THE IMPACT OF BACKGROUND DIVERSITY ON RESEARCHER INNOVATION

A thesis
Presented to
The Faculty of the Bauer College of Business
Of the University of Houston
And the
Faculty of the Honors College
Of the University of Houston

In Partial Fulfillment
Of the Requirements for Senior Honors Thesis
And the Degree of
Bachelors in Business Administration

By
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April 2022

THE IMPACT OF BACKGROUND DIVERSITY ON RESEARCHER INNOVATION

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Sources of Inspiration for Four Distinguished Professors

This notion of interdisciplinarity has always been interesting to me…I like the notion of boundary spanners, incorporating different fields into one another. How do you actually apply physics principles into biology and so on…when I would research, I would try to look at it creatively by borrowing things that nobody's ever used and putting it together. -Wynne Chin, Professor of Management Information Systems

I wanted to work in [academia] for 50 years and I sure did not want to do the same thing over and over. So, I was always looking for different real world problems and examples to transfer into research. -Betsy Gelb, Professor of Marketing

And so I have been across at least 3-4 fields, but I did each one of them very purposely and carefully…there were very few skills I ever cultivated that I didn't draw on later…Law Professor and Accidental Historian was probably the first time people understood the sort of range I had. -Michael Olivas, Professor of Law

I wanted to be able to do something with my math where I could apply to more abstract kinds of fields…this also extended to things like movies, food, autism, which I was able to incorporate into my research. -Irwin Levin, Professor of Psychology

Acknowledgements

First and foremost, I want to thank Dr. Rude for his patience and guidance through this process. Dr. Rude had never met me before we started this process together and my enrichment from this thesis goes far beyond what I learned about research. For the last year, my favorite part of every week was getting to sit down and talk with Dr. Rude. Although our conversations centered around research, the conversations that will stick with me for the longest are the ones that went far beyond research. Thank you for being my adviser and a mentor.

To Dr. Levin and Dr. Gardner, thank you for all the insight and help through this process. Once again, I had not formally met either before this process and they stepped in and went far beyond what I could hope for. Thank you Dr. Levin for being a great introduction to the world of academia and I/O psychology. Thank you Dr. Gardner for adding that much needed third-party objective view and all the help with writing.

Additionally, I want to thank my interviewees. All the interviewees were more than generous with their time and our interviews expanded well past the scope of this paper. I will have stories and advice I will be sharing for years to come.

Last, but not least, I want to thank my supporting case: my friends and family. They inspire me to pursue opportunities such as this thesis, while also having the patience to stick with me and support me through the most challenging times.

Abstract

Originally published in 1955, and replicated so frequently it established two laws (Lotka Law and Price Law), Wayne Dennis wrote that it is not uncommon in the field of science for the upper 10% in total output to contribute about 50% of all of the work (Dennis, 1955; Simonton, 2010). What about these researchers has separated them in such great disparity from their peers? This research aims to explore the relation between certain undergraduate and early career experiences and the role they play in research innovation and output.

I hypothesize that: researchers with undergraduate degrees outside their area of research, that attend larger universities and university programs, and have extracurriculars and work experience outside of academia produce more innovative research.

I tested these hypotheses with two different approaches. Study 1 involved exploratory interviews of four distinguished faculty across four different fields. Study 2 used archival data to analyze the backgrounds of I/O psychologists at 37 different tier one research universities.

This research showed mixed results about how a wide range of unique background experiences influenced researcher's ability to creatively think. Overall, there was evidence that researchers with a wider breadth of experiences, degrees outside of their area of research, various jobs and extracurriculars in undergrad, were able to synthesize these experiences into their research, which enabled them to be more creative. They were able to be more creative for two main reasons. One, the researchers were able to generate unique problem definitions, which in turn, expanded the possible solutions that the person generated. Second, they were able to generate more unique solutions to problems. To use an analogy, because of the researcher's background, they both expanded the size of the metaphorical pond they were fishing from and

looked in different spots than the other fisherman. This manifested in consistently innovative research ideas over their career.

Keywords: creativity, innovation, background experiences

Contents

Introduction

In 1905, a Swiss patent clerk published four research papers on four different topics in one calendar year. The achievement coined the name, “Miracle Year,” and Albert Einstein, the man responsible, would go down as one of history’s greatest physicists. More recently, a researcher by the name of Daniel Kahneman won the Nobel Prize in economics despite never formally studying economics. Kahnamen was a psychologist and had only studied psychology through his education. Additionally, Einstein and Kahneman did not produce one great idea, they produced great ideas over and over again (they had h-index, a citation based measure that indicates many citations over a number of works, scores of 119 and 155, respectively).

What Einstein and Kahneman exemplify is two things. One, there is a massive research disparity within fields of research. A few individuals, like Einstein and Kahneman, contribute a majority of the ground breaking ideas in a field (Simonton, 2010). Second, because so few account for so much, there is reason to believe there is something unique about these highly innovative researchers. The purpose of this research is to explore potential explanations for the innovativeness of these researchers. The emphasis will be on different aspects of a researcher’s undergraduate and early work experience.

I examined these potential explanations through two different studies, each with a different approach at examining the research question. Study 1 uses a case study approach to acquire a lot of focused data on each participant. By contrast, Study 2 uses a much larger sample, and collects much less information on each participant. Ultimately, Study 1 aimed to tease out specific correlations between certain experiences and innovativeness, while Study 2 was used to look for these same correlations in a larger population and with less control.

Literature Review

Current Literature

Unique and innovative thought is important in the field of research. The study of researchers and their productivity look at two distinct drivers: individual attributes (age, gender, etc.) and the departmental and institutional attributes of doctoral programs. The focus of this research will be on the former and exploring features of an individual's undergraduate experience.

Two main studies have focused on individual attributes. Nguyen's study had four individual attributes that influenced research productivity: being young, being male, being at a high academic rank, and having a doctoral degree (Nguyen, 2015). Dr. Gonzalez- Brambila's research analyzed age, country in which PhD was earned and gender (Gonzalez-Brambila, 2007). She found little correlation between age, country of PhD, and gender on research productivity (Gonzalez-Brambila, 2007). Her insight on age was contrary to the initial literature highlighting the need for more research on the subject and questioning the narrative of the influence of age on productivity. Institutional factors related to research productivity include funding, research assistants, research investment, and library expenditures (Lamari, 2018; Rawls, 2018). More specifically, only academic funding from funding councils and grants had a positive and statistically significant impact on almost all researcher productivity indicators (Lamari, 2018). Additionally, research assistants, research investment, and library expenditures all showed statistically significant influence on research productivity (Rawls, 2018). Interestingly, they all had comparable beta weight and statistical significance (Rawls). However, the library expenditures are hypothesized to be an indirect measure of a university's ability and desire to invest in research infrastructure (Rawls).

Campbell's Model of Creativity

Often overlooked, Campbell's model provides the basis for analyzing innovation and creative thought and the mechanisms that drive both and could lead to researchers like Einstein and Kahneman. Campbell's model contends that when someone encounters a problem they generate "thought trials" (Campbell, 1960). Thought trials are defined as imaginary experiences that simulate a possible solution to said problem (Campbell, 1960). This generation process is more or less random, blind, and lacking in foresight (Campbell, 1960). After each generation, the thought trial is evaluated and discarded until a satisfactory solution is found (Campbell, 1960).

This model has three key leverage points: generating multiple problem definitions to create a board inquiry, generating a large number of thought trials, and generating a wide variety of thought trials. The degree to which an individual can leverage one or more of these points influences their ability to generate creative ideas. This model provides the basis for analyzing where original thought comes from and who might be best at generating it.

Recently, Simonton (2010) revitalized and expanded the work Campbell had done. Simonton defines key concepts important for the sake of understanding the model, expanding on Campbell's model, and building out combinatorial models. These models take the basic theory that Campbell developed and specifies them in terms of individual domain samples, variable field size, ideational combination, and disciplinary communication (Simonton). Simonton has several important takeaways in his paper. First, he reiterates the importance of blindness in the creative process (Simonton). Second, he situated creativity within a dynamic model made up of three components: the individual, the domain, and the field (Simonton). The individual being the person who creates the creative idea (Simonton). The domain is the set of ideas that define a certain discipline (Simonton). For example, in psychology, the domain would be the theories, the

facts, the formulas. The field is the set of individual creators who are active in the discipline, as colleagues, competitors, etc. (Simonton). These vary from discipline to discipline, however the interaction of these three components are what generate creative ideas.

Lastly, Simonton discusses influences on exceptional creativity. Exceptional creativity being defined as creativity that yields products that contribute to a particular discipline (Simonton). Examples include research papers, novels, paintings, etc.. This creates the basis to operationalize creativity. Two distinct types of measures come to mind to capture creativity. The first one would be something that captures the collective work of a researcher. A researcher that is highly innovative will create ideas and theories that alter the field, and therefore are cited frequently (e.g. total citations). Second, there needs to be a measure that captures the creativity on an individual work level. A researcher that has one paper with many citations is not very creative. Therefore, a measure like H-Index, that looks at citations across all of a researcher's work, used in congruence with total citations, would indicate a highly creative researcher.

Simonton concludes that both genetics and environment play a role in one's ability to be creative. Simonton makes a point of emphasis on environmental factors that are unconventional, heterogeneous, and enriching, and that take place both in the home and school(Simonton). He also emphasizes a time in which these experiences are most impactful on an individual, childhood and adolescence (Simonton). Ultimately, Campbell's model predicts that researchers who generate multiple/wider problem definitions, generate a large number of ideas, and generate a wide variety of ideas will be more innovative. This study looks at how individuals' backgrounds influence these three leverage points.

Research Gap

The current literature fails to explore the implications of a researcher's background on their innovative research. Furthermore, these background characteristics develop one's ability to do the things mentioned in Campbell's model, ultimately influencing creativity and innovation. In particular, my research will focus on the implications of different undergraduate factors (undergrad degree vs. graduate degree, size of university, diversity of university.) on innovative research. Additionally, factors that demand looking into, but are outside the scope of this research project, are the size of the undergraduate program they were in, public vs. private undergraduate education, and location of university.

Hypotheses

1. I hypothesize that researchers with an undergraduate degree outside of their area of research are more innovative researchers.
2. I hypothesize that researchers that go to larger undergrad universities are more innovative researchers.
3. I hypothesize that researchers that have participated in extracurriculars and job experience outside of academia are more innovative researchers.

The hypotheses are derived from the three leverage points of Campbell's model. The number of trials was not used to generate hypotheses because it is composed of three variables: time (more time, the more thought trials that can be generated), attention (how much attention is given to said problem), and the speed one is able to generate and discard/approve of thought trials. These variables did not make for good hypotheses under the lenses we wanted to look at.

The other two leverage points, ability to generate board inquiry and variety of trials, are the points of manipulation for this study.

Hypothesis 1 and 3 center around the ability to generate broad problem definitions. The premise is these experiences will expand a person's ability to generate problem definitions because they will have more unique experiences to pull from. Their expertise expands outside of their own field and would help them have broader inquiries than their peers. Simonton refers to this concept as cross-domain sampling and discusses the potential positive impact it has on creativity (Simonton, 2010).

Hypothesis 2 centers around the other leverage point: the ability to generate a variety of thought trials. For hypothesis 2, the exposure to a larger number of people and faculty, in theory, will help them generate a more unique perspective for creating thought trials.

Methodology

My research was conducted in two different studies. The first study was an exploratory study that involved interviewing four distinguished professors. These professors all elicited high levels of research innovation in their respective fields and fit the criteria of the hypotheses(to varying extents). The second study is an analysis of archival data. In this study, I looked at I/O psychologists at Tier One universities across the U.S. and collected information on their educational experiences.

Study 1

In this study, I interviewed four professors and asked them to reflect on their educational backgrounds and research publications(questions in Appendix D). These interviews gave insight into the different kinds of experiences sought by accomplished faculty throughout their education

and the implications/advantages of a unique background on innovative research. The answers to these interviews helped show the connection between certain experiences and research output and ideal experiences for aspiring researchers.

Sample

A convenience sample was used to select the four professors that participated in the study. These faculty were selected based on their connection to myself and my adviser, Dr. Dale Rude, and the hypotheses of the study. All faculty chosen were at an advanced stage in their career (25 years plus). Three of the professors were men and one was a woman. As a baseline, all had to contain undergraduate degrees outside their area of research and have high research productivity scores. Unlike study 2, none of the interviewees had I/O psychology degrees because of the lack of availability and to explore the hypotheses out of that select population. All had h-index scores above 29 which satisfied the necessary metrics because of its indication in the literature for being a high level of achievement. For example, 84% of Nobel Prize winners have at least an h-index score of 30 (Hirsch, 2005).

Summary of Responses

Interview #1: Dr. Wynne Chin

Research Career

Dr. Chin is a well published researcher in the field of MIS (Management Information Systems). Although Chin focuses his research around MIS topics, his research expands into the social sciences,geoscience, and more. Currently, Dr. Chin has over 74,237 total citations and an H-Index score of 66.

Background

Dr. Chin is a C.T. Bauer Professor of Decision and Information Sciences at the University of Houston where he has been since 1997. However, Dr. Chin's academic journey started at the University of California-Berkeley where he completed his undergraduate in biophysics. Dr. Chin listed no particular reason for choosing Berkeley despite getting into other schools such as Harvard, MIT, and various others of the like. Dr. Chin chose biophysics because of the vigor of the degree. After entering college, Dr. Chin describes his experience as "muddling" around. He did not go to college for a certain job and spent most of his time taking random courses and pursuing interests outside of the classroom.

When it came time to graduate, he had not particularly applied himself to his degree, illustrated by his less than 3.0 GPA, and did not have any job prospects. Due to this, Dr. Chin decided to pursue additional education in the field of biomedical engineering to apply his biophysics degree to a more concentrated field. On the strength of his test scores, he gets into Northwestern's biomedical engineering PhD program. Although he applied to biomedical engineering, he was hoping to use his time there to find both the field of engineering he would be the best at and most liked.

After finishing all his coursework, and with only his research project left to complete, Dr. Chin decided that engineering was not what he wanted to spend the rest of his life working on and a lot of his peers were going into industry not academia. So, if he was going to pursue industry and not academia, he felt it was best to pivot into an MBA (Masters of Business Administration) program and "cash out." Dr. Chin has a lightbulb moment when he enters his MBA. He worked a lot on computers in his PhD program and, when he got to his MBA program, he got to see how technology intersects with people and organizations. After completing his MBA and working for a little, he decided to go back to school to pursue this intersection of

technology, people, and organizations in the form of a Computer Information Systems degree. Dr. Chin completed his PhD in Computer Information Systems from the University of Michigan and has been in academia ever since.

Reflections on Career

Dr. Chin did not give a lot of reasons for why he chose Berkeley and Northwestern and the subsequent degrees he pursued. However, in hindsight, he highlighted the interdisciplinary nature of all of it. He said he has always been drawn to the idea he calls, "boundary spanning," which involves incorporating various fields into one or how one field can be applied to another. The first instance, and the one he mentioned himself, was his biophysics degree (the combination of biology and physics).

Dr. Chin also commented on the size of his university. He mentioned how he "muddled" through college and being at a large university facilitated a lot of that because of the lack of accountability and assistance. However, he also explained how a large public university allowed him the opportunity to really explore through his undergraduate education and, how he describes how he, "truly got a liberal arts education."

Dr. Chin participated in several extracurriculars in undergrad and worked after his MBA. Dr. Chin made no note of the impact his work experience had on him, except for the fact that it pushed him back to academia. Although most of his undergraduate extracurriculars were for fun and exploration purposes, one experience had a more profound effect. For several years of undergrad, he worked on the student board planning upcoming movies for the university. This experience involved planning, leading, among other things and taught him that he wanted to do something beyond just a pure technical role.

Lastly, Dr. Chin did not participate in any undergraduate labs or have an undergraduate mentor.

Interview #2: Dr. Betsy Gelb

Research Career

Dr. Gelb had 124 publications when she retired from teaching. She worked with many doctoral students over her career and published consistently throughout her career. Dr. Gelb's research focused in the world of marketing from advertising in foreign countries to post-purchase customer processes. However, she also allowed herself to expand outside the world of marketing and explore topics like bridging the gender gap in confidence and mental health stigmatization in the workplace (but in 1980). Through her expansive career, she accumulated 5,213 citations and an H-Index score of 29.

Background

Dr. Betsy Gelb was a Marvin Hurley Professor of Marketing and Entrepreneurship at the University of Houston for her entire career. Her courses revolved around management and marketing strategy. However, originally, Dr. Gelb was a journalism student. Her first introduction to journalism was when she participated in the school newspaper her sophomore year of high school. From there, she went on to study journalism at the University of Missouri-Columbia. After college, Dr. Gelb wrote for CBS, and worked in PR, but after a city change and some job switch ups she found herself in a management role for a non-profit. At this point, Dr. Gelb felt that she lacked the skill set she needed to be successful at her job and went to get an MBA from the University of Houston. Coincidentally, as Dr. Gelb was wrapping up her MBA, the management department at Houston was creating a management PhD program. Based on the impression she made on certain staff in her MBA program, they encouraged her to continue her

education. One thing led to another and Dr. Gelb was graduating with a PhD in management and a minor in marketing. She was hired on to the UH staff right after graduation where she stayed for her whole career.

Reflections on Career

The influences of Dr. Gelb's undergrad were seen in an indirect way. First, journalism school instilled a confidence in her that propelled her through her whole career. Secondly, and this was present before college, but reinforced in college, was the pleasure she got in writing. Dr. Gelb always found writing "fun" and it encouraged the productivity she had. Journalism also taught her how to write for an audience. She treated academic journal reviewers as her audience when she wrote.

Dr. Gelb did not feel like the size of her university (which was around 10,000 students at the time) played a role in her education, or subsequent experiences. She credited this to the fact that she was in a 150 student program within the 10,000 person school and so it did not have the same feel as a large university. She did say that the prestige of the university played a role in the education she got and ultimately the skills she developed. She mentioned how prestigious universities attract the best professors.

Dr. Gelb's breadth of work and extracurricular activities heavily influenced her research career. The job she had before her PhD program inspired one of her papers about low income housing. Furthermore, she continued this process into your academic career. She incorporated experiences from other positions in the university to inspire research ideas. She gave the example of how working the entrepreneur hotline at the school helped her to pursue research on mental health stigmas.

Interview #3: Dr. Michael Olivas

Research Career

On top of the various administrative roles that Dr. Olivas worked for the University of Houston, he was a prolific publisher. He authored or co-authored sixteen books on top of his publishing career. His research focused on immigration law and legal issues surrounding Latino students. He currently has 4,820 total citations and an H-index score of 38.

Background

Dr. Olivas was the William B. Bates Distinguished Chair in Law at the University of Houston Law Center and Director of the Institute for Higher Education Law and Governance at the University of Houston before he retired in 2019. He now resides in New Mexico doing radio shows about law and rock and roll and continuing to write. Dr. Olivas's academic journey started right where it ended, in New Mexico.

Dr. Olivas began his college career at the College of Santa Fe as a seminarian. After his freshman year of studying English, his bishop sent him to Ohio to study at Pontifical College Josephinum. He graduated in 1972 from Pontifical College Josephinum with a dual degree in theology and english. After his undergrad, Dr. Olivas, under consultation with his bishop, arranged a deal to continue his theology studies, while also pursuing a PhD in English from the University of Ohio State. Due to his financial limitations at the time, while Dr. Olivas was pursuing these degrees, he was working all kinds of jobs, from construction, to teaching, to shining shoes.

During his graduate studies, he began to question his vocation and dropped out of seminary school to pursue an English PhD full time. Right after completing his master's program, the bottom fell out of the English field and his fellow students were no longer getting jobs after graduation. Still with the desire to be a professor, he transitioned to a field called

higher education administration, for his PhD, where he took the course higher education law. Everything clicked and Dr. Olivas decided to complete his PhD and go to law school.

Dr. Olivas attended the University of Georgetown Law School and, on the side, continued to work various jobs, now incorporating several jobs that helped support minorities. Ultimately, Dr. Olivas graduated in 1977 with his law degree. He worked a few jobs after college, mainly for The League of United Latin American Citizens, when the University of Houston called. Dr. Olivas, sold by the Phi Slama Gama at the time, took the job at Houston and worked for the university for 38 years.

Reflections on Career

Like several of the other interviewees, Dr. Olivas' early academic decisions were influenced more by circumstance than his own fruition. His choice to pursue an English degree was heavily persuaded by his mentor at the time.

Although Dr. Olivas indicated that the size of his universities influenced him, but more in a personal manner. He had to transition from Pontifical College Josephinum, where he was one of 89 students, to Ohio State, which had over 51,000 students.

The different work and extracurricular work experiences are largely what influenced and directed Dr. Olivas' research. Dr. Olivas generated the idea of his master's thesis from the John Updike books he read growing up. Several of his papers on immigration and Latino students resulted directly from his prior work experience with said populations. Dr. Olivas' most current work on Roll and Roll law stems from interest in the genre from a young age.

Lastly, Dr. Olivas was not in an undergraduate lab, however he was mentored closely by a professor at Pontifical College Josephinum and Dr. Olivas worked as his research assistant.

Interview #4: Dr. Irwin Levin

Research Career

Dr. Levin's research career expanded over five decades and covered an array of topics. He has an H-Index score of 58 and 16,246 total citations. His most cited works deal with the concept called framing effect. Besides framing effects, Dr. Levin's research spans over other decision making phenomena, and most recently has transitioned into autism research.

Background

Dr. Levin was a professor and director of the honors program at the University of Iowa. Dr. Levin spent his entire professional career working for the University of Iowa. Dr. Levin had several different appointments with the University of Iowa. His appointments ranged from being a professor of psychology and marketing to being the school's honors program director. His educational background is equally as diverse, despite being all at the University of California-Los Angeles (UCLA). Dr. Levin entered his undergrad in the height of the space race, 1950s, and was respectfully pushed into the direction of engineering. Dr. Levin quickly learned that engineering was not his place and transitioned to a mathematics degree, which he obtained in 1960. Due to several factors, all discussed later, Dr. Levin pivoted, once again, out of undergrad and proceeded to get a Ph.D. in psychology, also from UCLA.

Reflections on Career

Dr. Levin's reasons for choosing UCLA and his degree of engineering was largely determined by situational factors and non-academic related reasons. Dr. Levin chose UCLA because it was close to home, cheap, had great sports teams, and a good academic reputation. His major selection was also largely dictated by the societal pressures of the Cold War at the time. Although not intentional, Dr. Levin's pivots and untraditional foundation had two key impacts on his research career. One, he received a strong foundation in math which he was able to

leverage heavily in his research driven psychology career (additionally it exposed him to a key mentor and I will speak more to that later). Second, he was both able to explore what he enjoyed and was good at. Dr. Levin's pivot from math to psychology was because of the discovery that he could leverage his skills in math to an applied field like psychology and he found he enjoyed that much more.

Outside of Dr. Levin's degree, mentorship also played a role in his education. Dr. Levin impressed a psychology teacher in his undergraduate with his mathematics skills and later, that same mentor, pushed him to apply to psychology Ph.D. programs and was the adviser to his dissertation.

UCLA's size also influenced Dr. Levin's education. Dr. Levin described the size as a double sided coin. In one regard, it was easy to become a number and get lost in the crowd. However, because of its size, the university was very well funded, and once Dr. Levin became a graduate student, the university had plenty of resources at its disposal. Lastly, Dr. Levin did not mention much about his peers, but he did say having friends with common goals helped encourage him to be the best he could be academically.

Dr. Levin, despite involvement in several extracurriculars and outside jobs in his undergrad, indicated no effect on his research.

Study 2

Study 2 used archival data to collect information on researchers' backgrounds, mainly their degrees and the size of their undergraduate institution. I used a multivariate analysis to analyze the relationship between the researchers' degrees and size of undergraduate enrollment to their H-index scores and total citations.

Sample

The sample consisted of looking at tier one research universities with I/O psychology programs. From the universities that had I/O psychology programs, each of the research faculty were recorded. For each researcher, I recorded name, gender, faculty status (assistant professor, associate professor, etc.), the school in which they were currently working for, their PhD, year of PhD, the location in which they received their PhD, their undergraduate degrees, the school in which they received their undergrad, and the size of their undergrad school when they attended. The sample included 175 researchers from 37 different universities. Of the 175 researchers, 58 had complete data that could be analyzed. The sample had two control variables, length of career and gender. These control variables were chosen because of the indication in prior research on their influence on research output (Simonton, 2010; Nguyen, 2015). Age was measured in time since PhD was earned. For this study, only researchers 20 years past when their PhD were analyzed. This was to standardize the body of work that each researcher had.

Measures

The independent measures are undergraduate degree(s) and the size of university when they attended. This data was collected through public information on university websites, CVs, and LinkedIn profiles. The dependent measures were total citations and h-index scores for each researcher. The data for these measures were found on GoogleScholar and ResearchGate (https://scholar.google.com/, https://www.researchgate.net/). GoogleScholar and ResearchGate are widely used, independently run web search engines for scholarly literature. They are commonly used for performance appraisal of researchers (Lamari, 2018; Hirsch, 2005). H-index derives an *h* score from *h* amount of publications that have *h* amount of citations. For example, a researcher with a h-index score of 68 has at least 68 publications each with over 68 citations. The aim of the measure is to capture both the quantity and quality of a researcher's publications.

Used with total citations, it shows that researchers are innovative, by volume of total citations, and consistently innovative, illustrated by the h-index. Additionally, these measures have been used in the past to measure the innovativeness of researchers (Simonton). These measures will be used in unison to legitimize the results of study 1 and add strength to the findings.

Analysis

A multivariate analysis was used to analyze the different undergraduate degrees. For the size of undergraduate enrollment, a correlational analysis was used. Different methods were used for each independent variable because of the different nature of each variable (undergraduate degrees were categorical, while the enrollment size was continuous). For the size of the undergraduate school, this involved one statistical test. For different undergraduate degrees, the analysis was run in three different ways. In the first analysis, researchers were separated into three groups: only a psychology degree, a psychology degree plus another degree not psychology related (could not be sociology or applied psychology for example), and no psychology degree. The second analysis was run by combining the second two groups, the psychology degree plus another degree and the no psychology groups. In the third analysis, the two groups from the second analysis were used, however participants with a minor outside of a psychology related field were included in the degree outside of psychology condition.

Results

The hypotheses had mixed results through the two studies. Study 1 had evidence that degrees outside a researcher's area of research, the size of their undergraduate university, and work experiences before joining academia all contributed to creativity and influenced researcher innovation. Study 2 did not find any significant results, however there was some evidence that

degrees outside a researcher's area of research influenced creativity. Ultimately, the research demonstrated that these seemingly random and unconnected experiences of each of the researchers was able to be synthesized in a unique way to create a competitive advantage in research. This is particularly evident by the fact that every interviewee incorporated an interest or hobby into a future research design.

Hypothesis 1: Influence of Different Degrees

All of the interviewees reported that a degree outside of their research area enhanced their research creativity. In some cases, the influence was more direct and the interviewees could articulate it (e.g. Dr. Levin and Dr. Olivas). However, more commonly the development of a unique skillset or approach was later utilized in their research. However, study 2 did not replicate the results of study 1. When analyzing the researchers in three separate categories, psychology degree vs. psychology degree plus another degree vs no psychology degree, the Pillai's Trace reported levels of significance was .387 (with an F value of 1.047 and a df of 4), indicating no significance(Table B3).

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.657	51.618[b]	2.000	54.000	<.001
	Wilks' Lambda	.343	51.618[b]	2.000	54.000	<.001
	Hotelling's Trace	1.912	51.618[b]	2.000	54.000	<.001
	Roy's Largest Root	1.912	51.618[b]	2.000	54.000	<.001
Degrees	Pillai's Trace	.073	1.047	4.000	110.000	.387
	Wilks' Lambda	.928	1.034[b]	4.000	108.000	.393
	Hotelling's Trace	.077	1.021	4.000	106.000	.400
	Roy's Largest Root	.060	1.664[c]	2.000	55.000	.199

a. Design: Intercept + Degrees

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

Table B3

However, the psychology and other degree condition reported higher means for both H-Index scores (49.40 compared to 36.71 for no psychology degree and 47.13 for only a psychology degree) and total citations(26357.4 compared ro 17629.85 for only a psychology degree and 13391.57 for no psychology degree) than the other two conditions(Table B2).

Descriptive Statistics

	Degrees	Mean	Std. Deviation	N
HIndex	PsychologyDegree	47.13	28.100	46
	PsychologyDegree&OtherDegree	49.40	37.179	5
	NoPsychologyDegree	36.71	10.935	7
	Total	46.07	27.306	58
TotalCit	PsychologyDegree	17629.85	19629.619	46
	PsychologyDegree&OtherDegree	26357.40	37861.961	5
	NoPsychologyDegree	13391.57	14127.587	7
	Total	17870.71	20847.971	58

Table B2

When the last two categories were combined, the Pillai's Trace reported level of significance was .237 (with an F value of 1.478 and a df of 2). Despite movement in the right direction, the results are still insignificant (Table C3).

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.760	87.251[b]	2.000	55.000	<.001
	Wilks' Lambda	.240	87.251[b]	2.000	55.000	<.001
	Hotelling's Trace	3.173	87.251[b]	2.000	55.000	<.001
	Roy's Largest Root	3.173	87.251[b]	2.000	55.000	<.001
DifferentDegrees	Pillai's Trace	.051	1.478[b]	2.000	55.000	.237
	Wilks' Lambda	.949	1.478[b]	2.000	55.000	.237
	Hotelling's Trace	.054	1.478[b]	2.000	55.000	.237
	Roy's Largest Root	.054	1.478[b]	2.000	55.000	.237

a. Design: Intercept + Degrees2

b. Exact statistic

Table C3

Unlike in the first analysis, the mean of the H-Index scores was higher among participants with only a psychology degree, 47.13 compared to 42.00 (Table C2). However, the mean of total

citations was higher with the participants with a degree other than psychology, 18794.00 compared to 17629.85 (Table C2).

Descriptive Statistics

	Degrees2	Mean	Std. Deviation	N
HIndex	PsychologyDegree	47.13	28.100	46
	DegreeOtherThanPsychology	42.00	24.709	12
	Total	46.07	27.306	58
TotalCit	PsychologyDegree	17629.85	19629.619	46
	DegreeOtherThanPsychology	18794.00	25975.466	12
	Total	17870.71	20847.971	58

Table C2

In the third analysis, where the participants with minors outside of psychology were added to the second condition, the results were insignificant again. The Pillai's Trace reported level of significance was .320, with an F value of 1.164 and a df of 2 (Table D3).

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.808	115.849[b]	2.000	55.000	<.001
	Wilks' Lambda	.192	115.849[b]	2.000	55.000	<.001
	Hotelling's Trace	4.213	115.849[b]	2.000	55.000	<.001
	Roy's Largest Root	4.213	115.849[b]	2.000	55.000	<.001
DegreesandMinors	Pillai's Trace	.041	1.164[b]	2.000	55.000	.320
	Wilks' Lambda	.959	1.164[b]	2.000	55.000	.320
	Hotelling's Trace	.042	1.164[b]	2.000	55.000	.320
	Roy's Largest Root	.042	1.164[b]	2.000	55.000	.320

a. Design: Intercept + DegreesandMinors

b. Exact statistic

Table D3

There was a similar pattern with the reported means in the second analysis and the third analysis. The participants with only psychology degrees reported higher mean H-Index scores (46.23 compared to 44.24), but lower mean total citations (19344.18 compared to 17259.76) (Table D2).

Descriptive Statistics

	DegreesandMinors	Mean	Std. Deviation	N
HIndex	OnlyPsychology	46.83	29.407	41
	AnyAdditionalDegreeorMinor	44.24	22.118	17
	Total	46.07	27.306	58
TotalCit	OnlyPsychology	17259.76	20589.112	41
	AnyAdditionalDegreeorMinor	19344.18	22030.782	17
	Total	17870.71	20847.971	58

Table D2

Hypothesis 2: Size of Undergraduate Enrollment

Only two of the interviewees indicated that the size of their university later influenced their research, despite all the interviewees going to large (over 10000 student) universities. In Dr. Levin's case, the larger university was able to better fund opportunities he was interested in. In Dr.Chin's case, the larger university supplied a greater variety of opportunity, both with classes and extracurriculars. This enabled him to explore a greater multitude of interests and passions. Study 2 was not able to replicate the findings from those two interviews. There was a slightly negative correlation between undergraduate enrollment size and total citations and H-Index scores. There was -.082 Pearson Correlation between enrollment size and total citations and a -.173 Pearson correlation between enrollment size and H-Index sores (Table E1).

Pearson Correlation Table

	UndergraduateSchoolSize	TotalCitations	HIndex
UndergraduateSchoolSize	1		
TotalCitations	-0.082	1	
HIndex	-0.173	0.889	1
N	59	59	59

Table E1

Hypothesis 3: Influence of Work Experience/Extracurriculars

All of the interviewees indicated how influential their work experience and extracurriculars were on their research, however it was not measured in the archival data. All of them could point to specific experiences that later directly influenced a research paper(s). Additionally, there were even more examples of indirect ties between extracurriculars and research ideas.

Discussion

These two studies continued the conversation about creativity and aimed to explore the avenues in which creativity comes from. Firstly, the Study 1 reinforced Campbell's model by illustrating that the three leverage points, broader problem definitions, greater variety of solutions, and more total solutions generated, coincide with greater creative output. Study 1 expanded on the model by identifying some key experiences (different degrees, work experience, extracurriculars) that correlate with creativity. This also coincides with Simonton's work about creativity where he discusses, "creative development is enhanced by childhood and adolescent exposure to unconventional, heterogeneous, and enriching experiences both at home and in school" (Simonton, 2010). There is also evidence that this may also be influenced by early adulthood experiences.

Although Study 2 was not able to reinforce Study 1, there was some evidence that degrees outside of psychology influence creativity. In all three analyses, participants with only a psychology degree had lower mean total citations scores and only marginally better mean H-Index scores. The most interesting result of the three analyses was researchers with a psychology degree and another degree outperformed researchers with only a psychology degree and only a non-psychology degree. The researchers with both degrees had a 2.27 higher H-Index score on average than the next closest group and 8727.55 more total citations than the next closest group.

This reinforces the synthesis portion of creativity. Even with a wide breadth of experiences, without the ability to synthesize ideas across different fields there will be no influence on creativity. I speculate that researchers with a degree in psychology and a degree outside of psychology have enhanced synthesis skills over their peers who only have a degree in one respective field.

The implications for the field of research are profound. For one, it changes the narrative for the criteria that universities look for in potential researchers and PhD candidates. A more diverse background should indicate stronger future potential performance. Additionally, it influences the way research in general should be approached. Interdisciplinary teams should become a point of emphasis, particularly in the idea generation portion of the research process.

Furthermore, this research added complexity to the topic of creativity. The research emphasizes that a broad array of experiences correlate with research innovation, however the interviews also highlight that the personality of the individual plays a role as well. There is a certain personality type that both, either consciously or unconsciously, pursues this wide breadth of experiences and is able to incorporate these experiences into their idea formation process. This personality trait most aligns with someone who has a high degree of openness. People with high degrees of openness have a wide array of interests and are more likely to pursue new and unique experiences (Cherry, 2021). Additionally, openness has been correlated with divergent thinking and creativity (McCrae & Costa, 1987). Therefore, both the ingredients for innovative thinking, wide breadth of experiences and ability to synthesize these experiences, are captured by this personality trait.

Another implication of this study is the way we approach education and the learning process moving forward. All the interviewees highlighted how the range of experiences

influenced their creative thinking and research and, for most of them, these experiences were not picked with this specific intent in mind. This could inform a lot of change in the approach to the education process. One, students should engage with many topics and participate in a wide array of experiences. Secondly, the intent does not need to be directly stated. Just the mere exposure and engagement in the activities is enough to have the impact. This argues that the current model of specialization in undergrad may be a direct inhibitor on creativity and a broad interdisciplinary approach may be the best form of education for enabling innovative thinking.

Limitations

While this paper introduced a lot of ideas, and pointed to some overarching ideas, there are several things that limited the results of this paper and could be greatly expanded upon in future research.

Firstly, the quantitative part of this study severely lacked the appropriate sample size. This was primarily the result of two factors. The first of which I call a technology information lag. The quantitative part of the study used archival data that could be found publicly. This is a great idea with all the public information about professors. This was tremendously successful with faculty that started their careers in the past 10 years, and still solid for the next 10 years. However, although the technology is in place, and the newer generations have converted, the older, more senior faculty that were the focus of this research, had not transitioned a lot of their information over. This led to a lot of missing information from the population most needed for a study like this. The second issue pertains to the self-reporting nature of the archival data being collected. The whole point of this research is to catch outliers. To look for common unique experiences among the most creative researchers. However, because of the nature of this information, this is the information most likely left of self-reported documents because it may

lack inherent relevance. Furthermore, there really is no way to calculate or predict how much information is missing due to this.

Another limitation with the quantitative data surrounds enrollment data at schools. This data also has a technology lag, and although it is catching up, the data 30-40 years ago has a lot of holes in it. The larger problem is how schools report enrollment. Schools do not have to specify how they calculate enrollment information, and for non-public universities it is usually impossible to get the hard data. Therefore, besides the discrepancies in what is reported and when, the researcher is left to guess if the schools are using the same enrollment metrics.

Directions for Future Research

The research stands to go into a few directions. One direction would be expanding on the same criteria and generating a larger sample. Additionally, if similar fields (need to be similar because different fields have significant differences in h-index and total citations) were incorporated, the sample could be expanded to look for more concrete evidence. Additionally, the method for data collection could be fine-tuned. In the short term, reaching out to faculty that fit the criteria directly, through email or over certain social media platforms, could be a way to get a more complete data set and larger sample. This would also fix the issues around self-reporting.

Besides better replication, two important areas could be expanded upon. One, a wider array of experiences could be explored. This would likely entail going further into people's history. A possible idea would be examining if there are commonalities between environments growing. For example, do more creative people come from suburbs or inner city schools? Do they have more siblings? Do they come from certain high schools? The second idea would be to incorporate a personality measure. In the interviews, it was clear that a lot of this was not

conscious decision-making. The interviewees almost seem to bounce from one experience to another without necessarily any specific reason and make something out of it. As mentioned earlier, there is evidence that openness is linked with creativity and innovativeness. A potential added dimension for future research could be having participants take a Big 5 personality test along with the other information collected on them.

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Appendix A

Interview Questions

Hypothesis 1(Degree)

1. What is your educational background?
2. How and why did you pick your undergraduate school?
3. How and why did you pick your graduate school program?
4. Name, if possible, one of your publications where your undergrad degree gave insight which enabled you to think of it.
5. What impact, if any, did having a degree outside of your field of research have?
6. How did your undergraduate experience impact your career?
7. (If applicable)Why did you change degrees in undergraduate and/or graduate school?

Hypothesis 2(Size of University)

8. What undergraduate school did you attend?
9. With regards to your undergraduate education, what role, if any, did your peers play in your education? Does that impact your research today?
10. Do you think the size of your university played a role in the education you received at that institution? If so, did it later influence your research?

Hypothesis 3(Work Experience&Extracurriculars)

11. Is there something you did outside of school that had an impact on your later research?(from highschool through graduate school)
12. Did you work before joining academia? What impact, if any, did that have on your research?
13. Were you in any extracurriculars in undergrad? Did they enhance your career at all?

Extra

14. Did you have a mentor in undergraduate or graduate school? If so, did they play a role in future research?
15. Did you participate in an undergraduate research lab? If so, what effect, if any did that have on your undergraduate and graduate education?
16. If possible, is there a single most important experience or part of your undergraduate education that influenced your career?
17. How did you arrive at a PhD in your respective field?
18. What was the inspiration for your doctoral research?
19. What advice do you have for someone who is exploring graduate programs?

Personal

20. Where did your success come from?
21. Is there anything you would have done different if you could go back now?
22. What is your best publication? Where did the idea come from?

Appendix B

Between-Subjects Factors

		Value Label	N
DifferentConditions	0	PsychologyDegree	46
	1	PsychologyDegree& OtherDegree	5
	2	NoPsychologyDegree	7

Table B1

Descriptive Statistics

	Degrees	Mean	Std. Deviation	N
HIndex	PsychologyDegree	47.13	28.100	46
	PsychologyDegree&OtherDegree	49.40	37.179	5
	NoPsychologyDegree	36.71	10.935	7
	Total	46.07	27.306	58
TotalCit	PsychologyDegree	17629.85	19629.619	46
	PsychologyDegree&OtherDegree	26357.40	37861.961	5
	NoPsychologyDegree	13391.57	14127.587	7
	Total	17870.71	20847.971	58

Table B2

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.657	51.618[b]	2.000	54.000	<.001
	Wilks' Lambda	.343	51.618[b]	2.000	54.000	<.001
	Hotelling's Trace	1.912	51.618[b]	2.000	54.000	<.001
	Roy's Largest Root	1.912	51.618[b]	2.000	54.000	<.001
Degrees	Pillai's Trace	.073	1.047	4.000	110.000	.387
	Wilks' Lambda	.928	1.034[b]	4.000	108.000	.393
	Hotelling's Trace	.077	1.021	4.000	106.000	.400
	Roy's Largest Root	.060	1.664[c]	2.000	55.000	.199

a. Design: Intercept + Degrees

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

Table B3

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	HIndex	719.878[a]	2	359.939	.474	.625
	TotalCit	503226983.2[b]	2	251613491.58	.570	.569
Intercept	HIndex	48695.384	1	48695.384	64.104	<.001
	TotalCit	9030067338.1	1	9030067338.1	20.463	<.001
DifferentDegrees	HIndex	719.878	2	359.939	.474	.625
	TotalCit	503226983.17	2	251613491.58	.570	.569
Error	HIndex	41779.846	55	759.634		
	TotalCit	24271132717	55	441293322.12		
Total	HIndex	165596.000	58			
	TotalCit	43297365269	58			
Corrected Total	HIndex	42499.724	57			
	TotalCit	24774359700	57			

a. R Squared = .017 (Adjusted R Squared = -.019)

b. R Squared = .020 (Adjusted R Squared = -.015)

Table B4

Appendix C

Between-Subjects Factors

		Value Label	N
DifferentConditions	0	PsychologyDegree	46
	1	DegreeOtherThanPsychology	12

Table C1

Descriptive Statistics

	Degrees2	Mean	Std. Deviation	N
HIndex	PsychologyDegree	47.13	28.100	46
	DegreeOtherThanPsychology	42.00	24.709	12
	Total	46.07	27.306	58
TotalCit	PsychologyDegree	17629.85	19629.619	46
	DegreeOtherThanPsychology	18794.00	25975.466	12
	Total	17870.71	20847.971	58

Table C2

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.760	87.251[b]	2.000	55.000	<.001
	Wilks' Lambda	.240	87.251[b]	2.000	55.000	<.001
	Hotelling's Trace	3.173	87.251[b]	2.000	55.000	<.001
	Roy's Largest Root	3.173	87.251[b]	2.000	55.000	<.001
DifferentDegrees	Pillai's Trace	.051	1.478[b]	2.000	55.000	.237
	Wilks' Lambda	.949	1.478[b]	2.000	55.000	.237
	Hotelling's Trace	.054	1.478[b]	2.000	55.000	.237
	Roy's Largest Root	.054	1.478[b]	2.000	55.000	.237

a. Design: Intercept + Degrees2

b. Exact statistic

Table C3

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	HIndex	250.507[a]	1	250.507	.332	.567
	TotalCit	12898244.08[b]	1	12898244.082	.029	.865
Intercept	HIndex	75607.196	1	75607.196	100.215	<.001
	TotalCit	12626492640	1	12626492640	28.556	<.001
DifferentDegrees	HIndex	250.507	1	250.507	.332	.567
	TotalCit	12898244.082	1	12898244.082	.029	.865
Error	HIndex	42249.217	56	754.450		
	TotalCit	24761461456	56	442168954.57		
Total	HIndex	165596.000	58			
	TotalCit	43297365269	58			
Corrected Total	HIndex	42499.724	57			
	TotalCit	24774359700	57			

a. R Squared = .006 (Adjusted R Squared = -.012)

b. R Squared = .001 (Adjusted R Squared = -.017)

Table C4

Appendix D

Between-Subjects Factors

		Value Label	N
DegreesandMinors	0	OnlyPsychology	41
	1	AnyAdditionalDegreeorMinor	17

Table D1

Descriptive Statistics

	DegreesandMinors	Mean	Std. Deviation	N
HIndex	OnlyPsychology	46.83	29.407	41
	AnyAdditionalDegreeorMinor	44.24	22.118	17
	Total	46.07	27.306	58
TotalCit	OnlyPsychology	17259.76	20589.112	41
	AnyAdditionalDegreeorMinor	19344.18	22030.782	17
	Total	17870.71	20847.971	58

Table D2

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.808	115.849[b]	2.000	55.000	<.001
	Wilks' Lambda	.192	115.849[b]	2.000	55.000	<.001
	Hotelling's Trace	4.213	115.849[b]	2.000	55.000	<.001
	Roy's Largest Root	4.213	115.849[b]	2.000	55.000	<.001
DegreesandMinors	Pillai's Trace	.041	1.164[b]	2.000	55.000	.320
	Wilks' Lambda	.959	1.164[b]	2.000	55.000	.320
	Hotelling's Trace	.042	1.164[b]	2.000	55.000	.320
	Roy's Largest Root	.042	1.164[b]	2.000	55.000	.320

a. Design: Intercept + DegreesandMinors

b. Exact statistic

Table D3

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	HIndex	80.860[a]	1	80.860	.107	.745
	TotalCit	52212609.99[b]	1	52212609.986	.118	.732
Intercept	HIndex	99656.033	1	99656.033	131.563	<.001
	TotalCit	16101275379	1	16101275379	36.472	<.001
DegreesandMinors	HIndex	80.860	1	80.860	.107	.745
	TotalCit	52212609.986	1	52212609.986	.118	.732
Error	HIndex	42418.864	56	757.480		
	TotalCit	24722147090	56	441466912.32		
Total	HIndex	165596.000	58			
	TotalCit	43297365269	58			
Corrected Total	HIndex	42499.724	57			
	TotalCit	24774359700	57			

a. R Squared = .002 (Adjusted R Squared = -.016)

b. R Squared = .002 (Adjusted R Squared = -.016)

Table D4

Appendix E

Pearson Correlation Table

	UndergraduateSchoolSize	TotalCitations	HIndex
UndergraduateSchoolSize	1		
TotalCitations	-0.082	1	
HIndex	-0.173	0.889	1
N	59	59	59

E1

Correlations

		Undergraduate SchoolSize	TotalCit	HIndex
UndergraduateSchoolSize	Pearson Correlation	1	-.082	-.173
	Sig. (2-tailed)		.515	.191
	N	66	66	59
TotalCit	Pearson Correlation	-.082	1	.889**
	Sig. (2-tailed)	.515		<.001
	N	66	71	62
HIndex	Pearson Correlation	-.173	.889**	1
	Sig. (2-tailed)	.191	<.001	
	N	59	62	62

**. Correlation is significant at the 0.01 level (2-tailed).

Table E2