared light hits the nanoparticle inside the animal it converts it to blue light. This, in turn, activates the light sensitive protein controlling the flow of calcium to the cell.

The light-sensitive cells and nanoparticles, called opto-CRAC, were then delivered with the tumor antigen surrogate ovalbumin to mice with melanoma tumors in their lymph nodes to see if an immune response could be activated to target cancer cells. A tumor antigen, such as ovalbumin, is needed to program newly activated T-cells with their intended target.

"When we exposed a near-infrared laser beam to these animal models injected with both the nanoparticle and the genetically engineered immune cells, this caused calcium channels on the dendritic cells to open and we saw a corresponding increase in the number of T-cells that were activated," said Han.

"More importantly," said Han, "we saw significantly suppressed tumor growth and reduced tumor volume in these animals. This suggests that the activated dendritic cells were successfully programming T-cells to attack the tumor."

One advantage of this method is that researchers can finely tune which cells are activated and in what part of the body. This specificity could potentially reduce system-wide side effects often seen with other targeted cancer immunotherapies.

It's also likely that this technique can be adapted to study other immune, heart, endocrine or hematopoietic cells. "Any cell that used calcium to perform its task could potentially be activated using this newly developed technology," said Han. "The flexibility of this system means it can be adapted to explore other cellular processes while minimally interfering with other physiological or biological functions."

How Mobile Ads Leak Personal Data

The personal information of millions of smartphone users is at risk due to in-app advertising that can leak potentially sensitive user information between ad networks and mobile app developers, according to a new study by the School of Computer Science at the Georgia Institute of Technology.

Results presented Tuesday, February 23 at the 2016 Network and Distributed System Security Symposium (NDSS '16) in San Diego, Calif, by researchers Wei Meng, Ren Ding, Simon Chung, and Steven Han under the direction of Professor Wenke Lee.

The study examined more than 200 participants who used a custom-built app for Android-based smartphones, which account for 52 per cent of the U.S. smartphone market according to comScore's April 2015 report. Georgia Tech researchers reviewed the accuracy of personalised ads that were served to test subjects from the Google AdNetwork based upon their personal interests and demographic profiles; and secondly, examined how much a mobile app creator could uncover about users because of the personalised ads served to them.

Researchers found that 73 per cent of ad impressions for 92 per cent of users are correctly aligned with their demographic profiles. Researchers also found that, based on ads shown, a mobile app developer could learn a user's:

- gender with 75 per cent accuracy,
- parental status with 66 per cent accuracy,
- age group with 54 per cent accuracy, and
- could also predict income, political affiliation, marital status, with higher accuracy than random guesses.

Some personal information is deemed so sensitive that Google explicitly states those factors are not used for personalisation, yet the study found that app developers still can discover this information due to leakage between ad networks and app developers.

"Free smart phone apps are not really free," says Wei Meng, Lead Researcher and a graduate student studying computer science. "Apps — especially malicious apps — can be used to collect potentially sensitive information about someone simply by hosting ads in the app and observing what is received by a user. Mobile, personalised in-app ads absolutely present a new privacy threat."

How it Works

- Mobile app developers choose to accept in-app ads inside their app.
- Ad networks pay a fee to app developers in order to show ads and monitor user activity — collecting app lists, device models, geo-locations, etc.

This aggregate information is made available to help advertisers choose where to place ads.

- Advertisers instruct an ad network to show their ads based on topic targeting (such as "Autos and Vehicles"), interest targeting (such as user usage patterns and previous click thrus), and demographic targeting (such as estimated age range).
- The ad network displays ads to appropriate mobile app users and receives payment from advertisers for successful views or click thrus by the recipient of the ad.
- In-app ads are displayed unencrypted as part of the app's graphical user interface. Therefore, mobile app developers can access the targeted ad content delivered to its own app users and then reverse engineer that data to construct a profile of their app customer.

Unlike advertising on a Website page, where personalised ad content is protected from publishers and other third parties by the Same Origin Policy, there is no isolation of personalised ad content from the mobile app developer.

For the smartphone dependent population — the 7 per cent of largely low-income Americans, defined by Pew Internet ("U.S. Smartphone Use in 2015"), who have neither traditional broadband at home nor any other online alternative — their personal information may be particularly at risk.

"People use their smartphones now for online dating, banking, and social media every day,"

said Wenke Lee, professor of computer science and co-director of the Institute for Information Security and Privacy at Georgia Tech. "Mobile devices are intimate to users, so safeguarding personal information from malicious parties is more important than ever."

The study acknowledges that the online advertising industry is taking steps to protect users' information by improving the HTTPS protocol, but researchers believe the threat to user privacy is greater than HTTPS protection can provide under a mobile scenario.

The researchers contacted Google Ad Networks about their finding.

Eternal 5D Data Storage could Record the History of Humankind

Scientists at the University of Southampton have made a major step forward in the development of digital data storage that is capable of surviving for billions of years.

Using nanostructured glass, scientists from the University's Optoelectronics Research Centre (ORC) have developed the recording and retrieval processes of five dimensional (5D) digital data by femtosecond laser writing.

The storage allows unprecedented properties including 360 TB/disc data capacity, thermal stability up to 1,000°C and virtually unlimited lifetime at room temperature (13.8 billion years at 190°C) opening a new era of eternal data archiving. As a very stable and safe form of portable memory, the technology could be highly useful for organisations with big archives, such as national archives, museums and libraries, to preserve their information and records.

The technology was first experimentally demonstrated in 2013 when a 300 kb digital copy of a text file was successfully recorded in 5D.

Now, major documents from human history such as Universal Declaration of Human Rights (UDHR), Newton's Opticks, Magna Carta and Kings James Bible, have been saved as digital copies that could survive the human race. A copy of the UDHR encoded to 5D data storage was presented to UNESCO by the ORC at the International Year of Light (IYL) closing ceremony in Mexico.

The documents were recorded using ultrafast laser, producing extremely short and intense pulses of light. The file is written in three layers of nanostructured dots separated by five micrometres (one millionth of a metre).

The self-assembled nanostructures change the way light travels through glass, modifying polarisation of light that can then be read by combination of optical microscope and a polariser, similar to that found in Polaroid sunglasses.

Coined as the 'Superman memory crystal', as the glass memory has been compared to the "memory crystals" used in the Superman films, the data is recorded via self-assembled nanostructures created in fused quartz. The information encoding is realised in five dimensions: the size and orientation in addition to the three dimensional position of these nanostructures.

Professor Peter Kazansky, from the ORC, says: "It is thrilling to think that we have created the technology to preserve documents and information and store it in space for future generations. This technology

can secure the last evidence of our civilisation: all we've learnt will not be forgotten."

New Glass Technology Discovered: Window Doubling as a Huge TV?

Imagine if the picture window in your living room could double as a giant thermostat or big screen TV. A discovery by researchers at the University of British Columbia has brought us one step closer to this becoming a reality.

Researchers at UBC's Okanagan campus in Kelowna found that coating small pieces of glass with extremely thin layers of metal like silver makes it possible to enhance the amount of light coming through the glass. This, coupled with the fact that metals naturally conduct electricity, may make it possible to add advanced technologies to windowpanes and other glass objects.

"Engineers are constantly trying to expand the scope of materials that they can use for display technologies, and having thin, inexpensive, see-through components that conduct electricity will be huge," said UBC Associate Professor and lead investigator Kenneth Chau. "I think one of the most important implications of this research is the potential to integrate electronic capabilities into windows and make them smart."

The next phase of this research, added Chau, will be to incorporate their invention onto windows with an aim to selectively filter light and heat waves depending on the season or time of day.

The theory underlying the research was developed by Chau and collaborator Loïc Markley, an assistant professor of engineering

at UBC. Chau and Markley questioned what would happen if they reversed the practice of applying glass over metal—a typical method used in the creation of energy efficient window coatings.

"It's been known for quite a while that you could put glass on metal to make metal more transparent, but people have never put metal on top of glass to make glass more transparent," said Markley. "It's counter-intuitive to think that metal could be used to enhance light transmission, but we saw that this was actually possible, and our experiments are the first to prove it."

Mapping the Maya: Laser Technology Reveals Secrets of Ancient Civilization

The steamy jungles of northern Guatemala don't reveal secrets easily. For centuries, the overgrown landscape has protected most of the remains of the Maya who once tamed it — yielding slowly to modern scientists seeking to learn more about the ancient civilisation known for its sophisticated hieroglyphic script, art, architecture and mathematics.

The Maya civilization began to emerge about 3,000 years ago, and reached its peak during the Classic Period, from about A.D. 250-900. Now, technology that allows for digital deforestation has uncovered thousands of new Maya structures previously undetected beneath smothering vegetation. For archaeologists like Thomas Garrison, Assistant Professor of anthropology at Ithaca College, the findings have done far more than recast notions of the size and density of the Central American society.

"Frankly, it's turning our discipline on its head," he said.

Garrison helped orchestrate the 2016 aerial survey these revelations stem from. The findings and the technology behind them — LiDAR (light detection and ranging) — will be the focus of a new National Geographic documentary to premiere on February 6 at 9 p.m. EST titled "Lost Treasures of the Maya Snake King." The documentary will follow a NatGeo explorer as he treks deep in the jungle to seek out a pyramid detected in the survey.

Garrison appears in the documentary commenting on the LiDAR mapping and its results. The program will also feature custom-designed images of many of the newly revealed structures, as translated from the data.

Laser Show in the Jungle

LiDAR is a method of mapping from the sky: An airplane-mounted device sends a constant pulse of laser light across a swath of terrain; precise measurements of how long it takes the emitted beams to bounce off surfaces are taken and translated into topographic data.

The laser pierces through the smallest gaps in the vegetation to record the lay of the land below with remarkable accuracy. The resulting data can be tweaked to filter out the trees, thus offering an unencumbered view of everything else on the surface.

The technology is a boon for surveys in jungles like those in lowland Guatemala, where dense canopy hinders other methods of aerial survey and thick undergrowth can conceal the relationship even between known structures.

"In that kind of environment where you can't see [a few feet in front of yourself], it's very hard to piece that all together," Garrison said. In a swampy area of rolling hillocks rising from the muck, for example: "You have this idea that there's some little stuff on the hills, but the LiDAR lets you see it in its totality."

The survey of 2,100-square kilometers encompassed several major Maya sites, including the largest at Tikal, and El Zotz, where Garrison focuses his research. The LiDAR mapping revealed over 60,000 previously unknown structures in total, from unknown pyramids, palace structures, terraced fields, roadways, defensive walls and towers, and houses. Archaeologists are realising that the ancient population centers they've spent decades studying are much bigger than they speculated.

"Everyone is seeing larger, denser sites. Everyone," Garrison said. "There's a spectrum to it, for sure, but that's a universal: everyone has missed settlement in their [previous] mapping."

Especially telling to Garrison are newly revealed agricultural features that would be necessary to support the lowland Maya population during their centuries of civilization — population estimates have now expanded from a few million to 10–20 million — and defensive structures that suggest warfare was far more prevalent than previously known.

Only the Beginning

The LiDAR survey is a collaboration between archaeologists from the U.S., Europe and Guatemala, and the Fundación PACUNAM (Patrimonio Cultural y Natural Maya), a Guatemalan philanthropic and cultural heritage preservation organisation.

Garrison serves as one of the archaeology advisors to the project, and was fundamental in lobbying for the survey, which is now the single largest ever conducted in the field of Mesoamerican archaeology. Fundraising is already taking place for a second LiDAR survey of similar size, he said.

The LiDAR findings are only the beginning. There is still much to discover about the rise, peak and fall of the Maya civilisation. The LiDAR data points to new areas where those answers may be found through fieldwork and excavation.

"That's the challenge now. Now we have so much data," Garrison said. "How do we handle it and how do we move forward with it? We've still got to get to those places, we've still got to check them out.

"It's difficult to convey how exciting this time is for us."

Mobile Device Addiction Linked to Depression, Anxiety

Is cellphone use detrimental to mental health? A new study from the University of Illinois finds that addiction to, and not simply use of, mobile technology is linked to anxiety and depression in college-age students.

The study was published in the journal *Computers in Human Behaviour*.

"There's a long history of the public fearing new technologies as they are deployed in society," said U. of I. psychology Professor Alejandro Lleras, who conducted this study with undergraduate honors student Tayana Panova. This fear of new technology happened with televisions, video games and most recently, smartphones, he said.

Lleras and Panova surveyed over 300 university students with questionnaires that addressed the students' mental health, amount of cellphone and Internet use, and motivations for turning to their electronic devices. Questions included: "Do you think that your academic or work performance has been negatively affected by your cellphone use?" and "Do you think that life without the Internet is boring, empty and sad?"

The goal was to see if addictive and self-destructive behaviours with phones and the Internet related to mental health.

"People who self-described as having really addictive style behaviours toward the Internet and cellphones scored much higher on depression and anxiety scales," Lleras said. However, the researchers found no relationship between cellphone or Internet use and negative mental health outcomes among participants who used these technologies to escape from boredom. Thus, the motivation for going online is an important factor in relating technology usage to depression and anxiety, Lleras said.

In a follow-up study, Lleras tested the role of having, but not using, a cellphone during a stressful situation. Individuals who were allowed to keep their cellphones during an experimental, stressful situation were less likely to be negatively affected by stress compared with those without their phones.

"Having access to a phone seemed to allow that group to resist or to be less sensitive to the stress manipulation," Lleras said. This benefit was both small and short-lived, but suggests the phone might serve as a comfort item in stressful or anxiety-inducing situations.

While the role of phones as comfort items is somewhat tenuous, the relationship between motivation for cellphone or Internet use and mental health warrants further exploration, Lleras said. Breaking addictive technology habits may provide an important supplemental treatment for addressing mental health issues such as general anxiety disorder or depression, he said.

"We shouldn't be scared of people connecting online or talking on their phones," he said. "The interaction with the device is not going to make you depressed if you are just using it when you are bored. This should go toward soothing some of that public anxiety over new technology."

Researchers use New Technology to Sequence Mosquito Sex Chromosome

Researchers sequenced the Y chromosome — the genetic driver of sex-determination and male fertility — in a family of malaria spreading mosquitoes

A team of researchers with the Fralin Life Science Institute at Virginia Tech, working with a large international consortium, has sequenced the Y chromosome—the genetic driver of sex-determination and male fertility— in a family of malaria spreading mosquitoes.

The findings, published in the Proceedings of the National Academy of Sciences will inform a variety of genetically based mosquito control strategies that focus on creating more males than females.

Male mosquitoes do not bite and are harmless to humans, while female

mosquitoes bite humans to get the blood they need for egg production.

"Thirteen years after the publication of a draft genome of the *Anopheles gambiae* mosquito, we've finally characterised its Y chromosome," said co-author Zhijian Jake Tu, a Professor of Biochemistry in the College of Agriculture and Life Sciences and a Fralin Life Science Institute affiliate. "This is one of the last pieces of the puzzle. Having the Y will help us figure out the genetic basis of male biology in future studies."

The new information about the Y chromosome will facilitate efforts to reduce female mosquitoes or create sterile males—strategies of interest to research teams across the world.

"The Y chromosome had previously not been characterised because it mostly consists of repetitive DNA sequences that stump the algorithms used by computers to assemble the mosquito's entire genetic make-up," said co-author Brantley Hall of Christiansburg, Va., a doctoral student in the Genetics, Bioinformatics and Computational Biology program.

"We were able to get around this obstacle (at least partially) by using a new long single-molecule sequencing technology, a new bioinformatics algorithm specifically designed to identify Y sequences, and physical mapping of DNA directly to the Y chromosome," said co-author Igor Sharakhov, an Associate Professor of entomology in the College of Agriculture and Life Sciences and a Fralin Life Science Institute affiliate. "Our study provides a long-awaited foundation for studying mosquito Y chromosome biology and evolution."

"Our combined efforts have resulted in the most extensive characterisation of Y chromosome to date in additional malaria vectors as well, which will help identify targeted vector control approaches for different species," said co-author Atashi Sharma, a doctoral student in the Department of Entomology in the College of Agriculture and Life Sciences.

The research was in collaboration with Nora Besansky, the Rev. John Cardinal O'Hara C.S.C. Professor of Biological Sciences at the University of Notre Dame. Three graduate students at Virginia Tech were involved in the study, with Brantley Hall and Atashi Sharma being co-first authors on the paper. Xiaofang Jiang, a graduate student in the Genetics, Bioinformatics, and Computational Biology and Biochemistry, Vladimir Timoshevskiy, Research Associate, and Maria Sharakhova, an Assistant Professor of Entomology in the College of Agriculture and Life Sciences, from Virginia Tech also participated in the study. Philippos-Aris Papathanas of the University of Perugia and Changde Cheng of the University of Norte Dame are also co-first authors.

Malaria causes as many as 907,000 deaths each year, mostly among children in sub-Saharan Africa. Anopheles mosquitoes, which bite mainly between dusk and dawn, transmit human malaria by spreading Plasmodium parasites that multiply in the human liver and infect red blood cells.

Big Data for Text: Next-generation Text Understanding and Analysis

News portals and social media are rich information sources, for example for predicting stock market trends. Numerous

service providers allow for searching large text collections by feeding their search engines with descriptive keywords. Keywords tend to be highly ambiguous, though, and quickly show the limits of search technologies. Computer scientists from Saarbrücken developed a novel text analysis technology that considerably improves searching very large text collections by means of artificial intelligence. Beyond search, this technology also assists authors in researching and even in writing texts by automatically providing background information and suggesting links to relevant Web sites.

Ambiverse, a spin-off company from the Max Planck Institute for Informatics in Saarbrücken, will be presenting this novel technology during Cebit 2016 in Hannover from 14 to 18 March at Saarland's research booth.

Living in the age of business smartphones and enterprise chatrooms, most information in companies is not distributed via spoken words but rather through e-mails, databases, and internal news portals. "According to a survey by the market analyst Gartner, a mere quarter of all companies are using automatic methods to analyse their textual information. By 2021, Gartner predicts 65 per cent will do so. This is because the amount of data inside companies is continuously growing and hence, it becomes more and more costly to have it structured and to search it successfully," says Johannes Hoffart, a researcher at the Max Planck Institute for Informatics and founder of Ambiverse. His team developed a novel text analysis technology for analysing huge amounts of text where massive computing power and artificial

intelligence (AI) are continuously "thinking along" in the background.

"For analysing texts, we rely on extremely large knowledge graphs which are built upon freely available sources such as Wikipedia or large media portals on the Web. These graphs can be augmented with domain- or company-specific knowledge, such as product catalogs or customer correspondences," says Hoffart. By applying complex algorithms, these texts are screened further and analysed with linguistic tools. "Our software then assigns companies and areas of business to their corresponding categories, which allows us to gather valuable insights on how well one's own products are positioned in the market in comparison to those of the competitors," he explains. Particularly challenging hereby is the fact that product or company names are anything but unique and tend to have completely different meanings in different contexts, making them highly ambiguous.

"Our technology helps to map words and phrases to their correct objects of the real-world, that way resolving ambiguities automatically," explains the computer scientist. "Paris" for example stands for the city of light and the French capital, but also for a figure from Greek mythology or a millionfold-mentioned party girl with German ancestors — always depending on context. "Efficiently searching huge text collections is only possible if the different meanings of a name or a concept are correctly resolved," says Hoffart. The smart search engine developed by his team continuously learns and improves over time, and also automatically associates new text entries to matching categories. "These algorithms are hence attractive for companies that analyse

online media or social networks to measure the degree of brand awareness for a product or the success of a marketing campaign," says Hoffart further.

At Cebit, Ambiverse will further present a smart authoring platform that assists authors in researching and writing texts. Users who enter texts are automatically provided with background information, for example company-internal guidelines and manuals or Web links. "Relevant concepts are linked automatically and links for further research are shown" says the computer scientist.

Visitors to the Ambiverse Cebit booth (hall 6, booth 28) will also have the opportunity to compete with their novel AI technology by playing a question-answering game. Ambiverse is funded by the German Federal Ministry for Economic Affairs through an EXIST Transfer of Research grant.

Vention makes 3D Mapping more Accurate

A new 3D mapping model integrates multi-platform satellite/aerial imagery and laser scanning data to achieve a higher accuracy in mapping products by 26–66 per cent to centimetre level compared to the conventional mapping technologies.

The two major traditional 3D mapping techniques are photogrammetry using satellite/aerial imagery and laser scanning. The former offers higher accuracy in the horizontal direction while the latter shows higher accuracy in vertical direction. They may produce errors at different levels and there are usually inconsistencies between the mapping products derived from them.

To eliminate data errors and integrate the advantages of the existing technologies, Professor Wu Bo at The Hong Kong Polytechnic University (PolyU)'s Department of Land Surveying and Geo-Informatics developed a "Novel Integrated 3D Mapping Model." Integrating multi-platform satellite/aerial imagery and laser scanning data, the technology greatly improved the accuracy in mapping products by 26–66 per cent to centimetre level.

The cost of the mapping products produced by this model is more or less the same as the satellite imagery. This new technology

allows monthly updates and handling of massive data and can cater for the needs in the big data era. It can be used in topographic mapping and 3D modelling of cities for smart city development. For example, it is particularly useful in analysing ventilation, visibility and sunlight distribution between buildings.

The invention won a Gold Medal and Special Merit Award from the Nizhny Novgorod State Technical University, Russia, at the 44th International Exhibition of Inventions of Geneva.

Source: Science Daily Online