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# Belief in Genetic Determinism within Academic Levels

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## ❖ INTRODUCTION

Belief in genetic determinism (BGD) can be defined as the belief that genes attribute more influence on the expression of traits than scientific research supports (Gericke et al., 2017). The environment and other factors, such as epigenetics, factor heavily into the expression of traits (Salk & Hyde, 2012) and it is important that students from all backgrounds and at all academic levels understand this since BGD has been associated with societal instances of racism and sexism (Keller, 2005). Previous research using questionnaires suggest that there is no association between genetics knowledge and BGD (Gericke et al., 2017), but there is a lack of qualitative studies investigating this link.

**Guiding Research Question:** How do students with varying levels of background knowledge in genetics differ in the amount and types of BGD they display?

## ❖ METHODS

- **Qualitatively** analyzed essay responses using descriptive coding methods
- **Essay:** Socio-scientific issue (SSI) about **non-medical enhancement** of humans using **CRISPR/Cas9** technology
- Each code was associated with an *example* of BGD (**Table 1**)

| Description: Changing genetic make-up will have the following outcomes... without mention of other factors (environment, epigenetics) | Code applied (Abbreviation)     |
|---|---------------------------------|
| Alter non-specified phenotypic <b>traits</b>  | Traits (Tr)                     |
| Change <b>physical</b> characteristics: height, eye color, hair color, etc.   | Physical (Phys)                 |
| Change <b>behavioral</b> attributes: empathy, aggression, etc.  | Behavioral (Beh)                |
| Alter <b>intellectual capabilities</b> : intelligence   | Intellectual (Int)              |
| Change <b>race or gender</b>  | Race, Gender (R), (G)           |
| Cure or prevent <b>disease, disability</b>  | Disease, Disability (Dis), (Db) |
| Lead to <b>extreme side effects</b>   | Side effects (SE)               |
| Allow members of society to <b>design their children</b>  | Build-A-Baby (BAB)              |
| OR: Expressing the belief that DNA or genes are responsible for making individuals who they are                                       | Belief (Bel)                    |

- Distributed to 9 courses: four non-major biology, two lower level biology, and three upper level biology
- Analyzed as 3 **academic level** groups: non-majors (NM), lower level biology majors (LLM), and upper level biology majors (ULM)
- Compared the number of **instances** of BGD overall, and each BGD example between the three groups

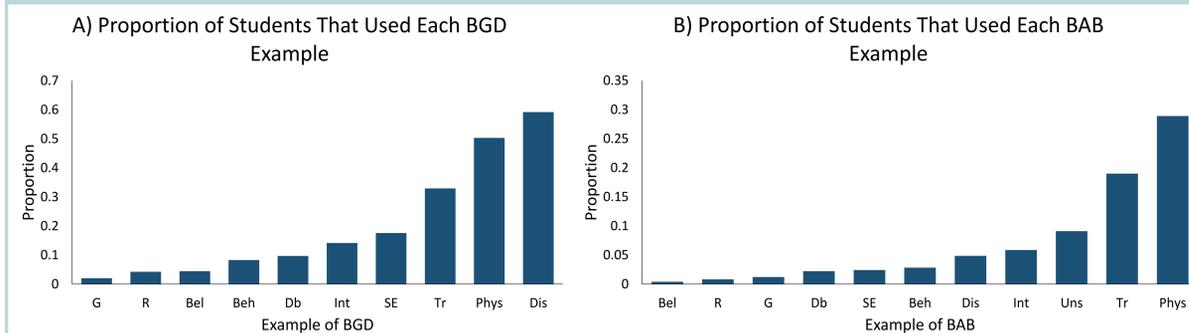
## ❖ Belief in Genetic Determinism Overall

**90%** of students used at least one example of BGD (**Figure 1A**)

- **Disease** was the most common BGD example present – 59% of the students
- **Physical** characteristics was the second most common – 50% of students
- **Traits** was third – 33% of the students.

**42%** of students referenced **designer babies** (**Figure 1B**)

- Changing physical attributes was used by 29% of students
- Changing traits, in general, was used by around 19% of students



**Figure 1. Curing and preventing disease was the most common example of BGD while altering physical attributes was the most common “designer baby” example of BGD.** A) Proportion of total students that used each BGD example. B) Proportion of total students that used each Build-A-Baby (BAB) example. Uns = unspecified.

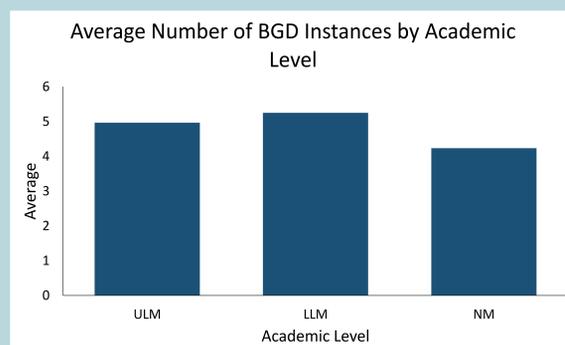
## ❖ Instances of BGD by Academic Level

### Hypotheses:

- ULM students will use **fewer** amounts of BGD compared to LLM and NM
- LLM students will use **fewer** amounts of BGD compared to NM

### Results:

- Students displayed the **same amount** of BGD across **ALL** academic levels
- On average, **NM** used slightly **fewer** examples of BGD (mean=4) compared to LLM (mean=5) and ULM (mean=5) students
- **Figure 2**



**Figure 2. Students from all academic levels had similar frequencies of BGD in their essays.**

## ❖ Types of BGD by Academic Level

### Hypotheses:

- Students with higher levels of biology knowledge would use common examples (disease, physical) less frequently

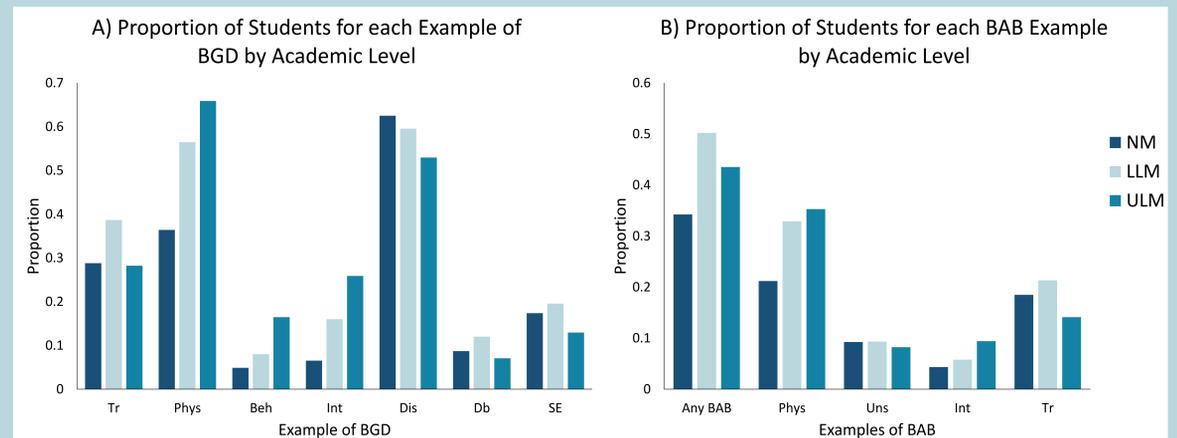
### Results

BGD examples (**Figure 3A**):

- **LLM** used for **traits, disability, and side effects** examples of BGD **more** frequently than ULM and NM students
- **ULM** used **physical, behavioral, and intellectual** examples of BGD **more** frequently than LLM and NM
- **NM** used **disease** examples of BGD **more** frequently than LLM and ULM students.
- Within the BAB subcodes, the above trends are also seen. Lower levels majors code more frequently for BAB/Traits and upper level majors code more frequently for BAB/Physical and BAB/Mental Capabilities.

BAB examples (**Figure 3B**):

- **LLM** referenced **designer babies** **more** frequently than ULM and NM students
- **LLM** used examples of **traits** being altered **more** frequently than ULM and NM students
- **ULM** used examples related to **physical** characteristics and **intellectual** capabilities **more** often than LLM and NM students



**Figure 3. The most common examples of BGD differed by academic level.** A) Proportion of students from each academic level that used the most common examples of BGD at least once in their essay. B) Proportion of students from each academic level that used each Build-A-Baby (BAB) example. Any BAB is the proportion of students from each academic level that used any example of BAB in their response at least once. Uns = unspecified.

## ❖ DISCUSSION

The frequency that BGD was displayed **did not differ** based on academic level, indicating that background knowledge in genetics **does not impact** the amount of BGD. The most frequent BGD that appeared across all academic levels was the belief that changing the genetic makeup of a human can cure or prevent a disease completely. Another frequent BGD that was present was Build-a-Baby, where a student believed that by only altering genes, we can choose the traits of our embryos and children.

The **types** of BGD that were displayed within each academic level were **different**. Students with the lowest background in genetics referenced eradication of diseases as a result of altering genes the most frequently. Students with moderate understanding of genetics discussed how changing genes can lead to changes in traits and prevent disabilities and emphasized extreme side effects more frequently than other students. Students with the highest background in genetics had fewer references to disease, but more for physical, behavioral, and intellectual capabilities compared to other students.

Most diseases and traits are caused by a combination of genes and/or the environment. Our results indicate that students do not fully understand the **multifactorial** effects that lead to the develop of complex traits, such as disease and physical characteristics. These differences in types of BGD can demonstrate how **curriculum** can **impact** a student’s overall views about genetics and then by extent, belief in genetic determinism.

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