Polymath Imagination Retreat
July 6-9, 2017

Participants

Stanley Fish: Professor of Law, English, Criminal Justice, Political Science, and Humanities, NYT Columnist, Award-winning author

Harvey Friedman: Professor of Mathematics and Philosophy, Inventor of "Reverse Mathematics", Music Theorist, and Classical Pianist

Rebecca Newberger Goldstein: Philosopher and Award-winning Novelist, Professor of English and Philosophy, Awarded the National Humanities Medal in 2015

James Hovey: Vice Chairman of Eisenhower Fellowships, Former President of The Fox Companies, Trustee and/or Director of Multiple Non-Profit Companies

Monica Lopez-Gonzalez-: Cognitive Scientist, Educator, Entrepreneur, Multidisciplinary Artist, Public Speaker, Science Communicator, Writer, and Co-Founder and Executive Scientific & Artistic Director of La Petite Noiseuse Productions

Steve Weinstein: Stock Options Trader, World Champion Bridge Player, and Poker Expert

Robert Wright: Evolutionary Psychologist and Award-Winning Novelist, Professor of Science and Religion

Martin Seligman: Director, Positive Psychology Center at Penn & Executive Director; Imagination Institute at Penn; Award-Winning Author and Founder of Positive Psychology

Scott Barry Kaufman: Scientific Director, Imagination Institute; Author and Blogger

Marie Forgeard: Lead Scientific Consultant, Imagination Institute; Post-doctoral fellow at McLean Hospital

Elizabeth Hyde: Research Specialist, Imagination Institute

Adam Kaplan: Psychology Researcher, M.S. Candidate, and World Champion Junior Bridge Player

Report Prepared By:
Adam Kaplan (Lead Author) and Scott Barry Kaufman

Preface

The Polymath retreat was the first of its kind, bringing together acclaimed thinkers across multiple disciplines for a weekend of discussions about creativity, imagination, innovation, and polymathy. Our discussions during the retreat were guided by a series of questions which examined the strengths and challenges of polymathy in academic, business, and personal contexts. We defined a polymath as a person whose expertise and success draws upon a broad variety of subject areas and disciplines. The polymaths for our retreat spanned cultural, professional, and generational backgrounds, from options trading to piano to Platonic philosophy. Bringing together thinkers across multiple disciplines led to numerous psychological and academic insights, as well as professional insights for the participants.

Polymaths occupy a unique place in the academic and professional worlds, where they are conversant in multiple disciplinary languages. Those who have a broader perspective on domain-specific problems are often able to ask naive questions which require returning to the foundational principles within an area of work. Polymaths and others who come from outside the area of work are more capable of identifying the basic premises and problems, and are able to produce progress through their differing perspectives. This retreat aimed to identify ways of nurturing polymathy, in addition to generating insights about the process of mastery, expertise, and creativity from serial-learners.

This report is broken down by areas of insight, and includes several conclusions which add to the scientific canon on polymathy. All quotes are from transcripts of the Imagination Institute's Polymath Retreat.

Antagonistic, Synergistic, and Disjointed Polymathy

Before exploring the broader implications of polymathy, we must understand the different types of polymath. Early in the retreat, Harvey Friedman coined the terms "Antagonistic, Synergistic, and Disjointed Polymathy." Each of these terms highlights the spectrum of skills and expertise involved in different types of polymathy: *Antagonistic Polymaths* are people whose skills and expertise in multiple areas routinely conflict or interfere with each other, leading them to pursue one area at the expense of the other. A mathematician and poet would be an example of an antagonistic polymath. Rebecca Goldstein highlighted the antagonistic nature of her work in math, physics, and philosophy compared to her work as a novelist, "When I started in math and physics, and then in philosophy, precision was everything; filling in every gap, and always foreseeing where somebody was going to come in with a criticism, and filling it in, was everything. Writing a novel is entirely different." … "You have to leave gaps so that the reader can come in with their own psychology and make their own experience out of it. Whereas when I'm doing, writing a proof, or an argument, I want to manipulate their thought processes entirely."

In contrast to antagonistic polymaths, *synergistic polymaths* are people whose skills and expertise in multiple areas build upon and complement each other, providing useful insights and discoveries across multiple fields. *Synergistic Polymaths* blend together ideas from multiple fields, and are able to serve as a bridge between disciplines. Monica Lopez-Gonzalez identifies herself strongly with the idea of synergistic polymathy; her work brings together insights from both arts and sciences to advance both disciplines.

Disjointed Polymaths are people whose areas of expertise overlap minimally, with little cross-pollination between areas of work. Babe Ruth, known for his pitching and hitting skills, is

an example of a disjointed polymath. Often, however, polymaths find connections between their work that others may not recognize. For example, Friedman, an accomplished mathematician, philosopher, and pianist, considers his areas of expertise to be synergistic on a high-level, while people may assume his areas of expertise are disjointed. He said, "I have friends in logic who say, "No, you're never going to be [an expert] in piano. Why are you wasting your time when you can do this other stuff so well."

Polymathy requires an inevitable antagonism between the two pursuits. As Steve Weinstein, referring to sacrificing his poker life for bridge, said, "There's going to be an expense in one of your fields, because you do have a finite amount of time and energy." Participants agreed that they experienced aspects of each type of polymathy during their careers, but that these distinctions remain an important way of understanding different types of polymathy.

The Hedgehog and the Fox

In addition to understanding different types of polymath, we also discussed each person's different ways of approaching the world: Are they big-picture thinkers, or do they focus on the details before widening their views to address larger questions? This division was first coined by Isaiah Berlin, who suggested that "hedgehogs" have a single broad world-view, are big systems thinkers, and see the world through a single unifying lens. In contrast, the "foxes" know a lot of little things, not one big thing. Foxes view the world as groups of smaller components. In psychological terms, hedgehogs rely on a "top-down" approach to the world, while foxes use a "bottom-up" approach. These differences are particularly interesting when discussing polymathy: Do polymaths view their areas of expertise as separate entities or as connected by an underlying universal theory? Additionally, does a polymath's creativity and imagination descend from a

single unifying source, or are they inspired by domain-specific ideas which build upon each other?

One can imagine Da Vinci as a hedgehog, a polymath whose creativity was driven by a unifying and transcendent idea applied to numerous domains, where each idea both built upon and influenced the next. One can also imagine Aristotle as a fox, a polymath whose world-view was built through numerous individual theories which did not interact extensively with each other. This dichotomy was also reflected in our polymaths. Friedman described a shared foundational "essence" across his pursuits, and Lopez-Gonzalez described her theory as a "large toolbox" where different disciplines choose their own tools from the box. Stanley Fish and Weinstein, in contrast, framed their approaches as consisting of numerous small toolboxes. Robert Wright also described how he came to be a novelist, illustrative of a bottom-up approach, "[My novels were] largely a synthesis of things that different people were already doing. [Evolutionary psychology] wasn't really known and I tried to put it all together." The diversity of opinion demonstrated that there is not a *correct* way to inspire polymathy within world-view: Both top-down and bottom-up approaches can provide a framework for polymathy and creativity, although synergistic polymaths may favor top-down approaches as they build connections between their fields, while antagonistic polymaths may favor bottom-up approaches as they attempt to separate and compartmentalize their fields.

Motivation and Grit

When reading through the accomplishments of the retreat participants, one cannot help having a sense of awe at the participants' levels of dedication and motivation to achieve mastery. While everyone differs in their precise motivations, several common themes arose. Weinstein, speaking about bridge, poker, and trading, said "I've taken it up, I've liked it, I've gotten good at

it and I've been successful at it." Similarly, Fish, speaking about his journey as a literary scholar, said that his journey followed naturally. He built on other areas of expertise, using his background to generate imaginative ideas. Despite this, he also rebutted other participants' insistence that he is naturally curious, saying he seized opportunity, not curiosity. He said that many of his biggest career changes and successes were, in fact, accidents, but hints at an original source for his motivation: "Everything I do is task-oriented, but you can trace the kind of tasks to which I'm attracted back to [an] initial course in classical rhetoric." Fish seems to derive his motivation and inspiration from a different place than Friedman and others; he said, "If I were to retire, that would be the end of any work that I would ever do, because for me, the only work opportunities or challenges or interests arise from some institutional commitment and membership."

Much of the satisfaction of tackling a new project or discipline was summarized by Fish, who recently entered the field of LGBT legal rights, "It was an immersion effort, where you're suddenly discovering that the central questions are not even ones that you were aware of when you began. And to me at least, it's enormously satisfying to have come out of the end of that [immersion]." At age 79, Fish's continued excitement for new fields demonstrates an unwavering intellectual vitality.

Fish's success in entering a new field prompted participants to consider their failed or unfulfilled career ambitions. From baseball to ancient Greek, participants expressed unfulfilled career interests. This led to a question of serial polymathy: Could polymaths enter a new field as naive and train themselves to become an expert? In Wright's case, he believes it is possible, "I've gone in knowing not much about [the topic] - I've immersed myself and written a book about it,

and that has virtues. You keep learning about new stuff, and I've been lucky enough to be able to study what I was interested in at the time."

These broad ambitions lead to an interesting conclusion made by Scott Barry Kaufman: Polymaths excel at "Diversity of Interest (DOI)." While scales of grit focus on consistency of interest and perseverance, the DOI measure (which is currently being validated by Kaufman and his colleague Reb Rebele) focuses on a complementary trait: a tendency to engage in a diverse range of interests. The current DOI scale includes items such as "I have lots of ideas every year;", "My ideas seem to grow and evolve", and "I have no problem dropping something else if I get inspired by something." The DOI measure provides a promising tool for measuring polymathy, as successful polymaths must cultivate a broad range of interests while also demonstrating sufficient perseverance to pursue their interests.

The processes measured by grit and DOI complement each other within fields of study. As Goldstein said, "All of these people who have the grit and just stick with [their work], I plunder what their patience has yielded." She suggests a role for small- and big-picture thinkers, where some scholars excel at intense study within one area, while others combine and utilize insights from multiple sources to form broader conclusions. In contrast to Fish's disciplinism, where his interest arises after his work, Goldstein said, "To me, everything is fascinating. And once you start exploring it, it's very hard to pull yourself out of it." Lopez-Gonzalez considers herself in the middle, both motivated by deadlines and an inherent fascination with her work.

In her book on grit, Angela Duckworth relates a story of her experience early in college. Her freshman year at Harvard, she took a course in organic chemistry and got a D on a test, and the instructor said, "You really should drop this class." And so she immediately went to the registrar and registered Chemistry as her major! This illustrates the concept of grit and

perseverance, and is common among highly achieving people. Similarly, Friedman's motivation lies in proving others wrong: "I like it best when I actually say I was going to do something, nobody thought it could be done, and especially didn't think I could do it, and then I did it." Weinstein's motivations, as an independent professional gambler and options trader, are rooted in his desire not to lose at all costs. He does not find motivation in money or deadlines, rather, his motivation is an intrinsic competitive urge to crush his opponents. This competitive nature was shared among the business-oriented participants, whose eyes "lit up" at the mention of crushing opponents, according to Kaufman. Weinstein's competitive nature arose at a young age, and provides the basis for his primary advice to students and budding competitors, "I would recommend to kids when they're going into a field, that they really enjoy the victories, whatever they're defining as victories, because for someone like me, the pain was so great, relative to the relief and the release of not losing. It wasn't winning. It was losing and not losing. And, it became winning as I got older."

Those in academia had a different perspective on competitiveness, as allies and enemies are constantly shifting. Goldstein was driven by a desire to beautify: "Whatever I'm doing, I want to add, I want to beautify. I want to just - add some beauty and rip out some ugliness." Fish describes a similar desire to extinguish ugliness in a different form: "I'm here, that is - doing this kind of work because there are a lot of people out there making mistakes, and I want to tell them, those people what those mistakes are. And I want to correct them. And that's what I do." Lopez-Gonzalez also shared her motivation to explore new fields and frontiers, "I'm curious to play with all the different pieces because I'm all about the unknown. I seek that out. I don't want to go in thinking, "Okay, I know I want to get this result because other people have said this, so I want to just prove it." No. I go in saying, "I don't know what's going to happen," and I'm just going to

see what happens. I'm driven by that and I think that's part of what adds to the complexity of the intellectual, conceptual frame and mindset." Participants' approach to new projects returns to a foundational philosophy of knowledge, where an underlying curiosity and motivation enables them to tackle new frontiers.

System Two to System One Transformation in Mastery

How do polymaths go about achieving success and mastery in multiple fields? Each participant in the retreat had experienced this crystallization of expertise on multiple occasions. One of the most frequent debates about mastery centers around the notion that experts have to start young. The idea of "prodigy" suggests a destiny and unique young talent, but one of the most unique factors about the retreat participants was their openness and ability to learn new skills and disciplines. Friedman is an extreme example from the notoriously prodigy dominated area of classical piano performance. It wasn't until well in his 60s that his piano playing took the leap to being of interest to piano professionals. Similarly, Fish and Goldstein have been able to cross disciplinary lines and become experts on new topics at an unusually fast rate. Dean Simonton proposes that it is career age which impacts mastery, rather than physical age, but this does not align with the experiences of our polymaths. Rather, the consensus was that they are able to achieve mastery in new skills at a much faster rate than the general population.

In an effort to better understand the polymath learning process, we examined the crystallization of expertise, which participants described as a process of automation. Weinstein provided a perfect description of the transformation from conscious effort to intuition: "You have so much you just know that you don't have to waste energy on it, because you've seen it, you know it, you've thought about it, it's all just part of who you are over the years that you just know the answer." This automatic approach to thinking was co-opted, most visibly by

psychologists Daniel Kahneman and Amos Tversky, who suggested a similar dichotomy in broader human cognition: "System One" thinking relies on fast, unconscious, automatic processes to guide behavior, interpreting situations from the bottom-up, similar to Weinstein's description, while "System Two" requires slower, effortful, and conscious thought, interpreting situations with a cognitively involved top-down approach. Scholars typically engage System Two when thinking about a difficult problem, as they rely on active cognitive work rather than intuitive processes, yet our polymaths described significant System One engagement once achieving mastery. These systems may offer insight into the process of mastery, especially as it concerns the transition from conscious and effortful thought to automatic processes.

The discussion brought up questions of the role of both systems of thinking during the process of achieving mastery. Martin Seligman, referring to Weinstein and bridge, said, "The cards just fly off his hands." He contrasted his own experiences progressing through the game of bridge as "something that always gave me a headache," saying, "I wasn't a natural at it, in the sense that I could see other people, they were naturals" … "I am a natural at psychology." A common grievance, echoed by Weinstein in response to Seligman's discussion about cards flying off his hands, is the missing acknowledgement of the effort invested by experts to create the illusion of being a "natural." For example, Weinstein spends hours tediously reviewing and practicing before every major bridge tournament. "To get to where it really looks easy, there's been so much work put in." Similarly, Friedman spent 4 months performing over 20,000 edits to create his 12 piano pieces, but the final product lacks immediate evidence of this immense investment.

Practice is a vital component of mastery which is often paid minimal attention compared to the "ease" of the final product. Fish also relates the importance of practice and automation in

writing, "Without practice in the forms [of writing] to the point where you never have to think about them, where they're thoroughly internalized, the supposedly grander aspects of the activity will never actually flourish." Much of the work invested through practice aids in the transformation from System Two to System One. Weinstein describes this shift, "It's just absolutely nailing every basic [concept] before you can take it outside the box." This transformation to System One can impact many aspects of one's career. Lopez-Gonzalez shared the impact that mastery has had on her preparation, "When I teach or even speak at public events, I do a lot of improvisation. It's because I know the theme so well now and therefore can integrate even the facial expressions of the audience. I can start taking in all that external sensory information because the rest is unconscious at this point." By using System One to engage with more components of a domain, experts are free to utilize System Two to generate new insights.

While we cannot make definitive conclusions from such a small sample size, these discussions suggest a trajectory of mastery development. If we simplify mastery to be the transfer of domain-specific functions from System Two to System One, then we can approach the problem of mastery by asking what processes aid this automatization. This is a significant paradigm shift, as it transforms the daunting question of achieving mastery into the smaller problem of facilitating a shift of cognitive systems through practice and training. If we can explore these systems in greater detail, we may be able to pinpoint specific techniques for achieving mastery on a broader scale.

Early life and education

Finding common threads within our participants' education offers insight into the ways that we can encourage and stimulate polymathy in future generations. While the retreat participants differed greatly in their upbringings, several similar details emerged. The primary

symmetry was the autonomy that participants had to pursue their interests beyond their standard education, and that they did not approach new topics from a strictly school-driven angle. This freedom not to "drink the Kool-aid," as Seligman observed, led them to develop new paradigms for their own education.

In Goldstein's case, this autonomy came from learning to survive alongside her mother's mental illness. As a student at an all-girls Orthodox Jewish school, where many academic pursuits were forbidden for girls, she found herself "wanting to know everything." She read and studied on her own to satiate this desire, and said she still feels the same way. While Goldstein shared a childhood filled with books and curiosity, she also said, "[My] mother was also mentally ill, and so it was basically, trying to survive. But that was very important because it gave me a great sense of autonomy. I never depended on grown-ups, I was never sure, my mother might end up killing me."

Lopez-Gonzalez's upbringing was both intellectually stimulating and motivating, "I would see opera one day, go to ballet the next, go to museums and see paintings, photography, and I grew up on world cinema, starting at ten years old. … And at the same time, because my parents are both PhDs and intellectuals, even polymaths themselves, I was exposed to science and economics and mathematics from day one." The intellectual freedom to pursue her interests, and willingness of her parents to expose her to vast amounts of knowledge from an early age led her to develop her interests across a broad spectrum of disciplines. She said, "I know for sure that … I am who I am today because I got exposed to all of those things, and I think just from day one I was always very curious and I always started asking questions."

Fish emphasized that his own childhood was a wildly different experience, "I spent my entire youth playing cards... badly, playing sports... badly, and chasing girls... badly. Those are

the only activities that ever entered my mind. No books at all, and no inclination to go the library and find them, or anything like that." Still, when he found his interests, he was able to dedicate himself to mastery.

The participants were united in tackling new topics with unorthodox approaches. Thus, the most important educational tool for nurturing polymaths may be the ability to instill a curiosity and willingness to question existing paradigms. For Lopez-Gonzalez and Goldstein, this was a broad exposure to culture and interdisciplinary canon, while for Fish, Friedman, Weinstein, and Wright, this was a lack of training in the standard educational approaches. This freedom allowed them to explore their interests, and as motivated and driven students, eventually develop varied domain-specific interests. As Wright suggested about his own upbringing, "There's some virtue in not being conventionally trained, and coming to the world of ideas, in some sense, from left field." Coming "from left field," allowed our polymaths to ask questions and see connections between disciplines which would have otherwise been forbidden. These connections often formed the basis of participants' early careers, taking advantage of their freedom to approach a discipline from outside the prevailing orthodoxy. As Fish said, "There's always things that shouldn't be said, and can't be said, or even can't be discussed. But they are opportunities as well as warnings."

Polymathy and Academia

Polymaths face unique challenges within academia. Due to the highly disciplinary nature of many academic fields, cross-pollination of ideas and approaches can be difficult, if not downright impossible. Additionally, as Fish said above, within disciplines many questions are treated as taboo, and have an accepted "cone of silence." Our polymaths often found themselves bridging disciplines or even creating new disciplines to sufficiently categorize and disseminate

their work. Goldstein said, "Universities love interdisciplinary discussions and dialogues, but they really won't support that within the departments. You get punished for it."

A common problem which often arises for polymaths working in the university environment is a lack of credibility and respect due to attempts to merge or integrate disciplines. Lopez-Gonzalez shared her experience bringing together artistic and scientific disciplines as one where scientists reject her ideas and questions as "fluff" and artists reject them as pointless and unrelated to the emotional ambitions of art. She attributed these dismissals to ignorance and not malice, but expressed frustration with the rigidity of disciplinary work. She uses her expertise to change hearts and minds, but the process necessarily involves resistance.

Achieving recognition and respect within a field proves to be challenging: Established scholars in a particular field often look down on polymaths as "masters of none," despite the cross-pollination of disciplines being essential to academic progress. For Lopez-Gonzalez, this meant promoting STEAM: Science, Technology, Engineering, Art, and Mathematics. Her work interweaves artistic insights with science, and her business depends on using scientific methods to develop artistic techniques and ideas. Lopez-Gonzalez said, "I could not fit in any academic department because I fit in all of them." Her STEAM classes at Johns Hopkins University have proven to be both popular and successful with students, giving them a fresh look at familiar disciplines and ideas.

Fish, however, believes the traditional academic approach has substantial merit: He said that interdisciplinary works lack a solid foundation, and that "Interdisciplinarity is a recipe for commonplace observations, which have no content whatsoever." Fish believes the common view that interdisciplinary work is an "expansion of perspective" is incorrect, but does not deny that disciplines can reformulate and repurpose questions from other bodies of work. For him,

academic questions must be viewed individually, using a bottom-up approach, in order to provide an adequate lens for tackling larger problems. He said, "The reason that universities never manage to do interdisciplinarity right is because it's not something that you can do as a plan. It's something that kind of happens in the borrowing [of ideas]."

Despite Fish's skepticism, however, others saw interdisciplinary work as an essential path for development. Both Goldstein and Friedman provided examples of important scientific advancements which built upon interdisciplinary principles. Goldstein, referring to evolutionary psychology, said "there's a tremendous collaborative and productive interdisciplinary conversation going on, to the betterment of both fields."

Even the presence of scholars from multiple different fields at the retreat led to several important discussions and realizations. Lopez-Gonzalez shared her experience with the process of disciplinism, "We are all about creating boundaries, and we've now come to the realization that these boundaries can no longer answer the basic questions and even the sub-questions of those basic questions, that we have to now bridge out and completely redefine disciplines." Friedman praised the retreat as performing a "vital service to academia" and even suggested that universities should consider similar interdisciplinary retreats with faculty on an ongoing basis.

Approaches to criticism

As innovative thinkers, polymaths frequently face criticism from a multitude of sources. Whether attempting to discredit their interdisciplinary work or questioning the appropriation of insights from other disciplines, criticism formed a regular part of all our participants' lives. A common framework for understanding response to criticism is a person's implicit mindset of ability. Originally coined by Carol Dweck, people with "growth mindsets" are flexible, and see criticism as an opportunity to improve their abilities in the future, whereas people with "fixed

mindsets" view criticism as a critique of, or assertion of their lack of inherent ability. As recognized by Kaufman, many of our participants seemed to have a third type of mindset. They approach criticism with a skeptical lens, first evaluating whether the criticism is even worthy of consideration. Thus, in addition to learning from or internalizing criticism, our polymaths have a third option of disregarding the criticism entirely. This third option blends grit and perseverance with a fiercely held conviction of correctness. This confidence defies current perspectives on mindset, and necessitates a reformulation of the dichotomy between growth and fixed mindsets.

Everyone agreed that it was important not to internalize criticism, and if anything, to use it as motivation to improve. Lopez-Gonzalez and James Hovey, both active in the business world, are used to being told no, and they do not let it hold them back. Doubt is an essential byproduct of creativity, and for our polymaths, criticism from a close friend or trusted advisor carried more weight than from a random stranger. This supports the third, "expert" mindset, where criticism must be evaluated for its legitimacy before it is considered. Goldstein said, "One of the things about being an expert is that you know the criticism that is good and isn't. It's a very sound reaction to be able to say, 'Yeah, I can dismiss this, this person hasn't got it. There's something to be done with the work, so I have to remedy that, but it's not a profound criticism.' That is just part of being an expert."

Retreat participants discussed how they are able to maintain conviction and motivation in the face of criticism, often a consequence of their polymath-related endeavors. Lopez-Gonzalez said she has an innate confidence about her calling, "I just believe that I know I'm onto something and I think it's my ... I wouldn't say I was put on this Earth to do that. Not to that extreme, but I know [my work] will have the effect, and the change that is bigger than myself." Her confidence is built on this bigger picture, as well as the ability to process potential futures, "I

do see the entire story, I do play it out, and I think that is what gives me the confidence, since I have seen it and conceptualized it in all its forms. I'm open to the unknown so it's okay if I don't get there, but the fact that I have conceptualized it fully is what matters."

Criticism, despite the obstacle it presents, also serves the essential function of motivating a reformulation of ideas and being a part of the creative process. When criticized by a respected figure in a field, everyone agreed they found the input valuable. For Goldstein, the effect of criticism depends on the area of her work at which it is levelled, "I take criticism in philosophy extremely seriously. You put it out there in order to be attacked. That's the way you make progress. … With my novels it's very different. It's something very personal, I love my characters, and it's very subjective." Weinstein even lamented that he is not criticized enough due to a culture of respect toward bridge professionals. He wishes there was a more open culture of criticism at the highest levels of the game, and said, "Come after me, but be right."

Fish, a prominent New York Times columnist, was able to read and absorb criticism without being discouraged. He regularly sought out and spoke with critics who left contact information. He said that often criticisms tied in with his earlier work, where people would say, "Well, you took that position and that means that anything you say about anything is suspect." The transitivity of wrongness is problematic, however, because being a polymath necessarily requires pushing boundaries and exploring unknown domains. In order to guide their work, they must identify and select important feedback from irrelevant criticism, and thus, they utilize the "expert" mindset. Similarly, when asked whether it would be worse to be considered wrong or uncreative, both Goldstein and Fish emphatically agreed that a lack of creativity would be much worse. Goldstein said, "We're bound to be wrong. If we try to be interesting we're going to be wrong one way or the other."

Doubt and Audience

Since wrongness is inevitable, the lines between doubt and criticism can become blurry. Doubt can come from both internal and external sources. External doubt and criticism rely on the involvement of an audience, whether academic colleagues, customers, or readers. When discussing the role of the audience, Weinstein said, "In my experiences, greatness has been so limited by people caring what other people think about what they're doing. You just have to put that aside." Often others' skepticism and doubt can be toxic, but it can also be a phenomenal motivator.

As academics and public figures, nearly all the retreat participants have faced constant tensions between themselves and their audience. Concerns about how people will receive new ideas are a necessary element of polymathy. Over-concern with audience reception can stifle creativity, while producing successful and domain-altering work necessarily requires considering the role of the audience in one's work. Goldstein said that, "[Engagement with critical audiences] just really depends on temperament. Do you love a good rousing argument or do you hate not being able to get through to people?" For those in the latter category, there is often a tension between lack of acceptance and pushing boundaries. Working in the arts and sciences has provided Lopez-Gonzalez with a framework for addressing audience doubt and criticism. While she is deeply self-critical and constantly revising her work, she said, "I don't begin to doubt myself because of others. It's because I take into consideration that maybe other people's opinions are equally as valuable and so why not accept them as different? I don't make it a negative aspect in my thinking."

Lopez-Gonzalez identified the lack of boundaries as a catalyst for her creativity, "I'm creative precisely because I am not worried about boundaries, I don't care about the boundaries, I don't look for boundaries and if they're there and I find them, I disregard them." For her and for Weinstein, this lack of inhibition serves as a license to explore beyond conventional wisdom. She said, "In order to answer big questions we need to break [defined boundaries] apart and people need to be far more open to this type of merging and transformation and mutation of discipline. I think that would be a positive aspect, leading to much better innovation." Weinstein, as an independent and widely respected bridge and poker player, does not consider his audience: "I have no limitations on what I have to do. I judge the success by what I do, by victory, or defeat. I care about how successful I am at what I do." For participants who are part of academia, however, they face an inescapable audience for their work. Wright agreed, responding to Weinstein, "The key difference that in academia, victory is defined to some extent by social consensus. You are totally liberated from that."

Internal Doubt

Internal doubt, in contrast to doubt arising from the audience, is a constant questioning of intent and success. Wright related his own experiences with doubt as coming from within, "There are very few people who don't need to be exposed to a kind of doubt to do good work. For a lot of people, it comes from colleagues. For some people, it comes from themselves to an extent. I think in my own case, I have enough self-doubt so that I could go up a fairly long way without feedback." Finding a balance between constructive doubt and paralyzing doubt continues to be a challenge, especially at the frontiers of polymathy. Wright, relating to Goldstein's admittance of her own self-doubt within philosophy and novel-writing, said, "I think it's in some

ways helpful to me with my work, although I sometimes have the problem [Goldstein has, that] self-doubt can be paralyzing."

While doubt is often thought of as paralyzing or stifling, both Fish and Friedman shared a different perspective on the role of doubt in their work. For Fish, internal doubt is actually an accomplishment that can only be experienced as a symptom of in-depth thinking. He proudly said, "Someone who is deeply embedded in a project will be capable of having a doubt that others are not capable of having." Friedman also thrives on pushing the limit, and he regulates his self-doubt to motivate his work, "Whenever I don't have any doubt, I rev up the ambition to another level so that I do get doubt."

The conflict between doubt and success, like the conflict between a decision and its outcome, is challenging to unravel. While everyone can have bad days, maintaining focus in the face of extreme adversity can be very difficult. Weinstein's doubts are internal, "You don't doubt your ability, you doubt the execution." While initial challenges are expected in any line of work, repeated and unrelenting adversity may force one to reexamine their work. Weinstein summarized the power of doubt in an inspiring way, "Doubt is an achievement, because when I doubt in whatever I am doing, it takes me to another level. It's not the public doubt, it's the self-doubt, because it forces me to look at what I'm doing."

Language and Communication

As bridges across disparate fields, polymaths are uniquely capable of transmitting insights across multiple disciplines. Hovey pinpointed an important distinction which characterizes successful academic and business leaders: The ability not just to generate ideas, but to communicate them. The presence of an audience necessitates communication, and many of our polymaths have excelled at synthesizing ideas and reformulating them in a broadly digestible

manner. As Hovey said, "A lot of people have had great ideas. They just didn't have the personality, the skills, or the language [to communicate them]." As novelists, journalists, columnists, teachers, and public academics, polymaths must have the language and communication skills to consistently bring together insights across disciplines and convey their ideas in a widely understandable fashion. Lopez-Gonzalez, relating to the importance of communication, said, "Part of the struggle is convincing people that one is a polymath because one is able to see convergence between different concepts and categories, and be able to break down those categories between disciplines."

An unfortunate side effect of bringing together ideas across disciplines into a more universal language is that the initial meaning of the ideas can get lost in translation. While Friedman builds his presentations for multiple audiences, he still faces suspicions and widespread rebuke from each discipline as a result of his work. Wright lamented, "Almost all academics are terrible communicators. It's not really a disease of academia, it's a disease of expertise partly. It's that whenever you're expert in anything it's hard for you to keep track of what knowledge cannot be assumed when you're reaching out to a different audience." Polymaths can avoid this "curse of knowledge" by being able to return to the fundamental questions of a discipline, and thus communicate ideas with the public.

The colossal undertaking of translating across disciplines requires an in-depth understanding of both before being able to "cross over." Lopez-Gonzalez said, "You're gaining an enormous amount of knowledge, the whole toolbox of a discipline, just to be able to then transform it into a completely new medium, be it a book or fictional work or talking with different people." As Lopez-Gonzalez emphasized, one of the biggest advantages for polymaths is the ability to approach fields from different perspectives, which provides a more universal

language of communication across disciplines. Understanding the underlying principles and questions of a discipline, the domain of the fox, allows the big-picture hedgehog to focus on broader questions. Even Fish, despite his insistence on bottom-up approaches, agrees that having the overarching big idea of a discipline can help outsiders contribute new insights, as well as extract important details from a field. He said, "You can ask them, 'What are you guys trying to figure out, and what is at stake for you?' Some of them will have forgotten, some of them will never have known." By being able to see the bigger picture, polymaths can gracefully pluck important insights from other experts within a single discipline, and interweave them to form universal insights which can be communicated in broadly understood language.

Teaching and Mentorship

Mentors can play an important role in academic and professional development. While many participants were quick to deny having mentors, further discussion led to several insights. Participants felt they had domain-specific inspirations or mentors, but lacked mentors in their polymathic development. Since polymaths are constantly at the frontiers of their areas of work, they lack a clear previously-charted path to follow. Rather than gleaning domain-specific insight from mentors, participants felt that their most valuable mentors taught them "streetwise skills," namely, which path to chart in the absence of direction, and how to do so wisely. These skills, Fish suggested, frequently formed the essential foundations of mentorship. Fish said, "I've known academics of, at least in my view, enormous talent whose careers were a succession of frustrations in part because of the lack of streetwise mentorship."

Due to the confidence and motivation inherent in our polymaths, they often defied the traditional university paradigm. As a consequence of their polymathy, they commonly were branded "unteachable" and written off by professors as bull-headed and stubborn. The tragedy is

that, as Kaufman suggested, "It's the unteachables who are the ones that are going to actually do something creative or imaginative." The most influential figures in participants' lives were those who were willing to give them a chance, and offer the necessary professional support to navigate the professional minefields ahead.

These "streetwise" skills may even arise as a result of polymathy. Lopez-Gonzalez shared that her ability to excel in entrepreneurship originated from the human connection inherent in the arts, and that her training as a performer provided her with the necessary tools to become proficient in streetwise skills. Much like the ability to communicate between disciplines, these skills aid communication with the general public, and allow ideas to be shared with the world broadly, rather than solely in academic silos.

Imagination and Creative Process

What is creativity? Much of creativity is thought of as "Aha!" moments where suddenly ideas click. Participants agreed that this idea is a misnomer, and that the creative process usually requires numerous iterations and failed attempts at success. Lopez-Gonzalez described her creative process using insight from her work in improvisation, "The way I have to formulate the argument or claim is really that it's not about the paradigm. It's more about the specific questions of where I could possibly go with what we already have." This iterative process is often lost in the final product, where the insight leading to discovery is later framed as coming first. Lopez-Gonzalez is currently working on this exact question, however, and remains optimistic regarding her work on generating these insights through artistic means. She described her creative process and imaginative experience, "There's a curiosity in the moment and then it just percolates as you learn new information. And then the growth, or the creativity, the imagination, is the birth of

letting those ideas percolate, and then just having intuition. The feeling of 'oof,' *that*, that's where I want to go."

A common theme shared among everyone present was a frustration with the consequences of creativity when going beyond the mainstream. Goldstein said, "It's very, very hard when your community just is not sharing your intuitions. It depends a lot on your personality. Are you a fighter, or not?" Lopez-Gonzalez pinpointed creativity as the ability to move beyond the rigidly formulaic academic framework, "One needs the formality to begin with, but once you want to go beyond into the more creative concept of that discipline, you have to get out of that formality. I would even argue that in science where you have your A, B, C, D, maybe you don't have to follow that exact pattern at all. You can mix and match to ask an even more complex question." Kaufman related to this, emphasizing the disdain within academia for people who push the traditional boundaries with their creative work, "[With] the most innovative, scientific ideas, I find everyone else in the field finds that person incredibly unrigorous." Indeed, Goldstein suggests her own creativity was stifled by the academic tradition of wearing blinders, "You have to actually be kind of stupid, and just keep working [the system] to death, until you hit that anomaly." Fish affirmed Goldstein's experience, "Every discipline has a series of strategies for dealing with anomaly. Which means putting off until the very last minute the possibility of questioning the paradigm." This rigidity suggests an inherent problem within academia which regularly serves as a barrier to polymathy and interdisciplinary work. While Fish lauded the rigidity as necessary for scientific advancement, the rest of the group condemned it as stifling creative insight. Fish described his own experience with creative insight which created his work on Milton's Paradise Lost, "That was just a moment of insight. Just like that! Just came to me. And that was it."

The value of practice in generating creative insight cannot be underestimated. Ultimately, this discussion relates back to the crystallization of expertise in System One thinking: These insights typically arise through intuition and unconscious thought, and therefore may be facilitated through repeated practice and bolstering of our automatic mental processes. Lopez-Gonzalez said, "You need the basics. Once you get past that, then the creative invention and imagination moments happen." Through this shift, we may be able to increase the probability that lightning strikes with creativity. Goldstein agreed, "It is practice before you can even aspire to creating anything. You have to invest many, many hours." Much of what we later deem as creativity may in fact be these sudden bolts of insight from our automatic systems of thinking. Lopez-Gonzalez is confident that the automation of expertise is an essential prerequisite to creative moments, "I think that's the crux of true innovation and creativity and I'm sure everybody's having these mini-moments of creative insight."

Identifying and Nurturing Polymathy

How do we create additional polymaths? This vital question underlies a major goal of the retreat. As big-picture thinkers who are capable of sharing ideas across disciplines, polymaths are creators, translators, and imaginators, and nurturing the development of future generations of polymaths is essential for the continued conversations between disciplines. Lopez-Gonzalez suggests that becoming a polymath is not entirely learning specific disciplines; rather, she suggests that polymathy is a consequence of "learning how to learn." She said "When you have had enough knowledge and experience with one or two disciplines, then I think that for the third, fourth, fifth, you really start with the gestalt and then you work your way back down." This approach suggests a foundational approach to education, where one develops the tools for tackling new disciplines through repeated practice, much like other skills.

A particular tool which Lopez-Gonzalez has found extremely useful is the French Salon approach to learning, where students and professors read and discuss topics across multiple disciplines in a round-table setting. This approach to learning, as Lopez-Gonzalez said, allows educators to "take people who are already proficient in several fields and keep them thinking and collaborating, and to translate that into those who are the young ones who have yet to learn this type of conceptual thinking." Her goal throughout her current teaching is to create an experiential learning environment which blends artistic creativity and imagination with scientific rigor. Her focus on experiential learning techniques is designed to "have [students] imagine and create to discover the principles about what I'm teaching them," and her teaching has yielded remarkable results. Students from both the arts and sciences have recognized the importance of integrating the other, and she has sparked a new generation of polymaths through her work. She said, "It's the power of finding and locating questions from one discipline across other disciplines."

Weinstein, like Lopez-Gonzalez, identified philosophical shifts in education which are important for supporting the creation of polymaths. When mentoring his poker and bridge students, he tries to instill a culture of skepticism and encourage his students to question existing theories in poker and bridge. Weinstein is also actively involved in supporting polymathy by training skilled bridge players to play poker. Weinstein said that extending this support for creative thinking to other academic pursuits is essential for encouraging polymathy. He believes that the best way to instill this philosophical approach is to take students who are successful in one area and teach them to utilize their existing tools in a new area, "I think that to train polymaths, you have to take somebody from a field in which they are already exceptional and motivate them in another field."

Friedman identified the fragmented and philosophically dishonest language used within disciplines as the primary barrier he saw to budding polymaths. Relating to his own experience studying at MIT, he said, "You [should] have some unified, single, common language presentation of subjects that would be accessible to people with high intelligence who don't have any special talent for any of these subjects, or maybe only a special talent for one of them." His suggestion returns to the importance of an overarching language across disciplines which would allow students to understand and translate concepts between areas of study.

Fish related his own experiences in law school, where he saw opportunities to nurture polymathy instead of stifling it. He lamented that the culture of studying law naturally discourages branching out, and despite the malleability of the discipline, monetary and educational incentives are not aligned with the creation of polymathy. He said, "The only way to become anything like a polymath in the law school world is to leave law school, not for practice, but to go get a PhD in some subject elsewhere." These institutional barriers are present across academia, and often limit students' opportunities to branch out beyond their current areas of work.

Wright agreed with Fish's assessment of institutional barriers, and identified an advantage he had while entering disciplines as a journalist, "I didn't have to care as much what departments thought [about my work]." Unfortunately, a side-effect of this freedom was that departments dismissed Wright's work as insignificant for academia. He wished for greater support of non-academics who are trying to tackle problems of academic significance. Similarly, Goldstein identified a sense of community as the specific area of support within academia which she finds invaluable. Goldstein is drawn into academia by the shared interest and excitement toward ideas, an "intellectual sustenance."

Conclusions

The Polymath retreat provided a forum for reaching a better understanding of polymathy. Identifying the current obstacles facing aspiring polymaths is an important component of finding ways to support and nurture polymathy, as well as better understanding the psychological processes at work in people whose expertise defies traditional disciplinary boundaries. Many of the insights from the retreat discussions carry far-reaching implications for structuring our educational system, the development of expertise, and inspiring creativity.

The first step in understanding polymathy is pinpointing the relationships between areas of work. This distinction focuses on whether the areas of work build upon each other, contradict each other, or are distinct from each other. We call these three types of polymath Synergistic, Antagonistic, and Disjointed polymaths, respectively. Polymaths traditionally experience all three aspects of these relationships at certain times during their career, and they provide a helpful framework for understanding the inter-domain relationships of polymathy. Once establishing this framework, we move on to understanding the differing world-views and motivations behind polymathy. We draw a distinction between top-down and bottom-up approaches to domain-specific problems, where those utilizing a top-down approach find overarching connections between problems, while those using bottom-up approaches utilize discipline-specific tools to tackle their specific questions.

One of the foremost advantages of being a serial-learner and polymath is the ability to approach new disciplines as a novice. According to Wright, this has the benefit of not being enslaved to the prevailing disciplinary paradigm, in addition to being able to bring cross-

disciplinary insights to problems within a field. Even Fish, who resists interdisciplinary "expansion of perspective," finds value in understanding the big picture and foundational questions within disciplines before delving into the details. These serial-learning processes are supported by immense internal motivation and grit, and the ability to transfer insights across disciplines can be measured using the Diversity of Interest Scale (DOI). An important tool for encouraging future polymaths is to cultivate their ability to utilize their diversity of interest to question existing paradigms, and to facilitate a healthy academic skepticism toward commonly accepted wisdom.

Just as polymaths must approach established orthodoxy with skepticism, their work also faces significant doubt and rebuke as a consequence of producing cutting-edge insights. While this can provide an impetus to redirect their efforts from erroneous pursuits, they must also decide when criticism is worth paying attention to. This process of evaluating criticism extends the concepts of fixed and growth mindsets and introduces a third, "expert," mindset. Within the expert mindset, criticism is first assessed for its value and importance before deciding whether to pay it heed. Accurate evaluation of criticism within the expert mindset is essential for professional success, especially because working in disciplinary frontiers necessitates sometimes being wrong. Beyond criticism, polymaths also face both internal and external doubt. Carefully managing this doubt to serve a productive, rather than destructive, purpose is an important challenge for polymaths. In order to convincingly create domain-specific change, they must excel at communicating their ideas with their audience, and at dispelling doubts among their detractors.

As multi-disciplinary thinkers, polymaths do not fit neatly within the structure of academia. Disciplinary silos stifle creative thought, and serve as major obstacles to career

advancement for polymaths. While polymaths serve as academic translators, possessing the ability to create universal "languages" which bridge disciplines, the result of this process is often rebuke from both areas. Finding ways to better support interdisciplinary work within academia is an essential first step. Part of this process includes realigning incentives to encourage mentors and advisors to give polymaths, and their "risky" cross-disciplinary interests, a chance. Creating an intellectual community for polymathy, as many participants agreed over dinner, will be an essential form of support for budding polymaths, and will lead to greater conversancy and idea-transference between individual areas of work. Facilitating a regular forum for polymath-related activities and correspondence, much like this retreat, would be a phenomenal tool for ensuring that scholars working in the frontiers of their areas of study receive the necessary support to continue their work. Just as this retreat sparked new ideas in the participants through intimate academic discussion, future efforts should focus on additional round-table discussions between multi-disciplinary experts.

Since polymaths have experienced the crystallization of expertise on multiple occasions, their perspectives on this process are particularly insightful. The automatization of knowledge plays a significant role in forming expertise, and allows the expert to focus their cognitive effort on new frontiers. This transference of knowledge can be conceptualized using the System One and System Two approaches to cognition, and can be facilitated through practice. Even the process of tackling new disciplines as a serial learner may be improved through practice, a form of "learning how to learn." Participants also identified practice and automatization as a vital tool for generating creative insights. The transfer of cognitive effort from System Two to System One frees experts to tackle new and difficult problems using their full range of cognitive skills, and may lead to a greater frequency of creative insights. While they may seem as unpredictable as

lightning strikes, creative insight may be able to be nurtured and improved over time and through practice. Although it currently is not possible to create an intentional catalyst for this creative insight, with further research on the processes of achieving mastery, it may be possible to facilitate more of these magical "Aha!" moments of creativity.