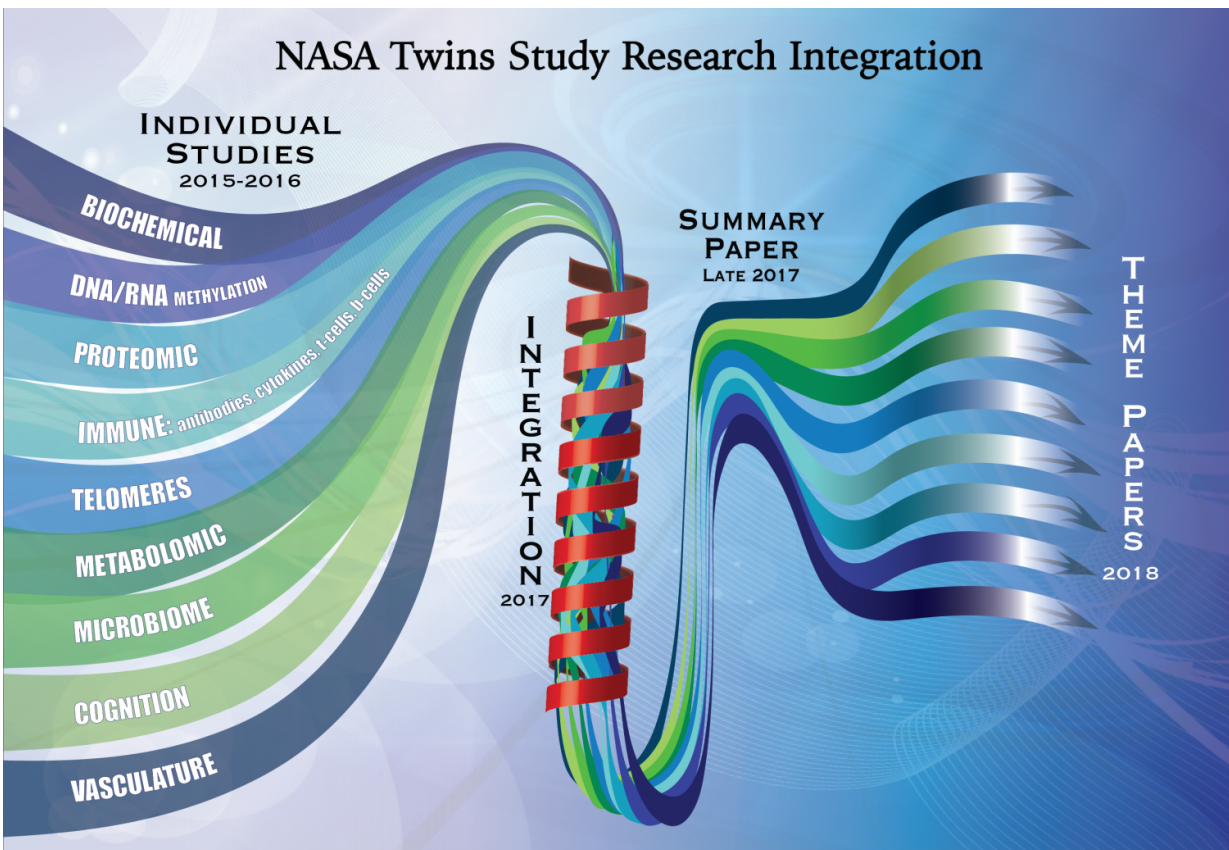


Symphonizing the science: NASA twins study team begins integrating results

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NASA Twins Study researchers are eager to integrate their results and create a symphony of science. Preliminary findings were discussed during the Human Research Program Investigators' Workshop in January, and now enthusiasm abounds as the integration process begins. Credit: NASA

It begins with one instrument. Then another joins in. Before you know it a grand symphony is playing before your eyes. NASA Twins Study researchers are eager to integrate their results and create a symphony of science.

Preliminary findings were discussed during the Human Research Program Investigators' Workshop in January, and now enthusiasm abounds as the integration process begins. The investigators are a unique group of researchers with different expertise associated with genetic and physiological areas of study.

While Scott Kelly spent a year in space aboard the space station, his identical twin brother, retired astronaut Mark Kelly, spent that year on Earth. Comparing the twins' biological samples will yield important information on how spaceflight affects the human body. These trailblazing genetic studies will help NASA keep astronauts safe on a journey to Mars.

The symphony begins with data. Big data. The Twins Study was established as a multi-omics pilot study for sharing data. Typically, research is done individually and results are made public in scientific journals that kickoff discussions of findings. However, this study is different. From the start, the Twins Study investigators have planned to integrate their results before publishing.

Each investigation is like an instrument. On its own, it plays solo music. But put them all together and you have something incredible.

"The beauty of this study is when integrating rich data sets of physiological, neurobehavioral and molecular information, one can draw correlations and see patterns," said Tejaswini Mishra, Ph.D., research fellow at Stanford University School of Medicine, who is creating the integrated database, recording results and looking for correlations. "No

one has ever looked this deeply at a human subject and profiled them in this detail. Most researchers combine maybe two to three types of data but this study is one of the few that is collecting many different types of data and an unprecedented amount of information."

The next step in the Twins Study is composing the symphony. As individual researchers analyze and compile their data they will be sharing their individual and integrative analyses with the Stanford team headed by Mike Snyder, Ph.D., who will apply different methods to further integrate it into [big data](#) sets and begin composing a masterful ensemble. After that, the investigators will begin to review the integrated data set to either confirm or modify their initial findings.

"There are a lot of firsts with this study and that makes it exciting," said Brinda Rana, Ph.D., associate professor of psychiatry, University of California San Diego School of Medicine. "A comparative study with one twin in space and one on Earth has never been done before. Each investigation within the study complements the other."

The researchers view the study as a new piece of music where they learn their individual parts and then join together with the conductor to play the musical score. Through the integration of data from biochemical markers, cognitive ability, gut bacterial composition, and biomolecules (DNA, RNA, proteins, metabolites), they hope to identify health-associated molecular effects of spaceflight to protect astronauts on future missions.

"The human systems in the body are all intertwined which is why we should view the data in a holistic way," said Scott M. Smith, Ph.D., NASA manager for nutritional biochemistry at the Johnson Space Center. He conducts biochemical profiles on astronauts and his research is targeted to specific metabolites, end products of various biological pathways and processes.

"If we see protein changes then we can look at the RNA, and if we see RNA changes then we can look at the DNA, said Rana. "By integrating data we can make a timeline to give us an indication if it is a precursor or result of genetics. Does a specific gene regulate protein change or do other genes? Once we know we can establish cause and effect and use molecules to measure."

Sometimes the science surprises us.

Susan Bailey, Ph.D., professor of radiation cancer biology and oncology, College of Veterinary Medicine and Biomedical Science, Colorado State University, received preliminary results contrary to her hypothesis.

Telomeres shorten as we age so she expected to see Scott Kelly's telomeres shorten after living in space almost a year. But to her surprise, the preliminary results showed an increase in average telomere length or an increase in the population of cells which have longer telomeres.

Therefore, she is searching for mechanistic data to explain what she is seeing. To determine if it is an anomaly or not, she is looking at Scott's exercise schedule, food logs and behavioral data. She also is looking at data from Andy Feinberg, M.D., M.P.H., director, Center of Epigenetics, Johns Hopkins University School of Medicine, who is analyzing methylation patterns, a major factor in gene regulation and gene expression, such as which genes are turned on and off.

Bailey will also look at data from Chris Mason, Ph.D., associate professor, Department of Physiology and Biophysics Weill Cornell Medicine, for mutations in the promoter region of the telomerase, to help form a correlation and confirm or refute her preliminary finding.

Mason said, "Both the universe and the [human body](#) are complicated systems and we are studying something hard to see. It's like having a new flashlight that illuminates the previously dark gears of molecular interactions. It is a more comprehensive way to conduct research."

"There is no doubt, the learnings from integrating our data will be priceless," said Emmanuel Mignot, M.D., Ph.D., director of Center for Sleep Science and Medicine, Stanford University School of Medicine. He studies the immune system and is enthusiastic to study specific immune cell populations because many of the other immune studies focus only on general factors.

The orchestra is only warming up now. As the data from individual investigations start filtering into the integrated composition, researchers and NASA eagerly await the results. When the full score of integrated [data](#) is ready, the summary of results will be published in late 2017 or early 2018. After that, individual investigators will publish theme papers with more detailed findings of the various investigations. As NASA embarks on its next journey, the results of the Twins Study will provide a front-row seat in this grand performance of human exploration.

Provided by NASA

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