



Response to Senator Flake's "Twenty Questions: Government Studies That Will Leave You Scratching Your Head"

The National Science Foundation (NSF) has been the backbone of America's science and engineering research enterprise for more than 60 years. NSF is the only federal agency that supports all fields of fundamental science and engineering research and education.

Each year, NSF competitively awards thousands of grants that collectively advance our nation's scientific capabilities and engage the talents of hundreds of thousands of researchers, postdoctoral fellows, technicians, teachers, and students in every field of science and engineering. Each proposal submitted to NSF—including those deemed "wasteful" and "out-of-touch" in the "Twenty Questions" report (authored by Senator Jeff Flake)—is reviewed by science and engineering experts well-versed in their particular discipline or field of expertise according to two merit review criteria: Intellectual Merit and Broader Impacts.

As Senator Flake highlights in the introduction of the "Twenty Questions" report, NSF has led the way in supporting America's leadership role in the sciences, as well as making information about research grants available to the public in searchable online databases. NSF agrees with the Senator that access to publicly supported research benefits all Americans and promotes the advancement of scientific discovery and understanding as well as transparency and accountability.

NSF-funded discoveries have expanded our understanding of the world in which we live, led to life-saving medical advances, enhanced our national security, improved our everyday lives, and yielded insights into the creation of the universe. The following summaries of the projects highlighted in "Twenty Questions" illustrate examples of promising NSF-funded research that were awarded support through the merit review process.

Graduate Research Fellowship Program

NSF Award 1144153

Twenty Questions: “Where does it hurt the most to be stung by a bee?”

Cornell University

The “Twenty Questions” entry for this award is disingenuous in terms of how much NSF funding went toward this study, and how significant this study was in relation to the researcher’s other work. The entry cites NSF’s spending as “part of a \$1 million grant” while acknowledging the researcher received funding through the Graduate Research Fellowship Program. The GRFP website clearly states that the maximum amount of funding for any award is \$138,000 (although this particular researcher’s total fellowship amount came out to \$6,000 less than the maximum). The report apparently used the total for all currently active GRFP awards at Cornell University, a number that is misleading, as GRFP awards are provided to individuals pursuing their own separate projects in a variety of disciplines. The report’s authors should be aware that such conflation amounts to misinformation, as NSF made them aware of a similar error made in a 2015 report.

GRFP’s more than six decades of success speaks for itself. The program awards fellowships to the nation’s outstanding graduate students pursuing degrees in science, technology, engineering and mathematics (STEM) disciplines. Out of more than 500,000 applicants since 1952, GRFP has funded more than 46,500 graduate researchers, many of whom have gone on to make significant contributions to science and engineering – including over 40 who became Nobel laureates. Annually, 2,000 applicants are selected as Fellows, from an applicant pool that currently exceeds 16,000. Applicants are evaluated by independent experts in their academic fields who make recommendations to NSF, which selects the awardees.

Furthermore, the “Twenty Questions” report unfairly caricatures the researcher’s work by failing to note that the experiment in question and resulting paper were a small part of a much broader portfolio focused on the behavior of honey bees and of certain parasites that can infect them. At a time when hive loss and other pollinator deaths has major economic and public health benefits given bees crucial role in agriculture and the U.S. food supply, this is a field important to the nation. The researcher has more than a half-dozen peer-reviewed, publicly available journal articles that acknowledge his GRFP support that focus on issues such as how the parasite *Apis mellifera* contributes to bee colony loss, how honey bee colonies survive exposure to that parasite in the wild (without the treatments colonies maintained by beekeepers receive) and how honey bees adapt nest resources for survival and reproduction.

In its introduction, the “Twenty Questions” entry also mistakenly identifies the research it highlights as an NSF “project.” In its acknowledgements of GRFP funding, the paper in question clearly states “The funders had no role in study design, data collection or analysis, decision to publish, or preparation of the manuscript.” GRFP supports graduate students’ educations, not specific research projects. GRFP fellows focus not only on their thesis research, but have the flexibility to incorporate creativity in their work and focus on projects that have broader impacts on society.

Social Categorization at the Crossroads: The Mechanisms by Which Intersecting Social Categories Bias Social Perception

NSF Award 1052896

Twenty Questions: "Do Republicans and Democrats look different?"

University of California - Los Angeles

The "Twenty Questions" report depicts the purpose of the research as dealing with the appearance of members of political parties when in fact it investigated the important topic of the information individuals use to form first impressions and how they then use that information. In that respect, the "Twenty Questions" report both misleads about the purpose of the research and downplays its significance.

The early impressions that people form about others can have a deep influence on their later interactions. The often automatic and rapid perceptions we make about others can affect whether we continue with an interaction or cut it short. They can affect whether we form friendships or choose to hire people. When a stranger approaches us for help, they can influence whether we provide assistance, respond aggressively, or ignore the person. Thus, understanding what information we use to form judgments of others and how we do so (for instance, whether we rely on accurate cues or stereotypes) is of fundamental importance to society and to psychological science.

This project – for which NSF funding ended in 2012 – promised to significantly advance how we "see" others. It delivered on that promise in three ways: First, the principal investigator was among the first to address perception in a way that preserves the true complexity of the multiple categories that people occupy. How we perceive an individual who is a young woman, for instance, is not necessarily equal to the sum of merely perceiving youth (versus older age) plus perceiving femininity (versus masculinity). Judging individuals who can be placed into multiple categories can be far more complicated, and these nuances matter in the real world.

Second, this project tested two competing theories about how such judgments are made. One theory focuses on accurate, body-based cues for making judgments. For example, the way men and women walk differently is a valid cue to gender. Body features such as hip to shoulder ratios are biologically determined, and such structural differences constrain the dynamics of walking. The other theory focuses on the inaccuracies that overlapping stereotypes (e.g., regarding youth, or women) have on "seeing" others. The researchers explored a variety of overlapping stereotypes, including those associated with sex, race, and political affiliation.

Third, a key contribution of this research was methodological -- improved methods regarding stimulus information used in forming judgments. This researcher's work has demonstrated the importance of dynamical information in social perception. Previous research often focused on static stimuli such as photographed faces; this researcher's work shows that a rich amount of information in the real world is also conveyed over time through the way people move. This is important not only for the underlying science of how we come to know others and form initial impressions but for applied reasons as well. For example, people with severely limited vision can use the motion of another person to identify that person when the static features of a distant face are not something they can see and readily process.

Identifying the Biological Influences on Political Temperaments

NSF Award 0826828

Genes and Politics: Providing the Necessary Data

NSF Award 0721378

Investigating the Genetic Basis of Economic Behavior

NSF Award 0721707

Twenty Questions: “Are Republicans or Democrats more disgusted by eating worms?”

University of Nebraska - Lincoln

The “Twenty Questions” report makes a fundamental error in describing this research – it represents a tool used by the scientists (the use of disgusting imagery shown to subjects) as the purpose of the scientists’ work. The associated NSF awards were not intended to examine whether Democrats or Republicans were more disgusted by certain images. The research was instead aimed at exploring the factors that influence political views, including genetics and neurobiology. This multi-stage research effort involved several different approaches to isolating those factors, including physiological tests and brain scans.

To perform such tests requires introducing the subject to a stimulus. In this case, part of this research involved imagery as a stimulus – and the researchers found it to be effective, helping to produce results that have contributed to our understanding of the factors behind political orientation. The success of a democracy depends upon an engaged citizenry. Hence, understanding what causes citizens to become engaged is of fundamental importance. The current, commonly held view is that citizens’ political attitudes are primarily shaped by the environment around them and are influenced, for example, by their education, interactions with friends and neighbors, and efforts to keep up with political news.

More recent research in neuroscience and genetics is adding a biological perspective to studies of political engagement. Preliminary research has shown that there are patterns connecting a physiological responses to stimuli to a person’s involvement in the political process. Therefore, researchers examined the possible roles that neurobiological and genetic factors might have in the development of political preferences, attitudes, and involvement.

Taken as a whole, these studies suggest that individuals with more conservative leanings appear more sensitive to aversive stimuli than more liberally leaning individuals and that they focus attention more on negative than positive attributes. This early research suggests that people of different political persuasions really might perceive the same situations quite differently. It’s equally important to note that this research is not conclusive and that it is part of a much wider area of study.

More broadly, this project demonstrates that an enriched understanding of human behavior can emerge from combining and integrating leading-edge social science with research from biology on genes and cognition. This innovative stream of research is generating fresh knowledge about citizen behavior that is basic to the practice and health of democratic governance, helping us to explain and predict decisions like election participation, political activism, volunteerism, and the propensity to engage in public service.

Complex surface structure and locomotion

NSF Award 0848894

Twenty Questions: “How many shakes does it take for a wet dog to dry off?”

Georgia Tech

If you’ve ever bathed a dog, you know firsthand how quickly a drenched pup can shake water off. A clothes dryer takes 40 minutes and much of our daily household energy budget to dry a load of wet clothing. But a wet dog can shake off 90 percent of the water collected in its fur after a bath in a fraction of a second. Over millions of years, animals have perfected the mechanism to dry quickly to avoid hypothermia.

The “Twenty Questions” report represents this research as utilizing high-speed videography to characterize the shakes of wet animals. However, the biomimetics research, which uses inspiration from biology to design and engineer better systems for people, could significantly advance many areas of technology ranging from military applications to the motion systems of robots to the exploration of other planets.

Understanding how animals shake themselves dry can help scientists develop ways to rapidly shed water from man-made equipment. The physics of the wet dog shake could help engineers concerned with motion on surfaces that have different properties, and it is of great interest to engineers working on many areas of technology. The findings from this research have the potential to contribute to technology that can harness the efficient and quick capabilities of drying seen in nature, important because self-cleaning and self-drying may arise as an important capability for cameras, sensors, and other connected-technology equipment subject to wet or dusty conditions. The research may even lead to improved functioning for robotics, such as the Mars Rover, which suffered reduced power from the accumulation of dust on its solar panels.

Provably Safe Automotive Cyber-Physical Systems with Humans-in-the-Loop

NSF Award 1239323

Twenty Questions: “Are cheerleaders more attractive in a squad?”

University of California - Berkeley

The work cited as part of this “Twenty Questions” entry was an offshoot study of a large, multi-university research grant to develop safe semi-autonomous cars. Specifically, the broader NSF-funded project aims to improve automotive safety and safeguard drivers riding in semi-autonomous vehicles and others on the road by developing methods that determine when an automatic control system should take over a human driver’s responsibilities.

To be able to do this, one line of research explored how people perceive the world around them and specifically tried to determine whether people who view cluttered scenes distort individual elements and tend toward the average element in that scene. This part of the project was completed by a graduate student during a summer session and was not supported directly by the NSF research award. The methods included asking undergraduate students to rate the attractiveness of hundreds of individuals, pictured both on their own and in a group, to determine if being in a group affected perception (none of the individuals pictured was a cheerleader, despite the use of the phrase “cheerleader effect”). The study concluded that the difference in perception was not significant; only a very small effect in perception resulted – enough to increase someone in a group from the 49th percentile of attractiveness to the 51st percentile. Even more importantly, the results of this study helped inform the design of the greater project: the automatic control system for semi-autonomous vehicles noted above.

Function of the Axial Musculoskeletal System in Locomotion and Ventilation

NSF Award 9807534

The Physiological Function of Cardiac Shunting in Crocodilians: An Experimental Approach

NSF Award 0445680

Modeling and measuring patterns of airflow in sauropsid lungs, with special emphasis on integrating research with education of the blind and on broader impacts

NSF Award 1055080

Twenty Questions: "Could you outrun a dinosaur?"

University of California - Irvine and the University of Utah

This "Twenty Question" entry claims that three NSF-funded awards are primarily focused on training treadmill-running alligators to determine whether humans could outrun dinosaurs. In fact, these awards funded research into basic biomechanical and physiological principles and how those principles influenced the evolution of vertebrates. Studying the structure and function of biological systems is a major field within biology; not only does this research enable us to better understand how and why organisms work; it often leads to insights about human physiology and reveals unifying principles shared across diverse forms of life.

Studying the relationship between locomotion and ventilation, for example, helps clarify the role that trunk muscles and bones play in breathing, moving, and stabilizing the back. One of the leading causes of disability in the U.S. is back injury; gaining a better understanding of exactly how those muscles help animals breathe and move means we can better protect or repair them. Studying cardiac shunting -- the particular pattern of blood flow in the heart -- enables us to more fully understand the healthy, functioning cardiovascular system. Because crocodiles have a unique heart structure, more similar to mammals than to other reptiles, they are an excellent model to use for cardiac research. Modeling how air travels through the lungs of alligators (or archosaurs, the group of egg-laying vertebrates that includes living alligators/crocodiles and birds, as well as their extinct relatives such as dinosaurs) is a way to understand the evolution of air breathing across species, and it provides a framework for understanding the evolution of the vertebrate respiratory system. Mechanical engineers are also interested in this research because the physiology of alligator lungs -- which use an aerodynamic valving system to breathe, possibly unique among four-legged animals -- may have practical applications. This research may lead to technologies that improve devices used for ventilating humans with poorly functioning lungs.

Like every NSF-funded project, these awards also helped train dozens of young scientists, providing a rich research experience, lessons in how to investigate and integrate complex biological problems, and a framework for thinking about biological diversity.

Meme Diffusion Through Mass Social Media

NSF Award 1101743

Twenty Questions: “Who will be America’s Next Top Model?”

Indiana University

This project is a scientific study of how information spreads in social networks – a communication landscape that is fundamentally different from anything that has come before. Researchers have developed a computational framework to enable the study of meme diffusion in large-scale networks. The framework enables the study of "memes" or "viral" ideas as they are tweeted and retweeted, enabling researchers to construct sophisticated mathematical models for the real-time analysis of massive data streams. The framework can help researchers study and answer some specific questions: How quickly or slowly does a diffusion process decay with time? How do different memes affect each other's diffusion as they compete for users' attention? To what extent do the diffusion processes follow a periodic pattern?

Contrary to the information included in the “Twenty Questions” report, this work can provide great value to the U.S. by helping researchers understand the source of messages individuals receive. This understanding enables us to better understand the genesis of cyberattacks, including malware or phishing attacks. The research can also help internet users discover where information they glean from the web or social networks has come from – did it arise organically, did it originate from authoritative sources, or has it been spread by bots designed to “game” social networks and spread misinformation? This project also has great value to other researchers studying the flow of information across the network, including a better understanding of why some memes travel faster than others, and how bad actors can game the network to their advantage.

Finally, this type of research can also help to explain how movements organize across the globe using new social communication tools. The explanations may improve the effectiveness of government communications for disaster preparedness and response, and helping authorities understand how fraud propagates.

Comparative Investigations of Future-Oriented Cognitive Processes

NSF Award 0924811

Twenty Questions: “Are chimpanzees better gamers than humans?”

Georgia State University

The research funded by NSF examined the development of “future-oriented processes,” brain functions that help us plan our behavior. Contrary to the “Twenty Questions” report’s representation of the work, this research was not asking whether chimpanzees or humans are better gamers.

Future-oriented processes play a critical role in normal human functioning. One such process, prospective memory, refers to the type of memory that allows individuals to remember to carry out an action at a future point in time – such as remembering to take medications at a specific time during the day or to show up for an important meeting. The NSF-funded research examined the development of prospective memory and associated processes across different ages in human children and across different species of nonhuman animals.

An increased understanding of future-oriented processes has the potential to advance theoretical understanding of a critical aspect of human cognition that underlies much of our activities, such as planning a route to a new destination, preparing an evening meal, or planning educational curricula. More specifically, one clear benefit of this research has been in the development of methods for assessing prospective memory in individuals with limited verbal ability, such as young children and certain patient populations.

The results of these studies showed evidence of some future-oriented processes in both human and nonhuman primates but clarified that nonhuman primates have limited ability to plan for the future.

Non-use as a Transformative Lens for Understanding Social Technology

NSF Award 1421498

Twenty Questions: “Is Facebook addictive?”

Cornell University

Understanding the rate of technological adoption – and particularly the factors that contribute to such adoption – is increasingly critical for worker productivity and for U.S. competitiveness in a number of fields, from robotics to health care. For instance, whether new technology companies succeed or fail is often predicated on how quickly people adopt a new tool or platform.

The research grant supporting the work cited in this “Twenty Questions” entry seeks to understand the motivations and practices of individuals and groups who are users and non-users of certain technologies. Although one focus of this research explores the adoption profile of Facebook, the project stands to offer insights to many American companies – including emerging small businesses that could become the next Google or Facebook – and to the U.S. government, as it can answer a number of questions: How can we understand the factors that shape, delay, or even prevent widespread adoption of a new technology? How do citizens understand privacy and how does that understanding help policymakers reconsider the definition and constitution of privacy?

Even more broadly, through this work, the research team has developed novel methods to analyze large volumes of survey data that combine computational techniques both with statistical analysis and with qualitative methods. These new techniques can allow researchers from a wide variety of domains to analyze data from surveys that combine open- and close-ended questions.

Training the Trainers: Genetics and Political Behavior

NSF Award 0921008

Methodological Training Opportunity for Politics and Genetics

NSF Award 1259678

Investigating the Genetic Basis of Economic Behavior

NSF Award 0721707

Genes and Politics: Providing the Necessary Data

NSF Award 0721378

The Genetic Basis of Social Networks and Civic Engagement

NSF Award 0719404

Twenty Questions: “Is being liberal a choice or genetic?”

University of Iowa, Penn State University, University of Nebraska - Lincoln, and the University of California - San Diego

These awards support projects that are much broader than “political scientists’ efforts to link politics and biology,” which is how the “Twenty Questions” report describes them. The research also addresses important questions about the genetic basis of prosocial and risk-taking behaviors as well as the methods underlying this work. In fact, this portfolio of research is part of a broad movement within the scientific community to combine emerging new techniques and findings in social science and fields including biology, genetics, and neuroscience to determine the processes that contribute to our behavior, including how we behave in the worlds of politics and public service. Two of the awards mentioned were training or workshop awards targeted at improving the use of these new methods in the field of political science.

Senator Flake dismisses the use of twin studies to determine genetic versus environmental influences, saying, “biologists and other political scientists are not convinced.” Twin studies like the ones mentioned here that compare identical twins who are 100% genetically identical to fraternal twins who share 50% of their genetic material have long been used to study heritable versus environmental causes in both behavioral and biologic science. The research extends these well-established methodologies into the domain of social science.

Understanding links between genetics and pro-social, risk-taking, and other important behaviors (including political ideology) has the potential to illuminate a broad range of societal concerns from risk-taking behavior among adolescents to decreasing civic engagement, from charitable giving to militant conflict.

Understanding and Optimizing Wireless Mobile Computing for Underserved Urban Communities

NSF Award 0803556

Twenty Questions: “What are the most popular emoticons used by college students in text messages?”

Rice University

The rapid proliferation of mobile devices in the last several years has been enabled by research in a number of areas of networking and information technology. Advances in networking technologies have increased connectivity and wireless availability. Improvements to the design of mobile devices have enhanced their usability. And innovations in software and hardware have allowed mobile devices to have more compute-power at affordable prices.

The research grant that supported the work cited in this “Twenty Questions” entry aimed to increase access for underserved urban communities to the then-emerging trend (in 2008) of wireless mobile computing. Specifically, the research that emerged from the project contributed to fundamental understanding of human-computing interaction and wireless computing, providing insights about the adoption, usage, and usability of smartphones, particularly in urban environments. One outcome of this work was a study that provided design requirements to improve the usability of mobile devices for low-income Americans living in urban environments, with implications to help to narrow the digital divide.

Locomotion Through Particulate Environments by Invertebrates and Vertebrates

NSF Award 1255127

Designing insect-inspired self-cleaning surfaces

NSF Award 1510884

Twenty Questions: “Which has more hairs, a squirrel or a bumble bee?”

Georgia Tech

These projects are part of the growing field of biomimetics, which uses inspiration from biology to design and engineer better systems for people. The project originated with an observation about bees. Bees carry an enormous amount of pollen relative to their body weight as they fly around from flower to flower, yet somehow the bee’s eyes remain perfectly clean. The hypothesis is that tiny hairs around and within the eye help keep it clean. If the cleaning mechanism can be understood, it can be exploited to design and engineer self-cleaning surfaces for a variety of uses.

Mimicking nature to make self-cleaning surfaces has been done for decades. Inspiration came from the lotus plant leaf, which appears smooth and stays clean of dirt and dust. Investigations showed that the leaf is quite rough on the micrometer scale, and small packets of wax-like substances are incorporated into the rough surface. This material is hydrophobic, so rain water that strikes the leaf easily runs off. But as the raindrops run off, they pick up dirt and dust and clean the leaf’s surface. This discovery led to an array of products that use synthetic materials to make surfaces hydrophobic and self-cleaning. Examples include self-cleaning ceramic tiles, roofing materials, and windows as well as new paints and coatings that are applied to ordinary surfaces to turn them into self-cleaning surfaces.

This project uses a mechanical, rather than chemical, approach to design self-cleaning surfaces. Experiments and numerical simulations show that as air flows toward the bee’s eye, hairs around the eye divert dust particles away, preventing them from depositing on the eye’s surface. Even more striking is that some hairs are able to bend during grooming and flick away any dust particles that managed to land on the eye’s surface. This mechanism is so effective that particles can be flicked away with accelerations 100 times that of gravity.

The investigators are imitating nature by designing synthetic hairs made of tiny polymer brushes. These polymer “hairs” will be used to create self-cleaning devices, such as lenses, sensors, solar cells and other surfaces that must be kept clean to ensure optimal performance. The polymer microbrushes could also be used in microelectromechanical systems (MEMS) to prevent fouling of actuators, accelerometers, microsensors, cantilevers, and other fragile, expensive components that are susceptible to damage by contaminants.

This project also has an educational component for K-12 students. The students examine the functions of hair in various animals ranging from insects to polar bears. By measuring the number, density, spacing, size and other physical features of hairs, they are able to compare how structure influences function across animal species. This outreach activity helps students see how physics and biology come together in nature.

Locomotion Through Particulate Environments by Invertebrates and Vertebrates

NSF Award 1255127

Twenty Questions: “How long does it take to pee like a race horse?”

Georgia Tech

The research highlighted in the entry titled “How long does it take to pee like a race horse?” is a portion of a large body of fluid dynamics research undertaken by a researcher highlighted in three separate entries of the “Twenty Questions” report. However, the work cited in this particular “Twenty Questions” entry is not the NSF-funded researcher’s, alone. In fact, the lead author on the journal cited in the “Twenty Questions” entry is a Ph.D. candidate advised by the NSF awardee, who focuses on the fluid dynamics of animal urination.

The NSF-funded researcher’s award is actually focused on understanding how animals, and in particular insects, deal with small particulates during flight. Flying insects must avoid or negotiate droplets in rain and mist. Larger organisms use eyelashes to divert particle-laden flows from delicate organs such as the eyes. The research couples sensory systems to locomotion; combining the rigorous study of everyday phenomena – an insect flying in rain and a blinking eye -- has possibly important technological applications.

The impact of the research is broad, spanning from biomechanics and fluid dynamics to applications in insecticides, self-cleaning surfaces, and even as a potential starting point for treatment for eye diseases in humans. This project is also directly related to national security and the continuing technological leadership of the United States and is funded in collaboration with the Navy Entomological Center.

Rapid Effects of Sex Steroids on Visual Processes Related to Social Communication

NSF Award 0849102

Twenty Questions: “What makes goldfish feel sexy?”

Bowdoin College

Sen. Flake’s entry titled “What makes goldfish feel sexy” is actually the title of a student-produced YouTube video related to NSF-funded research on steroid hormones, which have profound effects on social and reproductive activities in many species, including humans. Understanding the fundamental cellular mechanisms through which steroids affect behavior will help us better understand how animals engage with the world and interact with each other.

The lead researcher, Richmond Thompson, and his team studied the speed with which steroids can affect behavior, and where and how within the nervous system they produce those effects. They found that steroid hormones like testosterone can very quickly affect the ways that animals see, smell, or hear the world around them. The ability of these molecules to produce rapid effects on sensory processes was not previously recognized; Thompson’s findings indicate that steroids play more dynamic roles in the regulation of social interactions between individuals than would have otherwise been thought possible. The work has also begun to uncover how and where within the brain those effects are mediated. This has shed new light on the fundamental molecular and cellular mechanisms through which steroid hormones affect the brain and behavior, crucial knowledge relevant to many other areas of biology and behavior research.

The team used goldfish because they have relatively simple brains that can be easily manipulated, allowing the researchers to alter brain levels of steroid molecules – which are structurally identical in goldfish and humans – and measure the behavioral effects of those manipulations. They looked inside the brain to see exactly where and how steroids work within networks of cells, networks that are similar across all vertebrate species. Studying species other than rats and mice also helps us better understand what is truly general about how these molecules work; if we use only rats and mice as models for what these molecules may do in other organisms, including humans, then we would know only how hormones affect the brains and behavior of rodents. But if these hormones do similar things in different, distantly related species – like goldfish and tree frogs and zebra finches – then we know something truly fundamental that can be applied across species, and even to humans.

Goldfish are also easy for undergraduate students to work with and relatively inexpensive to maintain at the small, liberal arts college to which the NSF grant was awarded. Students who participated in Thompson’s research have gone on to some of the top medical and graduate programs in the nation, and are thus on their way to becoming tomorrow’s leaders in medicine and science. Their success, in part, is the result of what they learned about brains and behavior, as well as science more generally, through hands-on experiences working with goldfish. In fact, the purpose of the video that initially drew the attention of Sen. Flake was to increase awareness across a broad population of undergraduate students, many of whom are from groups currently under-represented in science and medicine, about opportunities to participate in the types of research that promote such success.