A View From The Rising Academic's Office

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In the Homerian tale of Odysseus, during the hero's return home he was forced to sail through a narrow channel, on either side of which lived a terrible monster. Sail too far to one side, and the many-headed dragon Scylla would eat his crew. Stray to the other side, and Charybdis would suck his boat down under the waves through an enormous whirlpool.

This metaphor of threading delicately between competing perils is an apt one for modern academic life. One of the first journeys of an academic is the path from graduate school to tenure. I am on this journey now, and I'm learning it is a formative one in which the substance and style of a research career are forged. The idea of navigating the middle way is particularly critical during this journey, because the young scientist must make a series of choices about the depth versus breadth of research focus, the pursuit of "newsworthy" versus incremental advances, and the scope of methodologies used.

There are unavoidable tradeoffs in the pursuit of science, whether one is just beginning graduate school or re-inventing the odyssey in a new field after achieving fame and fortune. My purpose here is to point out two kinds of tradeoffs that create problems in research and why there are no easy solutions that apply across the board. In the end, it is a call for us to recognize and celebrate the diversity of approaches in psychology; for although there is no single perfect approach, we gain strength in employing a multiplicity of approaches with complementary strengths. Odysseus had only a single ship, but we as a field have many.

I focus on two kinds of choices: The decision to allocate resources to either interdisciplinary or intradisciplinary research, and the decision to pursue research that is either "newsworthy" or incremental. The first issue bears on whether it is feasible for individual researchers to make psychology function as a "hub science" and indirectly on whether we should be using costly techniques like neuroimaging. (I think we should.) The second issue bears on the sociology of whether it is feasible for psychologists to build a cumulative, incremental science.

Interdisciplinary Versus Intradisciplinary

There's something broadly appealing about interdisciplinary research at this juncture in the evolution of science, particularly the marriage of psychological theory and biological measures of brain function. Perhaps it is that new tools are becoming available and connections are being made across fields. Perhaps some of it is the sheer novelty and "newsworthiness" of techniques like functional magnetic resonance imaging (fMRI). Whatever the reasons, there is both great promise and substantial cost to pursuing interdisciplinary science.

When I began graduate school in cognitive psychology, I had to choose between taking David Meyer's human performance class and graduate neuroanatomy in the medical school. I chose neuroanatomy. This was one of the first in a long series of tradeoffs between deepening my knowledge of psychology and interdisciplinary learning. I wished I could take both courses, but I chose what I thought would fill a

critical gap in my ability to use cognitive neuroscience tools effectively.
The essential problem, as I see it, is that time is limited. My scientific training has occurred during a time when many psychologists are embracing biological techniques: patient studies, pharmacological studies, transcranial magnetic and electrical stimulation, electroencephalography, genetics, positron emission tomography, and fMRI. In my estimation, it takes at least two years of full-time study to become proficient with fMRI experimental design and analysis and probably much more to learn neuroscience and neuroanatomy. Every hour spent learning about fMRI is an hour less for some other important knowledge.

I've had to make choices about which meetings to go to, which journals to submit to, and what kinds of collaborations to pursue. I've rarely attended the Psychonomics meeting, though I value it greatly, but I'm a regular at Cognitive Neuroscience, Human Brain Mapping, and the Society for Neuroscience meetings. Recently, I've become very interested in the brain regulation of pain and negative emotion, and I've made another series of increasingly interdisciplinary choices. I've recently found myself at the meeting of the International Association for the Study of Pain, the American Psychosomatic Society, and (in a bizarre twist of fate) the American Society for Pharmacology. I've pursued collaborations with researchers in anesthesiology, statistics, psychiatry, and neurology. If this sounds dilettante-ish, I argue that it's not: It's interdisciplinary and focuses on how cognitive processes regulate brain processing of pain from different perspectives. "Converging evidence from multiple methodologies" is one of the mantras of cognitive neuroscience.

There are costs to these choices and even danger. Can I actually get away with pursuing my scientific interests even if they cross disciplinary boundaries? (So far, yes. I'll keep you posted.) One danger is that the work will fall in a "no-man's land" between disciplines and be useful to none. It is difficult enough to master all the accepted practices in one discipline, and the problem is compounded with interdisciplinary research because each field has its own set of standards and accepted practices. Interdisciplinary research in general relies particularly heavily on goodwill, on the recognition of the value of diverse research and exploration, and on the willingness to let new ideas develop and mature. Its benefits are many: converging evidence across techniques, knowledge and ideas from diverse fields brought to bear on old problems, and — in the case of biologically based approaches such as cognitive, social, and affective neuroscience — the potential to enhance the cumulative nature of the discipline.

This last point deserves some elaboration. The structure of the brain is much easier to agree upon than the structure of the mind because it can be objectively measured, and grounding psychological theories in brain function is likely to promote agreement and cumulative work. In addition, brain biology is a common "language" that allows findings from diverse research areas to be brought to bear on theory. Psychological theories about how pain is created and represented, for example, can now be refined using knowledge gleaned from fMRI in healthy individuals and patients, single-neuron recordings in monkeys, neurochemical ligand-binding positron emission tomography, intracranial and extra-cranial stimulation studies in humans and other species, pharmacological lesions and manipulations, psychophysics, and transcranial magnetic stimulation.

Ultimately, there are both costs and benefits of pursuing interdisciplinary research to the individual and to psychology as a whole. For psychology to truly function as a hub science, it's important to recognize the challenges and be supportive of interdisciplinary work. Likewise, it's important not to get carried away with new techniques and fancy brain pictures, particularly if it is to the detriment of promoting a

solid foundation of research in core areas in psychology that provides our field with a home base. A key to our common happiness is to recognize the value of diversity and to deliberately promote different kinds of research both within and across traditional boundaries.

Newsworthy Versus Incremental

There is a push in psychological science, and perhaps science in general, toward being newsworthy. That means, for one thing, that your grandmother should be able to listen to a few sentences about what you've been spending twelve hours a day on over the last two years and say, "that's really interesting and important" with a clear conscience. This isn't just fun and games, because although your next grant isn't likely to be reviewed by your grandmother, it might be reviewed by someone from another field — a vision scientist, a social cognitive neuroscientist, a behavioral neuroscientist, or (yes, it's true) a chiropractor.

In the past, I don't think psychology needed to be so newsworthy. A big reason for the change is that the number of journals and papers are increasing dramatically, and it's impossible to read them all. Another reason is the increasingly interdisciplinary nature of science, which makes it difficult or impossible to find reviewers knowledgeable about all aspects of a study, which means the review process is less reliable as a quality control process. Increasingly, newsworthiness and journal impact factors are used as a surrogate for quality.

As with interdisciplinary research, there are both benefits and costs to newsworthy research. Benefits at the individual level include notoriety and grant funding, and public interest in psychological science can increase funding levels and attract talented individuals. However, there is a substantial cost to the pursuit of newsworthiness in the ability to develop a cumulative science.

Some things that are great science are newsworthy. But many are not. The bedrock of scientific and technological advances in many fields is the mundane, detailed, and incremental: the 12,500th gene mapped in the Human Genome Project or a cytoarchitectural study of cortical area 24b. Each bit of knowledge is not newsworthy in itself, but they fit together into a mosaic of knowledge with revolutionary impact. I believe that psychology needs much more of this type of incremental work. The question is, will we let ourselves become an incremental science?

Neuroimaging research is a good example of an inherently incremental endeavor. Each neuroimaging study gives us some information about the brain regions that respond to a given psychological manipulation (e.g., transient shifts in attention), but this usually provides little information by itself about the psychological nature of the tasks performed. Few neuroimaging studies are newsworthy by themselves, which is ironic because they are everywhere in the news these days. However, that does not mean they are not valuable. We can develop a picture of how different psychological processes relate to one another, by comparing the similarities and differences in the brain activity patterns they produce across many studies. This overall picture is something humanity has never seen before: a representation of the internal organization of mental processes.

In my lab, we've developed meta-analytic procedures to make such comparisons across neuroimaging studies. I believe this endeavor is essential because it allows us to quantitatively assess replicability and build a cumulative science across many psychological domains. Others believe this as — because my most highly cited papers are meta-analyses. But there is still a mythology of the single, revolutionary study, which is perhaps why a senior colleague once told me this bit of career advice: "Do 5-10 data papers for every meta-analysis." This is indicative of the potential problems faced with how credit is

assigned to incremental work.
I think we need to decide that incremental science, with its potential for solid long-term gains, is a critical goal in psychological research. Incremental science and newsworthy studies are both instrumental in the development of knowledge. Everyone loves the studies that turn a whole field on its ear, but without replication and incremental development, these studies make for little more than great cocktail-party conversation pieces.

The Genetic Algorithm
There are fundamental tradeoffs involved in different approaches to science. But the beautiful thing about psychological science being a collective enterprise is that, as a field, we can encourage a diverse set of approaches with complementary strengths.

In some of my work I use genetic algorithms, a class of general problem-solving algorithms based on evolutionary principles, to design experiments. Genetic algorithms solve problems by mixing and matching parts of different solutions to “evolve” towards an optimal one. The mixing is a direct analogue of chromosomal cross over in sexual reproduction. An important lesson is that diversity is critical for a genetic algorithm to function. Different, better traits cannot emerge unless the “gene pool” of possible solutions is diverse. In addition, sometimes the best solutions need a long gestation period before their value is universally appreciated. For both reasons, maintaining diversity is important.

The genetic algorithm offers an interesting metaphor for psychological science. New scientific ideas are generated by the cross over and inter-mixing of ideas from different areas. The fresh ideas of the next generation cannot be fresh unless there is a diverse array of techniques and ideas to draw from. And sometimes, a scientific approach may become critical for a new area or field only many years after it is first developed.

A healthy scientific community, like a healthy genetic algorithm or a healthy ecosystem, promotes diversity. If we want to continue to move forward, we must try out new branches of science, new methods, new ways of asking questions about the mind and then mix and match them, incorporating the best of those methods into the next generation of research paradigms. It is precisely the diversity of approaches that allows psychology to be a “hub” science that connects neuroscience, medicine, and the social sciences.