

DISCUSSIONS

The Undergraduate Research Journal of CWRU
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The Undergraduate Research Journal of CWRU

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DISCUSSIONS

Undergraduate Research Journal of CWRU

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Xiaoyi Xu



Letter from the Editor

Dear Readers,

I would like to thank you for taking the time to read **Discussions: The Undergraduate Research Journal of Case Western Reserve University's** newest issue. I, as well as the rest of the editorial board team, hope you enjoy our efforts in publishing the best of undergraduate-produced research. By reading Discussions, you are supporting not just the young authors whom we have published, but also all undergraduates currently participating in research in all disciplines.

Last year, we celebrated our ten-year anniversary. In this time period, we have tripled our submissions. In addition, to raw growth, we have also benefited from tremendous lateral expansion in research breadth. We are continuously receiving submissions in more disciplines, such as psychology, sociology, and the humanities. This growth excites us, and we look forward to supporting this expansion in research by working continuously to improve our journal's quality.

As we prepare for our next ten years, we would like to ask our readers for a favor. It is part of **Discussions's** mission to publicize undergraduate research, and our readers are the biggest part of this sharing network. We ask for you to spread the word of **Discussions** and the undergraduate research we publish. By doing so, you will be greatly helping us with our mission. Our readers are the biggest part of the **Discussions** community, and we are grateful for your support.

We accept undergraduate research in all disciplines, and welcome submissions at any time. If you, or someone you know, would like to submit to Discussions, we encourage you to visit our website at case.edu/discussions for detailed instructions. Our submissions are a cornerstone to our journal, and every submission we receive is thoroughly read by our team of reviewers.

As always, I would like to thank all of those who contributed to this issue of Discussions, including our authors, editorial board, and committee members. In addition, I would like to thank Case Western Reserve University's Support of Undergraduate Research and Creative Endeavors (SOURCE) office and the University Mediaboard for their unending support for our publication.

Sincerely,



Abhishektha Boppana

Editor-in-Chief

Discussions: The Undergraduate Research Journal of Case Western Reserve University

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Faculty Spotlight

AN INTERVIEW WITH

Dr. Radhika Atit

by Roshni Bhatt, Saloni Lad, Daniel Mendez,
Viral Mistry, and Lauren Spizman

Dr. Radhika Atit is an Associate Professor in the Department of Biology. In the following interview, she discusses her work in developmental biology, her experience as a professor, and how her background influences her teaching style.

Q: What do you do here on campus? What are you involved with?

A: I am a faculty member of the biology department, a Developmental Geneticist. I study skin and bone development in the head and face, and we study how hair follicles form in the skin. We are also interested in understanding how some of the things we study in developmental biology can become dysregulated in skin disease. In the core biology class, I introduce the undergraduate students to Developmental Biology. I also teach graduate students how to get a PhD in biological sciences. In the spring semester I teach an upper level class that is both undergraduate department seminar and also a graduate school course in Evo-Devo (Evolutionary Developmental Biology).

Q: You obviously perform research here on campus. What would you say is your biggest accomplishment so far?

A: I'll keep it to the big picture; we have found that Wnt signaling is required to instruct skin cell identity, particularly the dermal fibroblasts of the skin, skull bone identity, and hair follicle initiation. Most recently, we have shown that excess Wnt signaling in dermal fibroblasts of adult skin makes skin become fibrotic. But if you turn down the signal you can recover the fibrosis, so it will actually subside on its own, which tells you that the signaling is a very major stimulating event. We have moved towards drug discovery, and now we are participating with a group of people who are doing clinical trials and targeting the pathway with small molecule inhibitors. So now we are analyzing the results from the human trials of the drug to see how well our mouse model data and the human trial data correlate.

Q: Does that mean your research is more translational than it is fundamental?

A: We are headed towards that. We don't directly do the translational work but we're collaborating



Photo Credit: Daniel Milner

with people who do it, and then they give us back the data from the human side so we can connect it better with our mouse models.

Q: With your experience in both translational and basic research, would you say that you prefer about one over the other?

A: I don't think I prefer one over the other. Everybody has an eye towards translational research and think more forward-minded. In my lab, we're still in incredibly basic research science.

"We have moved towards drug discovery, and now we are participating with a group of people who are doing clinical trials targeting the pathway with small molecule inhibitors."

Q: You do research on campus and you're an instructor, how would you say that you are able to bring in that research mindset into the classroom?

A: There is definitely a synergy between teaching and doing research because how you teach somebody to think about a subject matter is the same skillset used at the bench. The first step is learning how to think like a scientist and the tool sets are incredibly similar between settings. Most of the work I do in the classroom or in the lab is what we call "inquiry based learning", which is basically forcing students to think, read, and write like scientists. That's what I do in my upper level classes when they're not focused on the content as much. I'm interested in helping people hone those skills whether they are in the lab setting

“...which is basically forcing students to think, read, and write like scientists, and I’m only interested in teaching that.”

or in the classroom setting. I tell my upper-class students, “If you don’t remember the details that’s ok, but next time you pick up a scientific paper, make a poster, or give a talk, you will hear my voice in your head.” I build the synergy from that.

Q: Would you say that you’re approaching the education a little bit differently from a normal, straight-lecture style?

A: Correct, because I’m not as wedded to the content. Now yes, I want you to understand the content enough so that you have an appreciation for it. I’m not that wedded to your ability to regurgitate the content.

Q: Would you say that that’s more of how you got into science, that sort of inquiry-based learning?

A: No, I came from the straight-up regurgitation style of things. I would say the “inquiry-based learning strategy” is a bit more modern way to think about things. My foray into science was more by doing it with my own two hands that brought me into it. In science you can learn a lot by just reading and watching other people and

watching people present, but what got me excited about coming into science was just my own sense of curiosity.

Q: What would you say to a freshmen student who just got here who is bright-eyed and interested in research? What would you say to them about what they can do for the future?

A: It’s what Steve Jobs told all of us at his address to Stanford, “Stay hungry, Stay foolish”. It’s the incredibly curious and motivated students who will always have success in this business. But I would always say to the incoming kids: keep an open mind, stay engaged, find new places to go be engaged. If you’re really curious about the research side of things, find yourself in a team, and it’ll open your eyes to lots of things. And from there you can learn a little bit, branch out, and try new things again. But don’t be shy! The whole point of you being in college is to find your passion. Go actively seek it out, it’s not going to come to you.

“To the incoming kids: keep an open mind, stay engaged, find new places to go be engaged. If you’re really curious about the research side of things, find yourself a team, and it’ll open your eyes to lots of things.”

A Selection of Dr. Atit’s Work

Atit, R. et al. (2006). β -catenin activation is necessary and sufficient to specify the dorsal dermal fate in the mouse. *Developmental Biology* 296(1), 164-176. doi: 10.1016/j.ydbio.2006.04.449

Myung, P. S. Takeo, M. Ito, M. Atit, R. (2013). Epithelial Wnt Ligand Secretion Is Required for Adult Hair Follicle Growth and Regeneration. *Journal of Investigative Dermatology* 133(1), 31-41. doi: 10.1038/jid.2012.230

Xiao, Y. Thoresen, DT. Miao, L. Williams, JS. Wang, C. Atit, R. et al. (2016). A Cascade of Wnt, Eda, and Shh Signaling Is Essential for Touch Dome Merkel Cell Development. *PLOS Genetics* 12 (7): e1006150. doi:10.1371/journal.pgen.1006150

Faculty Spotlight

AN INTERVIEW WITH

Dr. William E. Deal

by Roshni Bhatt, Saloni Lad, Cheryl Lin,
Daniel Mendez, Viral Mistry, and Lauren Spizman

Dr. William E. Deal holds a dual-appointment as professor in both the Department of Religious Studies and Chair of the Department of Cognitive Science. In this interview, Dr. Deal discusses a general overview into the cognitive science and schema that dictate religious and moral belief.

Q: How would you describe your field to someone who has never heard of it?

A: I think it would depend on what field I'm describing because cognitive science of morality is quite a bit different from cognitive science of religion. What I'd probably tell them about the cognitive science of morality is that our traditional religious or philosophical approaches to morality/ethics have broken down—to a large extent—under the scrutiny of cognitive science because ethical/moral systems are typically based on some sort of rationale that human beings are the kinds of creatures that can figure out what behaviors are right or wrong.

“Research evidence suggests very strongly, in fact, that human beings have a really fast, mostly subconscious, emotional-visceral response to moral ideas.”

But, research evidence suggests very strongly, in fact, that human beings have a really fast, mostly subconscious, emotional-visceral response to moral ideas; for example, they'll instinctively say, “Oh my god, that's wrong,” but then I'd say “Well, why do you *think* that's wrong?” It's only *post hoc*, or after the fact, that we then have a longer, slower thinking process (i.e. rationality and reason) that explains why we think this is wrong. In the class I'm teaching now, we have actually played around with this response by having the students do a moral dilemma survey. And, when we discuss some of those dilemmas, it's quite clear that they've had an immediate response followed by this much more—sometimes even quite tortured—complicated sort of rationalization of a very strong, immediate feeling.



Photo Credit: Paul Nettleton

Q: How do you approach religion from a cognitive scientific perspective?

A: You could think about that in an overarching way: given the kinds of embodied creatures that we are, and the kinds of brains and cognitive skills that we have, how does religion play into all of those systems? It's a good question to ask because unless you're going to argue that religion is somehow completely different from other kinds of human cognition, you're going to have to be able to explain in religion in terms of other cognitive skills that human beings have.

So one example I often give is to imagine that you're a religious person looking at somebody else's religion; how come those stories don't seem like they could possibly be true, but your own kind of religious stories—with supernatural deities and things that we don't encounter in the natural world—seem plausible? Furthermore, it seems very likely to me that the cognitive processes that are used in the example are the same kind of cognitive processes that we use to imagine science fiction or to write Harry Potter. These aren't things that we encounter in the natural world, and yet we can imagine them. It just seems to me that these are likely the same cognitive propensities that give rise to religious stories.

Now, there's a difference in why some stories have very deep meaning. For example, Harry Potter may be deep and meaningful, but it's probably not religious for these people, so there's something else going on there. I think that we're going to have to start with what cognitive processes we already know human beings have to work with to understand religion through cognitive science.

Q: What brought you into this field?

A: Well, I originally started out in comparative religion and history of religion, but I was always interested in the anthropology of religion, and—to some extent—psychology of religion. This was a natural fit for looking at ways in which human beings as embodied creatures relate to the external world. For me, the elements of cognitive science provide really powerful ways of explaining different kinds of religious propensities, so it was another sort of theoretical perspective that I could use to understand human religiosity. Yeah I got hooked, it seemed really powerful.

“The elements of cognitive science provide really powerful ways of explaining different kinds of religious propensities, so it was another sort of theoretical perspective that I could use to understand human religiosity.”

Q: What issues do you typically run into when conducting research or teaching a class on this topic?

A: It really depends on the subject matter. The most general problem, I suppose, is that whenever people have to examine heartfelt views, whether they're religious or moral views, many people will have a strong sense, at least initially, that you applying a cognitive science perspective to their views is somehow reducing their views to a mere natural phenomenon in the world. We tend to think of morality as somehow transcending us as human beings, that religion is something transcendent. Something like cognitive science really doesn't have a place in transcendent things, so we analyze this material from the point of view of empiricism.

“Cognitive science says a lot about why we act the way we act, think the way we think, and speak the way we speak.”

Q: Out of all the work that you've done, what is the biggest takeaway you'd want to have somebody know?

A: It seems to me that human beings keep learning new things, and cognitive science is very much in its infancy. It has a lot of things to say about how we understand what it means to be a human being. Cognitive science says a lot about why we act the way we act, think the way we think, and speak the way we speak. I just don't see the field going away anytime soon just like I don't see mathematics or physics going away anytime soon either. It doesn't mean cognitive science captures everything about what it means to be a human being, but there are some discoveries there that are really significant in pushing human knowledge forward. You don't get things like artificial intelligence or robotics or all sorts of other things without a cognitive scientific basis.

Q: What advice would you have for a student looking to pursue this type of research in this type of field?

A: That's a hard question because it depends on their interests, but I would say to think large and widely. Cognitive science is very multidisciplinary, and there's a whole lot of pieces of information that one needs negotiate, and it's not that one can't be a master of all of those, but you should focus on thinking broadly, finding connections that we might not have realized existed before. I suppose that would be my most basic advice.

This interview has been edited for length and clarity with the consent of Dr. Deal.

A Selection of Dr. Deal's Work

Deal, W., & Beal, T. (2011). Theory, disciplinarity, and the study of religion: Lessons from a publishing nightmare. *Journal of the American Academy of Religion*, 79(4), 1050-1064. doi: 10.1093/jaarel/lfr037

Deal, W., & Beal, T. (2009). Concerning theory for religious studies: William E. Deal and Timothy K. Beal answer Richard Schechner's questions. *TDR (The Drama Review - The Journal of Performance Studies)*, (53)1, 14-16. doi: 10.1111/j.1748-0922.2007.00196.x

Deal, W. (1996). Rethinking medieval Japanese Buddhism. *Religious Studies Review* (22) 4, 313-322. doi: 10.1111/j.1748-0922.1996.tb00319.x



Causal Inference to Ascertain Causes of Metastasis in Melanoma

Wesley Maddox - Case Western Reserve University

BIOGRAPHY

Wesley is a current third-year student studying Systems Biology at Case Western Reserve University and will be pursuing an MS in Statistics in the Integrated Graduate Studies Program in the fall.

ACKNOWLEDGEMENTS

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Abstract

Causal inference methods were performed on The Cancer Genome Atlas (TCGA) clinical datasets. First, relevant patient data were collected and merged. Then, an algorithm was used to create a causal directed acyclic graph (DAG). Next, the Iterative Deep A* (IDA) algorithm was used to guess the minimum bounds for causal effects on the probability of metastasis. Finally, marginal structural models and instrumental variables were used to verify the results from the IDA algorithm.

Introduction

Understanding the causes of metastasis in cancer is an important task in cancer medicine. Despite decades of research focusing solely on the genetic events implicated in the metastatic pathway, the actual causes of metastasis remain a mystery (Fidler, 2003; Gupta & Massagu, 2006). In cancer medicine, the current definition of metastasis is the growth of tumor cells that have become detached from the primary tumor, which is a fairly precise one. Recent work has shown that there is a strong genetic component.

As of 2006, metastasis remains the primary cause of death from cancer, causing approximately nine-tenths of all cancer deaths (Martinez, 2006). Looking solely at the statistics of bone metastasis, it is estimated that 350,000 people die each year from metastasis. A similar issue affecting the importance of metastasis is pain. Metastases, especially those in the brain and bone, are rarely silent in nature and quite often cause intractable pain in the bones themselves (Mundy, 2002). For both the clinician and the patient, understanding the causes of metastasis is important.

Skin cutaneous melanoma (SKCM) is a cancer affecting melanin-producing cells in the skin. It is a fairly common type of cancer with approximately 70,000 new cases diagnosed each year. Unlike many other cancer types, it has a fairly high survival rate with only approximately 8,000 deaths each year (The Cancer Genome Atlas, 2015). Similarly, many melanomas are diagnosed only after metastasis because many of those melanomas stay on the skin or other pigmented tissues and never metastasize. Much of the research regarding this disease has recently focused on attempting to understand

and predict metastasis of this type of cancer. In The Cancer Genome Atlas (TCGA) project, most of the research has been done on cases that have metastasized. This approach allows for a fairly interesting dataset which has several observations that are related to metastasis, including ample observations that include metastatic tumors.

With regard to SKCM, metastases are particularly notable for several reasons. First, these metastases often spread throughout the body. Often these metastases spread to bone, causing immense pain for the patient, or to other vital organs where the metastases can result in death (Martinez, 2001; The Cancer Genome Atlas, 2015). Second, melanoma that does not metastasize often has minimal negative effects and can linger on the skin undiscovered. Thus, research to ascertain the causes of the transformation of a non-metastasized melanoma to a metastasized melanoma is relevant and clinically motivated.

Causal inference techniques are increasingly used in research as an alternative and enhancement of traditional statistical techniques. Causal inference is used to gain more detailed knowledge about treatments and effects rather than just simply measuring associations (Hernans & Robins, 2016; Pearl, 2009). Techniques for causal inference, though strongly developed, are actually used much less frequently than other statistical measures. For example, while there are many studies that have developed measures of mutational importance to phenotypes in cancer, none of them attempt to address the problem from a causal standpoint (Ramazzotti et al., 2014; Korsunsky et al., 2014; Stingo et al., 2014; Zhang et al., 2014; Neapolitan et al., 2014). In the field of cancer biology, these uses of different causal inference techniques are novel.

In this project, the primary dataset for causal inference comes from the TCGA project's collection of clinical and new tumor event records for SKCM (The Cancer Genome Atlas, 2015). The dataset was assembled by adding together varying clinical data files. After adding together

"...the current definition of metastasis is the growth of tumor cells that have become detached from the primary tumor."

different datasets, a new dataset was compiled that contained 504 records for 71 different clinical observations. This approach results in a very high-dimensional observational dataset that may drastically increase the challenges for accurately utilizing causal inference techniques in order to understand the causes of metastasis.

Development of the causal graph.

Much of the work surrounding causal inference depends on the development of a causal directed acyclic graph (DAG) that describe the causal situation in the real data. Recently, several algorithms have been used to solve this problem and to attempt to infer these DAGs solely from observational data. This project utilized the PC algorithm originally developed by Peter and Clark (Spirtes, Glymour, & Scheines, 2000), and later implemented and refined by Kalisch and then Maathuis (Kalisch & Bühlmann, 2007; Maathuis et al., 2007).

However, this method also has several flaws. It bears noting that no algorithm can ever learn the exact structure of the causal graph from the data itself due to the fact that different graphs can have the same likelihood score and cannot otherwise be differentiated. Similarly, the PC algorithm also assumes that any correlations between data points that are not linked in the graph are solely due to the interactions of the other variables in the graph (conditional independence). Next, we must also assume that all of the variables in the data are Gaussian random variables that follow the conditional independence assumption above. The final primary assumption is the sufficiency condition, which states that there are no hidden variables related to the data that could potentially have a causal influence on any of the variables in the data set (Shalizi, 2013; Murphy, 2012). This assumption must exist for this project to occur, and its potential invalidity is in the “Discussion” section.

The PC algorithm consists of two separate parts. The first step of the algorithm is often called the PC algorithm, which maximizes the probability of the skeleton (undirected edges) of the causal graph for a certain amount of time. This probability is determined by iteratively finding different potential neighbors and testing them for conditional independence. The second step

of the algorithm determines the direction of the edges via testing independence of triples that are defined as pairs of nodes with a common neighbor. The end result of this algorithm is an equivalence class of DAGs that have estimated directed edges (Colombo et. al., 2012).

Although the algorithm itself is fairly complex, the results are easy to interpret. The output of this algorithm is a causal graph that has been tested for independence. Similarly, in building an implementation of this algorithm in R, Maathuis showed its accuracy on both simulated data derived from a multivariate normal distribution and real-world gene expression data from a model organism (Murphy, 2012; Maathuis, Colombo, Kalisch, & Bühlmann, 2010).

Methods

After generating the estimated causal graph, different methods were performed for finding the causal effects of different variables in the causal graph on metastasis.

Definition of causal effect.

First, it is necessary to define what a causal effect actually is. Perhaps the simplest measure of any causal effect, the average causal effect (ACE), can be described as:

$$ACE = P(Y^{a=1} = 1) - P(Y^{a=0} = 0)$$

Y is treated as the outcome variable and a as the treatment variable with two levels. In a population with possible different levels, this can be written in terms of expectations, such that:

$$ACE = E(Y^{a=1} = 1) - E(Y^{a=0} = 0)$$

Here, one should note the different notation being used—this is a counterfactual variable and not necessarily a variable that measures reality. This counterfactual expectation measures not the expected value of Y given the treatment a, but rather the expectation of the entire population if the entire population were given the treatment (Hernans & Robins). This treatment of a causal effect is just one of multiple methods of defining causal effects. A second one, developed by Judea Pearl, includes the usage of do-calculus (Murphy, 2012).

At its most basic level, causal inference requires three assumptions: consistency, positivity, and exchangeability. In order to causally inference, it is first necessary to assume consistency, which, as stated by Hernan and Robins, is “the outcome for every treated individual ... [is]... his outcome if he had been treated and the outcome for every untreated individual ... [is]... his outcome if he had remained untreated.” Under consistency, it is possible to assume that the versions of treatment are equal; it allows relation of counterfactual to the real value (Hernans & Robins). In the SKCM dataset, consistency of all treatments is required to be assumed in order for any meaningful analysis to be done. It does seem like this is a justified assumption, as the questionnaires that were used to generate the data are fairly straightforward. Next, the positivity condition requires that there must be a treatment level greater than zero for all treatment levels being analyzed. While this does seem trivial at first glance, it can become problematic in the real world (Hernans & Robins). In the SKCM dataset, the data was first cleaned in order to give the conditions for positivity.

The exchangeability condition requires that, in a population, the probability of the treatment is independent of the outcome (i.e. untreated individuals would have the same outcomes as those treated, had they also been treated). It cannot be expected to hold in observational studies in its broadest form, but most causal

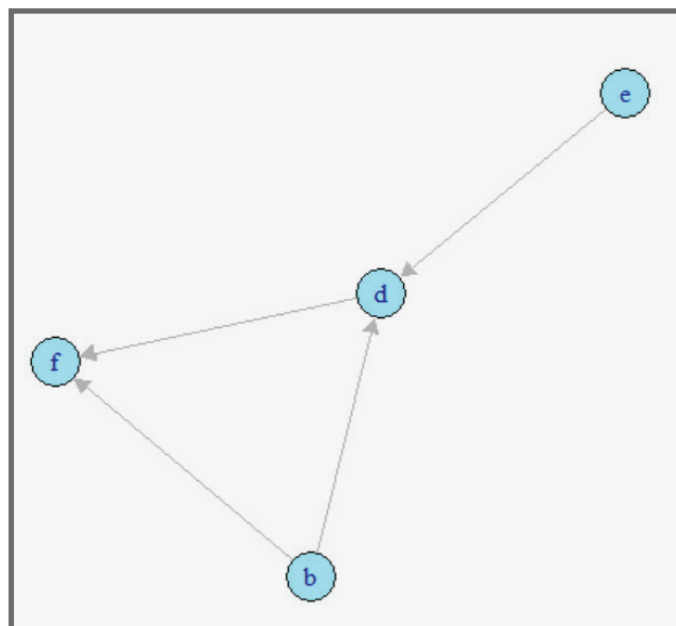


Fig. 1. Simple DAG to illustrate instrumental variables simple procedure.

inference methods allow for the more narrow conditional exchangeability to hold (the same outcomes would result for the untreated being treated given confounding and effect modifying variables). For any real meaningful analysis to be done, it was necessary to assume this condition also holds for the SKCM dataset.

IDA method

On purely observational data, it may be impossible to get completely accurate causal effects. This is mostly due to the fact that there are always confounding variables and that, like the trite statistics adage, an associational effect may not actually estimate the true causal effect (Hernans & Robins). However, different methods exist for estimating the causal effect on purely observational data.

One such method is the Iterative Deepening A* algorithm, or IDA (Maathuis et al., 2007). This algorithm describes the possible causal effect among all different DAGs in the set of equivalent DAGs that describe the dataset in question. The term IDA is short for “intervention calculus when the DAG is absent” and was originally developed to infer the causal effect of gene deletions on phenotype (Maathuis, Colombo, Kalisch, & Bühlmann, P., 2010)

Although the exact details of this algorithm are out of the scope of this project, the algorithm works on a fairly simple procedure. For each possible graph in the set of equivalent graphs in the class, it utilizes a simple regression procedure in order to gain an estimate of the causal effect of a treatment *a* on an outcome *Y*. The exact value returned is the minimum calculated effect of all of the equivalent graphs. This value can be shown to be the minimum value for the causal effect of *a* on *Y* (Murphy, 2012; Bühlmann, 2013).

Validation: other causal inference methods.

The IDA method requires validation in order to ensure that it was both estimated properly and that its output makes sense. DAG were constructed on the SKCM dataset and running the implementation of IDA on this dataset. The top six nodes estimated to have the highest minimum causal effects were taken and modelled using instrumental variable analysis and marginal structural models. In

“The causal effect of tumor status on the event of metastasis is actually fairly small.”

In addition, outcome regression was done for the modelings.

Instrumental variables.

Implementing instrumental variables is a relatively widespread method of performing causal inference in the presence of confounding variables (Cameron & Trivedi, 2005). In Figure 1, an instrument, e, for understanding the effect of d on f in the presence of the confounding variable b was implemented. One unbiased estimator can then be described in terms of covariances with respect to the instrument e. Thus, the estimated causal effect of d on f is estimated by the following equation:

$$\widehat{CE} = \frac{Cov(d, e)}{Cov(f, e)}$$

Figure 2 represents a more complex case, where there is the front-door path from e to f via g. Thus, determination of the causal effect of d on f using the instrumental variable b would require conditioning on g, which is easily accomplished.

Marginal structural models.

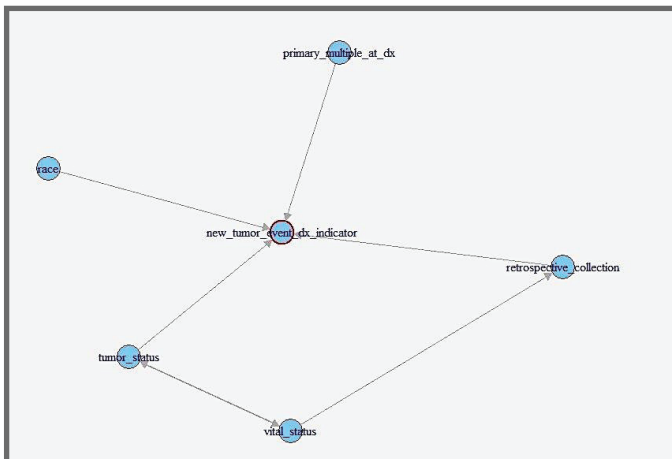


Fig. 4. PC-calculated partial DAG for a clinical correlate subset of the SKCM data.

Marginal structural models are another method of causal inference on smaller datasets which were also implemented. A very simple marginal structural model on a population has the form of the following:

$$E(Ya) = \beta_0 + \beta_{1a}$$

This is regression on a counterfactual and requires a pseudo- population or IP-weighting on the values of a in order to make correct predictions. IP-weighting is another procedure that estimates the weights of the population by finding the probability distribution of the treatment of A and dividing it by the probability distribution of P(A|L), where L is any other set of covariates in the model. It can also be shown that β_1 is a consistent estimator of the ACE, which shows its usefulness (Hernans & Robin).

“Notably, having a history of other malignant tumors and specific skin types for melanoma both have a significantly greater lower bound on causal effects.”

Results

After merging the dataset for the SKCM data downloaded from the TCGA project analysis was begun by utilizing the implementation of the PC algorithm in the R package pcalg (Kalisch, Mächler, Colombo, Maathuis, & Bühlmann, 2012).

Since the only tuning parameter is the significance level of the edges, multiple different parameters were tested. However, utilizing a low significant level resulted in a DAG with too few connections. Thus, the utilized significance level was determined to be .25, which is high but still yielded in accurate results. The resulting estimated DAG is shown in Figure 3.

The next step after generating the estimated causal DAG was to run the IDA algorithm to estimate lower bounds on the causal effects for all correlates on metastasis. This was done using the pcalg package in R. The estimated lower bounds of the causal effects for the largest, positive

nine correlates as well as two other interesting negative correlates are shown in Table 1. Many of the correlates that IDA calculated to have a large causal effect are actually metastasis specific.

Five of these variables including primary_multiple_at_diagnosis, race, vital_status, and tumor status were then chosen to further validate the bound analysis. Notably, having a history of other malignant tumors and specific skin types for melanoma both have a significantly greater lower bound on causal effects. Many of the correlates that IDA calculated to have a large causal effect are actually metastasis specific.

Next, the same PC algorithm was used on the identified of clinical correlate subset to better understand this relationship between the correlates. The result of the algorithm’s analysis is shown in Figure 4. Next, marginal structural models and instrumental variables on this DAG class were used in order to verify the results. In the marginal structural models, IP-weighting is applied to measure a pseudo-population across the other covariates. The results of this causal effect is shown in Table 2.

Finally, vital status (binary: 0=alive, 1=dead) was used as an instrument for estimating the causal effects that both tumor status at recording time and the retrospective collection indicator have on metastasis. Due to the front-door paths in

“First, the IDA algorithm is a fairly accurate and useful tool in identifying the causal relationships between different nodes.”*

the DAG for tumor status and retrospective collection, when calculating the instrumental variable estimator, it was necessary to condition the algorithm to block those paths. The causal effect of tumor status on the event of metastasis is actually fairly small. This result is verified by the fact that many metastases do not result in death but instead require surgery to remove both the metastasis and the primary tumor. The retrospective collection indicator also shows that the TCGA Project did not choose a random sample of SKCM patients when collecting data for this survey, but rather a sample of SKCM patients that were biased towards metastasis. Although these results are larger than the values calculated by the IDA algorithm, they do seem to agree overall.

Discussion

Using causal inference methods on this set of clinical correlates for SKCM does give some interesting results; however, much of the data do seem to depend on each other, which dampen the results. For example, three of the eight highest values of estimated lower bounds on causal effects that were found from the IDA algorithm exist only in cases of metastasis. Although the methods implemented in the study may have worked correctly, this is in reality a reversal of causal effect (metastasis would cause these other

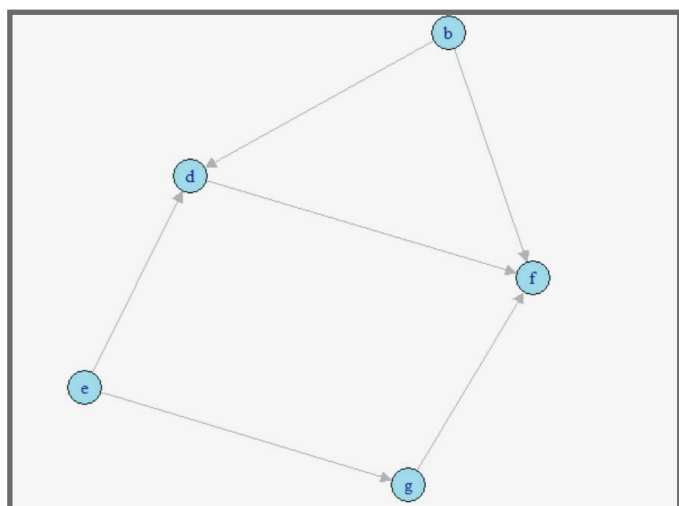


Fig. 2. More Complex DAG to illustrate instrumental variables.

Name of Variable	Lower Bound of Causal Effect
primary_multiple_at_dx	1.03
history_other_malignancy	0.8535
new_tumor_event_histo_type	0.4707
primary_melanoma_skin_type	0.2456
new_tumor_event_prior_to_ber_tumor	0.197
new_tumor_event_met_site	0.1841
race	0.09829
vital_status	0.09316
retrospective_collection	-0.06896
tumor_status	-0.00215

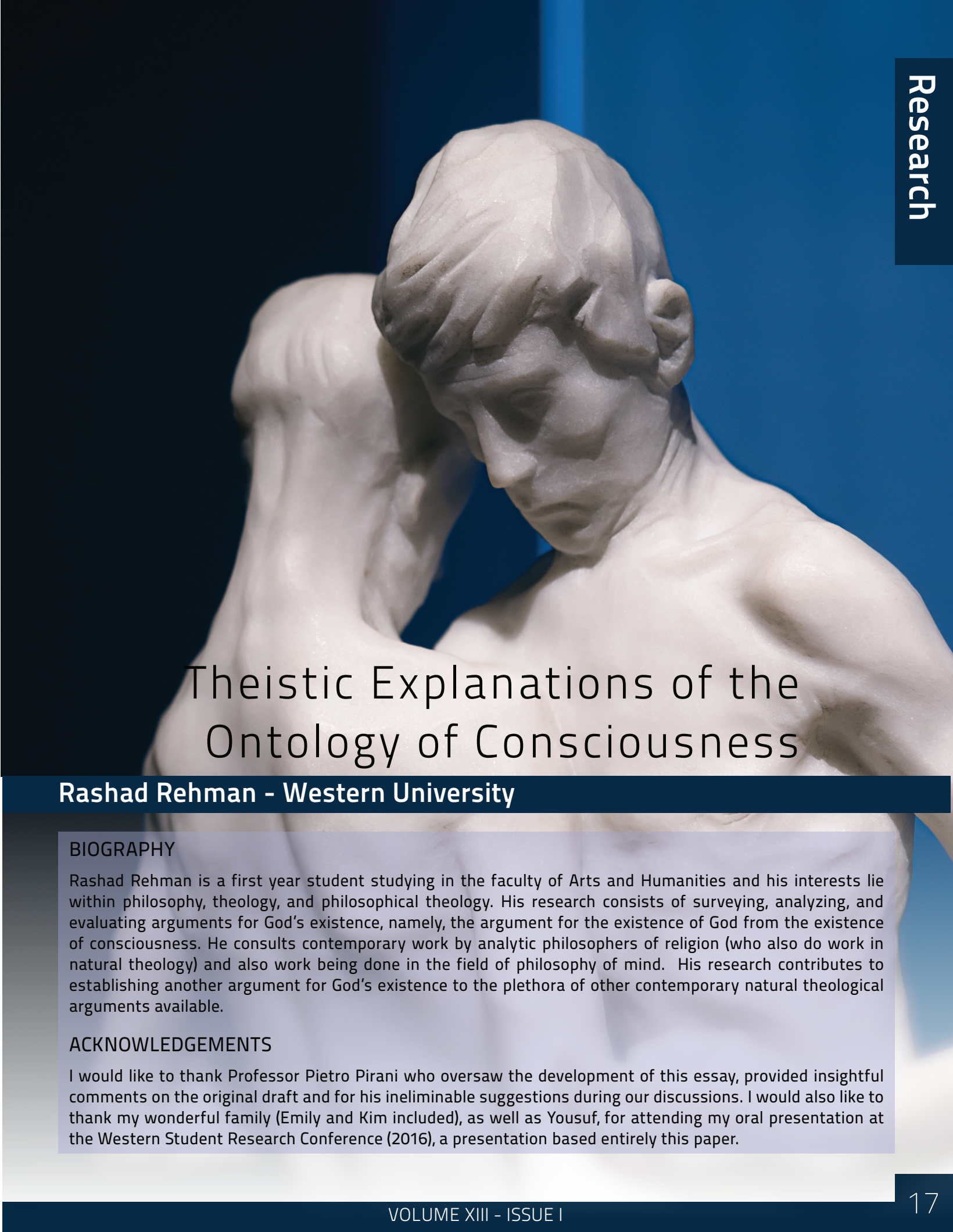
Table 1. Estimated lower bounds for causal effect of a given metastasis event as generated by the IDA algorithm.

develop at the same time, this relationship may just show the increased probabilistic risk for metastasis if a patient has multiple melanomas. For example, a patient with multiple melanomas at different sites on their body would have an increased risk for at least one of these melanomas to metastasize. This fact seems to be understood among clinicians but has not been empirically proven before (Martinez, 2001).

Finally, the validity of these methods shows that this type of analysis can be extended to include more than just the clinical features of the tumor. The TCGA Project did not only collect the clinical features of these tumors, but also sequenced the DNA of either the metastatic tumor or the primary tumor in the same patients. The sequencing data as well as multiple other data types is also publicly available. or future work in this direction, integrating variants identified either from DNA sequencing (genome) or in mRNA sequencing (transcriptome) could be integrated into the causal DAG. This may actually allow for more accurate identification of driver and passenger mutations in melanoma (and other cancers), which is a large field of current research (Greenman et. al, 2007). This type of integration may also allow for a more accurate understanding of the genetic causes of metastasis. Further research could also attempt to integrate data of multiple types for example the type of clinical data used in this project, as well as both genome and expression data collected from the TCGA Project.

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Theistic Explanations of the Ontology of Consciousness

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BIOGRAPHY

Rashad Rehman is a first year student studying in the faculty of Arts and Humanities and his interests lie within philosophy, theology, and philosophical theology. His research consists of surveying, analyzing, and evaluating arguments for God's existence, namely, the argument for the existence of God from the existence of consciousness. He consults contemporary work by analytic philosophers of religion (who also do work in natural theology) and also work being done in the field of philosophy of mind. His research contributes to establishing another argument for God's existence to the plethora of other contemporary natural theological arguments available.

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Consciousness is a thought-provoking phenomenon. In recent decades, though, the philosophy of mind has revealed consciousness to be, in the words of Thomas Nagel, “what makes the mind-body problem intractable” (Nagel, 1979). Though consciousness has made the mind-body problem seemingly intractable, to some philosophers, finite and irreducibly subjective conscious experiences call for an explanation (Locke, 1959). It seems to some that a scientific explanation will not and cannot provide an adequate explanation for the existence of consciousness. Although this is controversial, the important natural theological argument for the existence of God from the existence of consciousness (AC) needs to be explored. Two important defenders of the AC, Richard Swinburne and Robert Adams, argue it is improbable that a scientific explanation of psycho-physical laws can be given. However, in light of a nuanced formulation of the AC, there has been a lack of dialogue amongst recent objections to traditional AC arguments which merit attention. Thus, a focus will be put on Timothy O'Connor and Kevin Kimble's argument in their article “The Argument from Consciousness Revisited” (2011). They argue that the existence of consciousness contributes to the natural theological argument from fine-tuning and agree with traditional AC defenders Swinburne and Adams that consciousness raises the probability of theism. It is only in virtue of the AC shifting its functional role to contribute to a design argument that the probability of theism is raised. However, in light of an argument against Kimble and O'Connor's thesis, J.P. Moreland's text *Consciousness and The Existence of God* (2008) provides the best AC model. Kimble and O'Connor's

“Though consciousness has made the mind-body problem seemingly intractable, to some philosophers, finite and irreducibly subjective conscious experiences call for an explanation.”

objections to Swinburne's argument will be explored with a thought experiment. Although Kimble and O'Connor provide an alternative AC, it will be concluded that Moreland's deductive AC is the best current model. In Swinburne's *The Existence of God* (2008), his AC is formulated by first constructing an epistemological framework. He

begins by distinguishing types of explanations and types of inductive arguments and distinguishes between personal and scientific explanations. In his view, a personal explanation is an explanation which is brought about by a rational agent acting intentionally (Swinburne, 1979, 32). Alternatively, a scientific explanation is for some phenomenon in the absence of such personal agency. Swinburne differentiates between C-inductive and P-inductive arguments. A C-inductive argument is an argument such that the premises contribute to raising the probability and/or establish the truth of the conclusion. A P-inductive argument maintains that the conclusion is more probable than not, given the premises of the argument (Swinburne, 1979). So, to use a natural theological ex-

“Given Swinburne's probability considerations and epistemological framework, the AC ... does not establish conclusively the truth of theism.”

ample, the probability of God's existence from some deductive argument may only serve to raise the probability of the conclusion, not establish it as a conclusion. Thus, the deductive argument in question serves as a C-inductive argument. Given this epistemological background, Swinburne construes the AC as to increase the probability of God's existence on a Bayesian Model (Swinburne, 1979, 64). Here, h is the hypothesis, e the evidence and k the general background knowledge:

$$P(h/e.k) = \frac{P(e/h.k)}{P(e/k)} \times P(h/k)$$

For Swinburne, the probability of God's existence given the natural theological argument from consciousness brings about the conclusion that God's existence is C-inductively more probable than not. He concludes that “A priori, theism is perhaps very unlikely, but it is far more likely than any rival supposition” and hence “our phenomena are substantial evidence for the truth of theism” (Swinburne, 1979, 290).

Given Swinburne's probability considerations and epistemological framework, the AC raises the probability of theism, but does not establish conclusively the truth of theism. In Swinburne's view, theistic or personal explanation would amount to "God[s] intervention in the natural order bring[ing] about [human persons]" (Swinburne, 1979, 290). On the scientific picture of reality the existence of consciousness is improbable. As a result, agents which are conscious, embodied, and effect-producing through their intentions are much more probable. Given this assumption, Swinburne then makes terminological distinctions between mental and physical events, a precursor for the essential premise of the AC. In Swinburne's later work, he has defined much more thoroughly mental and physical events, alongside further distinctions and classifications. He begins a series of definitions as follows: "a mental event [is] along the same lines as one to which the substance involved has privileged access, and a physical event as one to which the substance involved does not have privileged access, and a pure mental event as a mental event which does not entail a metaphysically contingent physical event as that substance" with the implication that "no mental event is identical to or supervenes on any physical event" (Swinburne, 1979, 161). For instance, "thoughts, feelings, sensations, imaginings, conscious decisions" are all mental events (Swinburne, 1979, 161). Contrarily, brain events are essentially physical events. Given these definitions, Swinburne claims that the argument "needs laws, not merely a collection of generalizations correlating brain events and mental events" (Swinburne, 1979, 169). Applying this to Bayes's probability theorem, Swinburne summarizes his argument: "Let k be the premise of the arguments which we have discussed so far, viz., that there is an orderly (and beautiful world). Let e be the existence of conscious men with brains of the kind which they have. Let h be, as before, the hypothesis of theism—that there is a God. $P(e/\sim h.k)$ is low" and therefore "the argument from consciousness is a good C-inductive argument for the existence of God" (Swinburne, 1979, 174).

Kimble and O'Connor, in their article "The Argument from Consciousness Revisited", are skeptical about traditional AC-type arguments (Kimble, et al., 2011). They direct their critique on the AC formulated by Swinburne and Adams. They "both argue that there can be no—or, more cautiously, that it is very unlikely that there can be a—sys-

tematic scientific or natural connection between physical properties and experiential qualities that would explain why they are correlated in the patterns that they are" (Kimble, et al., 2011, 134). Thus, for Swinburne and Adams, the natural account of 'psycho-physical laws' is vastly improbable in the absence of a rational, intentional personal agency. Kimble and O'Connor reject this and argue the following: "[Swinburne and Adams'] versions [of the AC] are defective, since they overlook a naturalistic form of explanation that is available even on a robustly dualistic view of conscious states" and therefore the AC "may more plausibly be recast by treating the very form of explanation of conscious states we outline as a further datum in the currently popular fine-tuning version of the design argument" (Kimble and O'Connor, 2011, 110). So, the traditional function of the AC was to provide evidence for the hypothesis of theism. However, Kimble and O'Connor challenge this contention and argue that there are problems the traditional AC argument entails which can be overcome through a functional shift of the traditional AC so that it now contributes to the design-argument. They begin their critique with primary considerations concerning qualia, the phenomenal character of experience. They note that Swinburne does not admit to qualia being quantifiable. However, Kimble and O'Connor dismiss Swinburne's contention on the grounds that it may well be the case that qualia are quantifiable. To use their example, qualia might display or be in geometrical relations (The Conscious Mind, as cited in Kimble and O'Connor, 2011). However, elsewhere, Swinburne clarifies his statement regarding qualia by means of making a distinction. He admits that there can be measurements of beliefs, but these beliefs can only be measured relative to each other, not absolutely. (Swinburne 2014). Unlike Swinburne, Adams admits that qualia are quantifiable, but notes that there remain two problems for a scientific theory of consciousness. First, that a hypothesized law correlating psycho-physical only describes, and does not explain, why they are correlated as they are. The second is the problem of "finding a mathematical relationship between the qualia of the different modalities" (The Virtue of Faith, as cited in Kimble and O'Connor, 2011, 135).

Kimble and O'Connor respond to Adams' claim by arguing that Adams is correct in his analysis until he precludes any form of explanation at all. Instead, they suggest that the "form of explanation

that non-panpsychist qualia realism precludes is a reductive and maximally unified explanation” and, further, “admitting primitive phenomenal qualities that causally interact with certain kinds of structured physical states is also to give up the aspiration for maximal theoretical unification” (Kimble and O’Connor, 2011, 135-136). Here, Kimble and O’Connor argue that the implications of such a view is that the aforementioned properties are emergent “robustly” (in an ontological sense). These emergent properties, then, entail “correspondingly irreducible laws that chart their patterns of instantiation and their contribution to the dynamical evolution of physical systems” (Kimble and O’Connor, 2011, 136). It might be tempting here to think that Adams’s first argument still holds. Suppose that Kimble and O’Connor’s argument is true and that the laws describing the patterns of instantiations can be measured mathematically. It seems that this does not extend to be an explana-

“Why do the fundamental particles in the actual world exhibit the causal disposition to give rise to phenomenal states?”

tion; rather, it merely describes the phenomenon itself. It seems that Kimble and O’Connor anticipate such an objection, and so go on to explain why they think that there is an explanation of the psycho-physical laws themselves. They then go on to distinguish two kinds of causal dispositions. The first kind involves what they call “locally determinative” causal dispositions found in small-scale systems. This sort of causal disposition includes, to use their example, the property of “negatively charged particles to repel one another” (Kimble and O’Connor, 2011, 136). Contrarily, they label the other causal disposition as a configuration of some organized system which contributes to bringing about or generating an emergent property. The argument so far, then, brings about an important consequence, namely, that causal disposition can apply to neural states, which are essentially physical. They give the following example: “if we ask why neural state N1 gives rise to an experience of phenomenal blue, rather than phenomenal yellow, there will be a true answer involving a fundamental disposition of the fundamental constituent particles of N1 toward just such an effect in just such a context, a disposition that is essential to them” (Kimble and O’Connor,

2011, 136). So, it is in virtue of the causal disposition of the constituents of a neural configuration N1 that a particular phenomenal state arises. So to ask ‘why did one have a phenomenal state of purple?’ is in principle reducible to asking ‘why did the constituent properties of the neural configuration N1 have a causal disposition to bring about the phenomenal state of purple?’ Thus, Kimble and O’Connor argue that “the phenomenal realist may reasonably suppose the existence of basic, general laws connecting neural-state types and families of phenomenal-state types (corresponding more or less directly to distinct sensory modalities)” (Kimble and O’Connor, 2011, 135-136). As Kimble and O’Connor note, an inevitable question arises: since fundamental physical entities could have properties having causal dispositions far different from the dispositions they do have, such as phenomenal states, or not at all, why do the fundamental particles in the actual world exhibit the causal disposition to give rise to phenomenal states? Now, their answer here does not address why some phenomenal character correlates to some neural configuration; it seems that it is arbitrary. For instance, it could be the case that some neural configuration N2 has constituents which bring about the phenomenal character of purple. It seems that reality could have been constructed to have a different neural configuration N3 which brings about the same phenomenal character. Whether or not this is the case, it seems logically possible that it is. In their view, however, it is in virtue of the truth of theism that the causal disposition of a neural configuration to bring about phenomenal states is to be expected. They conclude their paper by suggesting that “the argument from consciousness is best developed as adding to the data of fine-tuning” (Kimble and O’Connor, 2011, 139). The argument presented by Kimble and O’Connor, however, rests on the causal disposition of fundamental physical entities. However, it can be argued that Moreland’s deductive AC in his *Consciousness and the Existence of God* (2008) is the best model so far of a successful AC.

Kimble and O’Connor’s argument, as it rests on the causal dispositions of the constituents of neural configurations to bring about phenomenal states is not successful. A thought experiment shall be presented that renders their argument improbable. First, given that some neural configuration N1 brings about some phenomenal state P1 in virtue of the causal dispositions of the constituent prop-

erties, it follows that these phenomenal states hold independently of a subject. Although this objection might not work on a naturalistic framework, theism makes this improbable.

Suppose that there is a robot R which is an essentially material being created by some engineer, say, Dylan. There are two important considerations here. First, suppose that Dylan constitutes R in such a way that R ends up having something strikingly similar to the human brain. In fact, suppose Dylan somehow was able to duplicate the human brain in its entirety. R would, then, have neural states. So, if Kimble and O'Connor are correct in their analysis, it follows that a robot R would have phenomenal states (in virtue of the constituent properties having causal dispositions to bring about phenomenal states). This, at least in theism, seems improbable, or any sort of material object, simply in virtue of its constituent properties being arranged in a particular way, would exhibit phenomenal states. It seems more likely that it is human persons who experience phenomenal states and that, further, these phenomenal states are possessed by a rational thinker who acts through her/his intentions, not merely a robot who is configured in the right way. The benefits of phenomenal experience seem inapplicable to material beings independent of a subject having phenomenal experiences. Secondly, if there is a higher probability of human persons, and not merely configurations of matter, exemplifying phenomenal states, it follows that it is arbitrary what has phenomenal states. This arbitrariness does not seem to hold well in theism. Swinburne, for instance, suggests that God has good reasons to bring about human persons. Thus, Kimble and O'Connor would have to explain why God would bring about the ability for human persons to have the capacity in principle to bring about neural states which bring about phenomenal states. They would also have to explain why there would be better benefits to having this state of affairs being realized in the actual world rather than alternative state of affairs. The explanation given by traditional AC-type arguments suggests that psycho-physical laws exist in virtue of a personal explanation, not of the dispositions of the constituent properties of a configuration of matter.

A probable counterargument could be that it is a part of human moral responsibility to have the ability to bring about phenomenal states, and,

therefore, the capacity to do so is just another way in which the capacity for freedom of the will and our moral responsibility is realized. It seems more likely, instead, that God would bring about human persons exemplifying these properties insofar as they are good for human persons. It seems that the burden of proof lies on Kimble and O'Connor. It is improbable that phenomenal states are explainable in terms of the causal dispositions of the neural configurations.

Though Swinburne and Adams have provided formulations of the AC, Moreland, in his *Consciousness and the Existence of God* (2008), has provided a different formulation which formalizes the AC in important ways and makes considerable progress in the construction of AC-type arguments. Although Moreland's argument is consistent with Swinburne and Adams's argument, Moreland's argument has benefits with regard to its deductive construction and the criteria he sets for scientific theory acceptance prior to the construction of the argument. Prior to the deductive argument, Moreland argues that "three issues that inform the adjudication between rival scientific theories are relevant to AC" (Moreland, 2008, 28). He argues that basicity, naturalness, and epistemic values are criteria which hold epistemological weight in scientific theory acceptance. He takes basicity to mean essentially a phenomenon which is ontologically basic. For Moreland, "Consciousness

"It seems more likely that it is human persons who experience phenomenal states and that, further, these phenomenal states are possessed by a rational thinker who acts through her/his intentions, not merely a robot who is configured in the right way."

is ontologically basic for theism since it characterizes the fundamental being" (Moreland, 2008, 29). With regard to naturalness, Moreland argues that some entity should be "at home" in the theory. That is, the entity in question should not be "out of place" in one's ontology. For instance, if in some possible world all that exists are causally inert abstract objects, such as numbers, sets, and propositions. It is not natural that there should

exist a materially existent, concrete book, for example, Plato's Republic, amidst the abstract objects. Lastly, epistemic values roughly amounts to "a normative property, which, if possessed by a theory, confers some degree of rational justification on that theory" (Moreland, 2008, 30). For instance, a theory's possessing the property of simplicity is an epistemic value which does not in and of itself justify a theory's truth, but which attributes a rough degree of rational justification on the theory itself. Since Moreland takes consciousness to be basic, natural, and possessive of epistemic values on theism, this criteria serves as a prelude to his AC. He mentions three forms of the AC as such: inference to the best explanation, Bayesian, and deduction. Since inference to the best explanation has been implicitly and explicitly discussed and Swinburne's Bayesian AC has been explored, Moreland's deductive argument is as follows:

1. Mental events are genuine non-physical mental entities that exist.
2. Specific mental event types are regularly correlated with specific physical event types.
3. There is an explanation for these correlations.
4. Personal explanation is different from natural scientific explanation.
5. The explanation for these correlations is either a personal or natural scientific explanation.
6. The explanation is not a natural scientific one.
7. Therefore, the explanation is a personal one.
8. If the explanation is personal, then it is theistic.
9. Therefore, the explanation is theistic (Moreland, 2008, 37).

This deductive argument reaches the same conclusion as the traditional AC-type arguments, namely, that the best explanation of mental events or psycho-physical laws is a theistic explanation. However, there are three reasons why this argument is conducive to yield a correct formulation of an AC. First, this deductive argument essentially formalizes the traditional AC-type arguments, that is, the premises are explicitly stated and they incorporate the essential theses and premises of

"It is improbable that phenomenal states are explainable in terms of the causal dispositions of the neural configurations."

the traditional AC. Secondly, one cannot dismiss the AC on the basis that it relies on Bayes's theorem. So, such an ad hoc attempt of avoiding the AC does not work given the deductive construal of the argument. Lastly, Moreland's argument allows one to "gain clarity on the precise considerations that most likely provide the basis for an IBE [Inference to the Best Explanation] argument or for assignment of probabilities to key factors in the Bayesian approach." (Moreland, 2008, 37). Thus, Moreland's deductive formulation, whether or not successful, is the best formulation of the AC. Although the argument by Kimble and O'Connor provide an alternative to the traditional AC, Moreland's deductive AC yields the most successful model.

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Appendix

Asides those who have denied the existence of consciousness altogether, there have been broadly two methods by which an explanation of consciousness has proceeded; either a personal (theistic) explanation is given, or a scientific (natural) explanation. The personal (theistic) explanations are usually construed the context of an AC. The first attempt at such a personal (theistic) explanation is found in John Locke, *An Essay Concerning Human Understanding*, vol.2, (New York: Dover Publications, 1959), Book IV, Chapter x. For developments by contemporary philosophers of religion, see J.P Moreland, *Consciousness and the Existence of God* (New York: Routledge, 2008), Chapter 2; Robert Adams, *The Virtue of Faith and Other Essays in Philosophical Theology* (New York: Oxford University Press, 1987), Part IV, Chapter 16; Richard Swinburne, *The Existence of God*, 2nd ed. (New York: Oxford University Press, 1979), Chapter 9. For a response to traditional AC arguments, see Kevin Kimble and Timothy O'Connor. "The Argument from Consciousness Revisited." *Oxford Studies in Philosophy of Religion* 3 (2011): 110-141. For a naturalistic theory, see Paul M. Churchland. *The Engine of Reason, the Seat of the Soul* (Cambridge, Massachusetts and London, England: MIT Press, 1996) (the citation is from Quentin Smith and Aleksandar Jokic eds., *Consciousness: New Philosophical Perspectives* (New York: Oxford University Press, 2003).). This citation from Smith and Jokic also contains theories which are both naturalist/non-naturalist with regard to explanations of consciousness.

I will present Swinburne's argument in detail; Adams' argument, though closely related, is manifest in the critique Kimble and O'Connor make in their "The Argument from Consciousness Revisited." (2011).

Though Swinburne and Adams' arguments are differently presented, their central points (theses) are similar. Alvin Plantinga, in his "Two Dozen (or so) Theistic Arguments" classifies perhaps the central scope and claim of Swinburne and Adams' argument from (what he denotes as) the 'Argument from Colors and Flavors': "What is the explanation of the correlation between physical and psychical properties? Presumably there is an explanation of it; but also it will have to be, as Adams and Swinburne say, a personal, non-scientific explanation.

The most plausible suggestion would involve our being created that way by God." Alvin Plantinga, "Two Dozen (or so) Theistic Arguments," Lecture presented at the 33rd Annual Philosophy Conference, Wheaton College, Wheaton, Illinois, October 23-25, 1986. This citation was retrieved from William Lane Craig, "Does God Exist?" Accessed December, 16 2015: <http://www.reasonablefaith.org/does-god-exist-1#ixzz3uWUqhFPE>. Thus, I will present Swinburne's argument and therefore only make textual references to his work(s) and not Adams. I do this for two reasons. First, Swinburne's Bayesian formulation of the argument is helpful for thinking about probability considerations. Secondly, Swinburne's account is taken in conjunction with all other arguments (which serves as part of the k value in Bayes's theorem) and thus his argument is all the stronger insofar as it is not taken individually. Though this may be controversial, I leave this aside as it is beyond the scope of my paper.



A TALE OF MATTEL'S TWO DOLLS AND THE POLITICS OF DOLL- PLAYING: A CRITICAL EXAMINATION OF BARBIE AND AMERICAN GIRL'S ROLES IN EDUCATING YOUNG AMERICAN GIRLS

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BIOGRAPHY

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A quintessential aspect of many American girls' childhood involves plastic bodies (Rogers, 1999, 112). Pieced together by molded plastic heads, plastic arms, and plastic legs that are efficiently mass-produced by our formidable technology today, dolls are inanimate objects: silent, unable to walk on their own feet, and certainly incapable of independent thinking (medicaldaily.com). Yet, despite all these characteristics, dolls such as Mattel's Barbies and American Girls play a significant role in early childhood education and socialization (Jillson, 2011, 99).

While young American girls construct identities for their dolls by conjuring stories for them, to an arguably greater extent, their identities are in turn shaped by the inanimate dolls. Indeed, the very act of playing with dolls is a form of education in itself. While Barbie and American Girl, two of Mattel's most renowned doll products, teach important lessons on values such as self-confidence and independence, the way in which dolls shape ideology is often politically and socially problematic.

To understand what kinds of lessons girls may learn from doll-playing, one needs to first appreciate the complexity inherent within our protagonists, who serve as the teachers and influencers in girls' early development: Barbie and American Girl.

Setting the Stage: Our Protagonists as Imperfect Icons/Role Models

"Some Like It Barbie", "Barbie Like Me", "My Fair Barbie", "Our Barbies, Our Selves", and "The Woman Who Would Be Barbie" are just some chapter titles of M. G. Lord's *Forever Barbie: The Unauthorized Biography of a Real Doll* (Lord, 1994, 106, 158, 180, 222, 244). As these titles suggest, Barbie dolls not only provide young girls with a means of self-identification, but also serve as icons:

"Indeed, the very act of playing with dolls is a form of education in itself."

individuals who provide "a point of recognition widely shared with other members of one's society" and let people "imaginatively explore race, sexuality, and femininity" (Rogers, 1999, 2-3). Barbie is an icon intended to have more

direct personal connection through possession with girls, allowing a sense of autonomy and ownership (Lord, 1994, 1). This unique attribute of Barbie could potentially amplify the doll's power unintentionally, by influencing little girls' early childhood development, molding certain aspects of their identity, attitudes, values, and ideology in both positive and negative ways.

"For instance, Barbie restricts the definition of women's beauty by limiting it to traditional roles for women, as exemplified by her arched feet that could not flex and thus could only wear high heeled shoes."

Fundamentally, Barbie is a fashion doll that encourages creativity, individuality, and the audacious pursuit of beauty. Barbie also embodies female independence to a certain extent, since there are no familial relations in Barbie's world (Piche, 2009, 7). Her creators altered Barbie's figure by giving her the image of femininity without the reality of femininity (i.e. breasts with no nipple, flared hips with no womb, and spread legs with no vagina): in short, "no milk, no sucklings, no procreation" (Cunningham, 1993, 21). However, there are tensions between the aforementioned liberating and empowering qualities that the doll encourages in girls and the simultaneously restrictive role Barbie plays to "confine women within a certain role" (Piche, 2009, 5). For instance, Barbie restricts the definition of women's beauty by limiting it to traditional roles for women, as exemplified by her arched feet that could not flex and thus could only wear high heeled shoes (Piche, 2009, 9).

Barbie's intrinsic complexity extends far beyond this tension, as we may find by delving into her history and evolution. Indeed, the doll's very origin may be shocking for those unacquainted with Barbie's history. Far from being inspired by another children's doll, Barbie was born out of her creator's wish to emulate a "German sex doll designed for adults"; one that is hyper-sexualized yet still bound by traditional European standards of femininity (Lord, 1994, 8).

The evolution of Barbie features a few paradoxes. In order to communicate the message that any girl can aspire to be and identify with a Barbie, the designers initially made Barbie's facial features look bland (Barbie Nation: An Unauthorized Tour Collector's Edition, 2007). Over time, however, Barbie has evolved to become incrementally more beautiful to generate more revenue for Mattel (see Appendix A) by satiating America's obsession with beauty: For example, Barbie's doll packaging overuses the word beautiful, hinting at an excessive obsession with linking beauty to superficiality, materialism, and consumerism – many criticized aspects of American culture from which children should be protected (Thomas, 2000, 70). Even as touchable icons, the standard of beauty that Barbie creates is still virtually unattainable. Barbie has promoted a doll culture

“Indeed, we may wonder why Addy, the African American girl, lives back in the slavery era instead of the modern day.”

where its centerpiece, the “American Waistland” (see Appendix B), encourages the idea of seeing women as bodies rather than possessing bodies, and has repeatedly provoked criticisms related to eating disorders (Edut, 1998, 222; Cunningham, 1993, 81, 79). To respond to such criticisms, Mattel has introduced a new collection featuring a variety of figures such as curvy, tall, and petite (barbie.com). Meanwhile, Mattel has also responded to external pressures to diversify the racial makeup of Barbies by expanding its product portfolio to include more ethnic representations, although the original white, blonde model is still referred to as the standard (Schwarz, 2005, 299). Despite the company's timely adaptations, however, sales have been faltering. In contrast, Mattel's more recently acquired American Girl collection continues seeing increase in sales (Sherry, 2009, 202).

Sometimes called “the Anti-Barbie” for moving beyond tired stereotypes by looking “normal” and “real”, American Girl is distinct from Barbie even though they are owned by the same company and both are critical to the early development of children (Inness, 1998, 164). As the brand name suggests, the 18-inch American Girl dolls are girls rather than teenagers, and are therefore

not sexualized (americangirls.com). Since the dolls are closer in age to their users, girls may relate more closely to them. Instead of being a platform for projecting into one's teenage future and serving as an iconic figure whose beauty status is near-unachievable as in Barbie's case, where “reality is not the intention” (Schwarz, 2005, 298), American Girls set good examples in communicating positive values (e.g. philanthropy, family values, and self reliance) which can help make positive differences in society (Inness, 1998, 166). Compared to Barbie, American Girls can be considered more realistic role models for young girls to emulate.

Unlike the European-inspired and internationally famous Barbie whose product portfolio includes “Barbies around the world” (barbie.com), American Girl is more “America-centric” (Inness, 1998, 175). There is great emphasis on educating girls on American history, since the brand's most popular product line features 13 fictional dolls representing nine historical eras and several ethnic groups in the United States (americangirl.com). The books that accompany the dolls create a narrative of a protagonist's life in her specific historical time period (Inness, 1998, 169). Although these stories take place in America's past that may be unfamiliar to them, contemporary American girls tend to create intricate backstories for their dolls, “intertwining content from the books with their own family histories” (Diamond, 2009; Sherry et. al., 2009, 118). This further illustrates the extent and influence of American Girl dolls on young American girls.

Although American Girl exemplifies a more socially acceptable lifestyle than Barbie does and dispels parents' concerns on “precocious sexualization” (Diamond, 2009; Sherry et. al., 2009, 123), the dolls are certainly not flawless (Inness, 1998, 169). From the beginning, American Girl has been criticized for being unaffordable for the majority of American families, ranging from 115 to 120 dollars per doll, contradicting its name's hinted universality of its unique brand. Further, as much as Barbie is a flawed icon, American Girls are also imperfect role models whose influence can be problematic at times, despite their well-marketed positive values. The brand has also been criticized for ignoring the complexity of American history, specifically the absence of unhappy endings and presenting unrealistic and

“Although American Girl does not explicitly state that everything is historically accurate, for young girls the books often construct illusions that confuse the line between fiction and nonfiction.”

stereotyped accounts of racial differences and ethnic minority characters (Sekeres, 2009, 408).

The Home: Politics of Play

Girls, sometimes unconsciously, learn intrinsically complicated identities from the plastic bodies' and as a result become more social. As plastic as their bodies are, dolls can actually be “imbued with [three main forms of] ideology”: the politics of advocacy, attack, and assent (Inness, 1998, 170).

The politics of advocacy and attack are reverse sides of the same coin: while the politics of advocacy refers to “pleading for and promoting a specific cause, or upholding a particular point of view or course of action as being valid and right” (Sutherland, 1985, 145), the politics of attack is generated by “amusement, outrage, or contempt when [people] encounter something that runs counter to their concepts of right and wrong, good and evil[, etc.]” (Sutherland, 1985, 147). In *American Girls* (see Appendix C), both the politics of advocacy and attack are present; the former is exemplified by the “revisionary history that offers girls new stature”. Not only are the American Girl dolls and novels presenting girls' history, but also actively promoting it, which is a worthwhile change from the typical omission of females from history. This is illustrated by the recurrent attack on the evils of slavery in the novel *Meet Addy: An American Girl* (Inness, 1998, 172-174). Both politics of advocacy and attack teach “behavioral messages that have broad appeal” to girls, underscoring the significance of dolls in influencing young American females in their early stages of growth (Inness, 1998, 174).

If the three forms of ideology were mapped on a spectrum, placed in between the politics of advocacy and attack would be the comparatively insidious and often hidden politics of assent, defined as affirming the status quo and

continually reinforcing it (Sutherland, 1985, 151, 155). Examples are omnipresent in both Mattel dolls. For American Girls, not only is it present in the collection's “overwhelmingly American-centric attitude” revealed in the brand name itself but also in the books' repeated suggestion of American superiority as a vision that becomes so familiar that people assume it is the truth. The politics of assent also works to show only long hair as natural on women and implies that short hair is unfeminine on both Barbies and American Girls, serving as a traditional standard on how girls are expected to look and reinforcing established societal norms of feminine culture (Inness, 1998, 175, 177).

The politics of assent is further exemplified by American Girl's presentation of its collection as real history (Inness, 1998, 175-176). Although American Girl does not explicitly state that everything is historically accurate, for young girls the books often construct illusions that confuse the line between fiction and nonfiction. This may have disturbing effects, especially since the stories are largely legitimized by their presence in schools. Here the politics of assent renders American Girl's approach to teaching American history to girls partially problematic, for the dolls and their accompanied backstories already constructed by Mattel help form young American girls' limit notions about the history of race and ethnicity (Inness, 1998, 176). Noticeably, most novels sold with the dolls focus on upper class characters and present the United States as largely white with little to no mention of other ethnic groups in a positive manner.

The politics of assent can be further linked to what Schwarz, 2005, terms as “the politics of nostalgia” in both dolls' cases (297). Native American Barbies, like many other ethnic minority dolls from both the Barbie and American Girl collections, demonstrate Mattel's tendency to present “frozen stereotypes”, where Native American Barbies still live in a pristine past and are always dressed for special, traditional occasions (Schwarz, 2005, 295). In these instances, the politics of nostalgia often works to “conceal fundamental ideological principles used to legitimate a dominant one-dimensional view of history written as an unchanging narrative” (Schwarz, 2005, 298). This “commodification of folklores”, while helpful in generating more profit for Mattel, engenders a false illusion that distorts the ethnic group's view of their identity in the

past and present, while reinforcing damaging stereotypes (Thomas, 2000, 65).

Meanwhile, we may use similar logic to critically examine the American Girl collection's strategy of focusing on earlier periods in American history as a means of socializing contemporary American girls with strategically preselected emphases and purposeful understatements of today's persisting racial violence. Indeed, we may wonder why Addy, the African American girl, lives back in the slavery era instead of the modern day. While one may argue that focusing on injustice in America's past shields young children from harsh social and political realities and intelligently helps Mattel maintain racial correctness, this approach can have drawbacks (Wall, 2010, 799).

One limitation concerns individual American identity. Consider, for instance, a black girl whose family immigrated to the United States from Africa 20 years ago. While the girl may be a U.S. citizen, she may not identify with Addy because her family history is one that is devoid of slavery. This could curtail her own American identity, and reduce the doll's influence. These concerns highlight the multifaceted complexity of dolls' roles in educating young American girls. One could further evaluate the politics of doll-playing by broadening the scope of consideration more holistically to include the market at large, both from the demand side (American girls as doll-players and consumers) and supply side (Mattel, the creator of Barbies and American Girls).

The Market: Consuming Children and the Cycle of "Parenting"

In our capitalist system, consumers have the right and freedom to choose which products they would like to purchase; suppliers produce goods to generate revenue. The relationship between commodities, producers, and consumers is complicated, as the doll-player's internal personal territories and external corporate/ cultural politics shape each other (Chin, 1999, 306). While children's demand for dolls can create and influence supply, sometimes boosting Mattel's sales as a result, the outward forces of corporate and cultural politics also invade children's personal territories by educating them in potentially problematic ways.

One should further consider the nature of children who are consumed by the enchanting allures of doll-playing, as one examines both the supply and demand in relation to the mutual influence between the marketplace and the mind (Diamond, 2009; Sherry et. al., 2009, 126). Existing scholarship on children as consumers is generally polarized between those who feel that children's innocence must be protected from corporate advertising, and scholars who feel that children have the rights as consumers (Linn, 2004, 1; Sekeres, 2009, 405). Often, the decision-making power to choose between protecting children from corporate influence and granting them more liberty to make decisions as independent consumers belongs to the parents (Diamond, 2009; Sherry et. al., 2009, 122).

"However diverse the dolls and their stories may be, they share similar, often problematic ideologies reaffirm stereotypes and upholding dominant societal values and culture."

Although girls are the direct consumers of Barbies and American Girls, their parents make the purchase. This purchase has broader implications: it transfers an aspect of parenthood to Mattel: the lucrative corporation to which educating children is a means to profit maximization. Mattel's American Girl Place, the supply side, can be understood as an "archetypal parent": not only a shrine worshipped by girl consumers, but also a dwelling: it is both a commercial and domestic space (Diamond, 2009; Sherry et. al., 2009, 132).

On the demand side, girls may also take a parental role when they create and shape identities for their Barbies and American Girls in role-play games (Schwarz, 2005, 296). Ironically, it is the Barbies and American Girls that serve as an imaginative outlet who remain as powerful educators and influencers molding the girl consumers' identities and ideologies while the girls pretend to be shaping theirs through imagined parental dominance (Piche, 2009, 5).

At the marketplace, girls who are ostensibly only picking their playmates are actually choosing the way in which they want to be molded. However

diverse the dolls and their stories may be, they share similar, often problematic ideologies reaffirming stereotypes and upholding dominant societal values and culture.

In the cycle of parenting, biological parents delegate some of their parental power of raising their daughters to Mattel, whose agents, Barbie and American Girl dolls, socialize and educate the children in spite of their own static state. Young American girls, meanwhile, fantasize by imagining themselves as parents educating their daughters, the dolls, who in turn shape and mold their own identities.

Conclusion: Plasticity in Reverse

Doll-playing, a seemingly simple childhood pastime that is most commonly associated with the domestic setting, is intricately intertwined with the outside world. Not only do Barbies and American Girls arrive at girls' homes from their corporate creator Mattel, but they also influence girls on their identity (Rogers, 1999, 1).

Indeed, the dolls are not so plastic, after all. While girls receive history lessons and absorb American societal and moral values such as charity and independence through doll-play, Barbie and American Girl's roles in socializing American girls are problematic in elements such as their frozen racial representations and constraints on femininity per traditional standards. The reinforcement of society's status quo, inherently present in both types of Mattel's malleable plastic bodies, may dangerously shape girls in static directions skewed towards dominant groups. Static, much like the dolls' unalterable and somewhat uncanny smiles made from inanimate plastic.

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Appendix A

Bratz, fashion dolls known for their “revealing” clothes and “heavy application of make-up”, is an example of Barbie’s competitors (Hernandez 64). As American girls are statistically found to have “grown up faster” (Diamond, Sherry, et al. 123), Mattel discovered that the age for playing Barbie dolls was slipping: once the favorite of older girls, Barbie “was now relegated to the preschool market”, while Bratz’s “hippy and sexy looks” capture that segment of the market (Linn 143). As a result, Mattel has introduced new products such as the “bigger-lipped, bigger-hipped, belly-button-baring” “My Scene” Barbie and the Lingerie Barbie (Linn 143).

Appendix B

To reach this “waistland” and look like a real life Barbie doll, a woman like Barbie fan Cindy Jackson who aspired to become a “human Barbie” may need as many as 20 operations consisted of “chemical peels, tummy tucks, face-lifts, eye-lifts, breast implants, and liposuction” that cost \$55,000 back in 1993 (Lord 245-246).

Appendix C

In Barbie’s case, the politics of advocacy and attack are more implicit but nevertheless present, as doll-players are granted more creative license to create their own stories instead of blending Mattel’s existing stories with their own creations, as they do in American Girl’s case. While analyzing Barbie’s politics of advocacy and attack may depend on each individual’s different version of the dolls’ stories Barbie’s generally advocates qualities such as independence, creativity, self-expression, and individuality and reject dependence on males or family members, as mentioned in a previous section of this paper.

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