COMPARATIVE ANALYSIS OF COGNITIVE ILLUSION SUSCEPTIBILITY IN HIGH-PERFORMING STUDENTS VS. THE GENERAL POPULATION

Mishi Chaturvedi, Tanvi Daita, Francesca DiMarcello, Glen Finnie, Mahek Khan, Bryanna Liu, Aidan Ryu, Arlind Sinani, Audrey Wang

Advisor: Patrick Dolan
Assistant: Brenna Hezel

ABSTRACT

Cognitive illusions are common and predictable lapses in thinking, decision making, and other mental processes. This study aimed to explore the connection between intellectual ability and susceptibility to cognitive errors. To do so, a survey framed as a personality assessment was distributed to two groups: 46 high-achieving high school students attending the New Jersey Governor's School in the Sciences and 46 online participants representing the general population with varying ages and academic backgrounds. The survey contained personality-related questions as well as various standard cognitive illusions that tested memory, judgement, and attention. The participants' responses were anonymously collected and compared by group. Results varied based on the specific illusion, which may be attributed to the nature of each task. One consistent trend was that Governor's School scholars were more susceptible to the illusions related to self-evaluation. Overall, the results show that while academic intelligence may correlate with susceptibility to cognitive illusions, even high-performing individuals are ultimately vulnerable to them due to the inherent tendencies of the brain to make assumptions and have selective attention. This research highlights the importance of studying these illusions in order to gain further insight into the mechanisms behind human psychological behavior.

GENERAL INTRODUCTION

Cognitive psychology has roots tracing back to ancient philosophers such as Plato, who studied the association between mental processes and brain functions. Though his definition was elusive and more descriptive than structural, it laid the groundwork for future inquiry in the field (1). Research continued and reached an all time high in the 1950s and 1960s–a time period known as the cognitive revolution–marked by influential work from scientists like George Miller and Noam Chomsky who made notable early breakthroughs (2). The first concrete understanding of the cognitive sciences emerged in 1967 from German American psychologist Ulric Neisser, who defined cognition as "all processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used" (3). In simpler terms, it is the way the brain perceives, understands, remembers, and learns information. The scope of cognition can be further divided into domains such as perception, attention, memory, decision making, etc.

The human brain has evolved to be remarkably efficient at cognitive tasks, enabling us to succeed in everything from developing language to planning and problem solving. However, these same evolved efficiencies leave the brain prone to systematic errors known as cognitive illusions (4). Cognitive illusions are predictable mistakes in thinking, remembering, or judging–errors where individuals typically remain convinced that they correctly interpreted and

answered the task. As Rüdiger F. Pohl notes, a distinctive feature of cognitive illusions is that they "appear as rather *distinct* from the normal course of information processing" (4). In other words, cognitive illusions' unique properties demonstrate that errors in cognition arise not randomly but from the same cognitive mechanisms and heuristics that generally support effective functioning. Though cognitive illusions are typically encountered in harmless studies and brain teasers, their effects can be far from trivial. They have serious real world implications, notably one being within the justice system. The Innocence Project has identified 375 wrongfully convicted prisoners, over 70% of which arose from eyewitness misidentification–a failure often rooted in cognitive illusions such as false memory, illusory correlation, change blindness, and own-race bias (5). If such errors stem from cognitive illusions, studying them becomes crucial not only for academic research, but also to ensure equality and fairness in our institutions (6).

The fact that cognitive illusions are rooted so deeply in the processes of the human mind raises questions about the connection between an individual's cognitive capabilities and their susceptibility to such errors. Our study aimed to investigate how individuals of varying cognitive abilities respond to cognitive illusions. Our primary participant group consisted of 46 scholars attending the New Jersey Governor's School in the Sciences (GSNJS). These rising high school seniors are driven, high-achieving, and academically accomplished in science and mathematics. Their strong academic background and advanced reasoning skills made them an ideal group for studying how cognitive illusions affect even the most focused, logical thinkers. Additionally, due to their background in evidence-based reasoning, they may have had a more skeptical approach to the questions. The responses from this group were compared with a group of randomly selected participants from the Internet, representing a broader cross-section of the general public.

Our goal in this study was to understand GSNJS scholars' relative susceptibility to cognitive illusions in comparison to the general public. We wanted to understand how academic proficiency and associated traits–intelligence, conscientiousness, and creativity–affect their approach and responses. We hypothesized that the more academically-driven students would be less susceptible to cognitive illusions than the general public due to their extensive educational experience and inherent proclivities.

GENERAL METHODS

Participants

In this study, there were a total of 92 participants: 46 GSNJS scholars and 46 online participants. The GSNJS scholars, high-achieving high school students from New Jersey, had an average age of 17 years. The online participants, with an average age of 40, came from diverse academic backgrounds and locations since they were openly recruited via CloudResearch's Connect platform to complete the survey. 54.5% of GSNJS scholars were female, 40% male, and 5% were unidentified. 52.17% of online participants were female, 45.65% were male, and 2% were unidentified. All were proficient in English and professionally engaged in survey participation.

Materials

Qualtrics, a software used to create the survey for this study, was used to collect data from our survey of cognitive tasks. All participants were asked for consent before they

proceeded to partake in this study and complete the survey (Appendix I). As a feasible guise for the purposes and intents of this study, personality-related questions were extracted from the Eysenck Personality Questionnaire, containing questions about four dimensions of personality: extraversion, neuroticism, psychoticism, and social desirability (7). These questions were dispersed throughout the survey with 16 other standard measures of cognition known to lead to predictable errors (Appendix II).

Procedure

GSNJS Scholars completed the survey in a controlled setting on Saturday, July 12, 2025, at 10 p.m. Each small group was proctored by at least one researcher. All participants took the survey on their laptops and wore earbuds during the video portions of the survey. To reduce bias, the study was initially pitched as an anonymous personality questionnaire. Participants were strongly urged to remain silent throughout the testing period to eliminate confounding variables. Since the survey was administered via Qualtrics, the system arbitrarily assigned participants different test versions, thereby helping standardize the results. The online participants, on the other hand, completed the survey remotely and without supervision due to the nature of online data collection.

The 12 cognitive illusions were analyzed and their results are detailed below.

MCGURK EFFECT - PERCEPTION

Introduction:

The McGurk Effect, first discovered in 1976 by McGurk and MacDonald, demonstrates how discrepancies in sensory input lead to false interpretations of the signals received (8). This phenomenon occurs when visual and auditory cues do not correspond. Individuals tend to hear the sound that they visually process or experience a blended sound that combines both visual and auditory input such as a video that shows a person pronouncing “Fa” when the sound plays “Ba” that causes individuals to falsely perceive the sound as “Fa” or a mix of both. Ultimately, this effect highlights how visual sensory cues heavily influence speech perception despite auditory signals (9).

Methods:

Participants were asked to listen to the video shown on their respective screen (Appendix III). The control group received a video where the visual and auditory stimuli matched – both indicated a man saying the consonant “Ba”. The experimental group received a video where the stimuli conflicted; the auditory stimulus stayed constant (“Ba”), but the visual cues showed a man pronouncing the syllable “Fa.” After listening, participants were asked, “What is he saying?” in the format of an open-ended response. Individuals of the control group were expected to record “Ba,” while those of the experimental group were expected to record “Fa.” It was hypothesized that GSNJS scholars and the general population would be similar in terms of response accuracy.

Results:

Of those in the control group who received the “Ba” video, 100% responded that they heard “Ba” across both GSNJS scholars and the online participants. In the experimental group

where the auditory and visual stimuli conflicted, the Governor's School scholars were less susceptible to recording what they visually perceived (Table I). When comparing the results from participants, 43% of GSNJS scholars heard "Ba," compared to 14% of the online participants. On the other hand, 77% of the online participants heard "Fa," while this was the case for only 52% of GSNJS scholars. A small percentage across both groups of participants heard a blended noise, "Va".

A two-tailed t-test was conducted to analyze the results from the "Fa" Video. The p-value was less than the alpha, indicating that there was a significant difference between GSNJS scholars and the online participants, specifically GSNJS scholars performed better (Table II).

Table I: Participants Perceived Sound vs. Video Watched

	Ba	Fa	Va
GSNJS - Ba Video	100%	0%	0%
GSNJS - Fa Video	43%	52%	4%
Online - Ba Video	100%	0%	0%
Online - Fa Video	14%	77%	9%

Table II: Statistical Data for GSNJS Scholars vs. Online Participants

	p-value	alpha = 0.05
Fa Video	0.0273	< 0.05

FALSE MEMORY - MEMORY, PERCEPTION

Introduction

In 1959, psychologist James Deese introduced a method for studying false memories–the phenomenon of recalling words or events that never actually occurred. This method was later expanded in 1995 by Roediger and McDermott, resulting in what is now known as the Deese-Roediger-McDermott (DRM) task (10). The DRM task demonstrates that subjects often falsely remember the presence of words semantically related to words presented in a list. A wide body of literature has since corroborated the reliability of this experiment (11).

Methods

Participants were shown a list of 15 words that were semantically related to the word "doctor" (Appendix IV). Participants were directed to choose their favorite word from the list to encourage consideration. With the list no longer presented, participants were asked how much the list interested them personally, provoking further thought while concealing the intentions of the question. Then, participants were asked to type all words they remember from the list. GSNJS Scholars were predicted to falsely remember the word "doctor" more than the online participants, and also correctly remember more words.

Results

48% of GSNJS scholars incorrectly remembered the word “doctor” compared to 57% of the online participants. GSNJS scholars correctly remembered 40% of the list correctly on average, compared to 35% for the online participants (Table III).

A two-tailed t-test was conducted and the p-value was greater than the alpha, indicating no significant difference when comparing the GSNJS scholars and the online participants (Table IV). Although in this sample size, there was no statistical significance between the data, there was a difference in the percentage (Table III).

PRIMING OF AMBIGUOUS PICTURES - PERCEPTION, ATTENTION, MEMORY

Table III: Participants Perceived Sound vs. Video Watched

	False “Doctor” Recall	Correct Words (% of List)
GSNJS	48%	40%
Online Participants	57%	35%

Table IV: Statistical Data for GSNJS Scholars vs. Online Participants

	p-value	alpha = 0.05
False “Doctor” Recall	0.259	> 0.05

Introduction

Priming ambiguous pictures is an illusion that targets predictive processing, a function in the brain used to make experience-based predictions about the environment rather than registering raw sensations (12). A classic example is the bunny-duck image, first studied in 1899 by Joseph Jastrow (Appendix V). When shown a bunny prior to the illusion, participants were more likely to perceive the illustration as a bunny, and vice versa for the duck (13).

Methods

In this study, participants were shown images of various animals. As a misdirection, they were asked if they considered them for a pet. In order, they were shown an elephant, a macaw, and the third image, which was used to prime participants, was either a donkey, a seal, or a snake. Afterwards, participants were shown the ambiguous image, interpreted as either a donkey or a seal, and were then prompted in an open-ended format to explain what they saw (Appendix V). Participants showed a snake was set as the control group and others were expected to answer with the animal from the “primed” image, with less GSNJS scholars susceptible to the priming.

Results

Both GSNJS scholars and online participants were more likely to guess “seal” or “donkey” when primed correspondingly (Table V).

Two chi-square tests were used to analyze the results, and both p-values were less than the alpha (0.05) indicating that both GSNJS scholars and online participants were significantly affected by the priming (Table VI).

Table V: Participants Primed Image vs. Perceived Animal

	Donkey Prime	Seal Prime	Snake Prime
GSNJS - Donkey Guess	67%	40%	38%
GSNJS - Seal Guess	27%	60%	56%
Online - Donkey Guess	82%	42%	87%
Online - Seal Guess	6%	25%	13%

Table VI: Statistical Data for GSNJS Scholars vs. Online Participants

	p-value	alpha = 0.05
GSNJS Priming	0.00000489	< 0.05
Online Priming	0.00000147	< 0.05

CHANGE BLINDNESS - PERCEPTION, ATTENTION

Introduction:

First studied by Levin and Simons in 1997, change blindness is a phenomenon in which observers fail to notice when visual changes are made between different shots of the same scene (14). The concept of change blindness is often paralleled to those of selective attention and selective perception, where individuals overlook differences between images because they do not pay special attention to them (15). This phenomenon reveals how our brains often rely on broad impressions rather than detailed visual representations of a scene.

Methods:

Participants were shown a video clip of two women conversing. The video switched between multiple angles, and with each cut, details of the visual scene changed such as cups changing locations. Only half of participants were arbitrarily warned that there were editing mistakes while the other half received no such warning (Appendix VI). After watching the clip, participants were asked an irrelevant personality-type question (Appendix VI). This was followed by an open-ended prompt asking if and what they noticed was unusual about the video (Appendix VI). We hypothesized that both groups of participants would fail to see the changes in the video, but those who were warned about mistakes should have noticed more, and this may have been particularly true for the Governor's School scholars.

Results:

When warned, 2 online participants (9%) and 4 GSNJS scholars (18%) noticed the correct editing mistakes, while others were incorrectly concerned with the audio instead of the visual changes (Table VII). Participants who were not warned did not correctly identify any changes in the video. Neither group significantly benefitted from the warning.

Since only a few participants (4 for GSNJS and 2 for Online) noticed changes, both groups performed poorly, and no further statistical analysis was conducted.

Table VII: Participants Noticed Changes With Warning vs. Without Warning

	With Warning	Without Warning
GSNJS (Noticed Difference)	18%	0%
Online (Noticed Difference)	9%	0%

MOSES ILLUSION - PERCEPTION, ATTENTION

Introduction:

The Moses Illusion is a phenomenon that captures how the brain relies on shallow processing and mental shortcuts rather than fully interpreting the specific information (16). In 1981, Erikson and Mattson examined the way people skim when they read and fail to process mistakes in sentences—even when they possess the knowledge needed to detect them. By testing individuals with factually incorrect questions, the findings reveal that the brain prioritizes efficiency over accuracy, often overlooking mistakes due to reliance on heuristics (17).

Methods:

Participants in this project were first told that they were entering a "lightning round" and instructed to answer the given questions as quickly as possible. Responses were open-ended, allowing participants to respond with "can't say" if they believed that the question could not be answered. To familiarize them with the rapid-response format, participants were first primed with two common knowledge questions to acclimate them. Participants were then given one of two potential questions. Half of the participants were asked "What shape has a circumference of πr^2?" while the others were asked "What is the name of the man in the red suit who rides a sleigh and delivers birthday presents in December?"

While participants were expected to answer with "circle" for one and "Santa" for the other, the correct response for both questions was actually "can't say" because of the errors present in the questions. We hypothesized that GSNJS scholars would say "can't say" more than the online participants for the question with "circle". However, we also expected for GSNJS scholars and the online participants to perform equally in the question with "Santa".

Results:

Out of the GSNJS scholars given the circle question, 61% answered with "circle". Out of the general public, 59% who were asked the circle question answered with "circle". Out of the GSNJS scholars who were asked the Santa question, 100% answered with "Santa". Out of the online participants who were asked the Santa question, 95% answered with "Santa". (Table VIII).

Two two-tailed t-tests were conducted to analyze the results for both question sets. Both p-values were greater than the alpha, indicating that there was no significant difference in the performance between GSNJS scholars and online participants (Table IX).

Table VIII: Participants Circle and Santa Incorrect Percentages

	Circle:	Santa:
GSNJS	61%	100%
Online	59%	95%

Table IX: Statistical Data for GSNJS Scholars vs. Online Participants

	p-value	alpha = 0.05
Circle Question	0.906	> 0.05
Santa Question	0.312	> 0.05

SHEPARD TABLE TOP - SENSATION, PERCEPTION, AND ATTENTION

Introduction

The Shepard Tabletop Illusion, first presented by Roger Shepard in 1990, demonstrates how visual perception of geometry can be misleading. In this optical illusion, two shapes with identical dimensions appear to be different from each other through depth perception confusion (18). This illusion works because the brain relies on shape constancy, which interprets flat images as three-dimensional shapes (19). Inverting the orientation of the table downward reinforces the illusion of depth, deceiving the individual into thinking that it is longer than the original shape. Despite these visual tricks, the surface areas of both shapes are the same.

Method

Participants were shown an image of a standard box with a shaded red top, and were asked to identify which of the two options had the same surface area as the standard (Appendix VII). The order of the options were randomized to control for confounding order effects. Participants made their selections solely based on perception and visual judgement, as they were not provided any measuring tools to check the dimensions. It was hypothesized that GSNJS scholars and the online participants would be equally susceptible to the illusion because general intelligence and academic performance do not directly correlate to enhance depth perception.

Results

23% of Governor's School scholars correctly identified the matching surface area whereas 11% of the online participants answered it correctly (Table X).

A two-tailed t-test was conducted to analyze the results, and the p-value was greater than the alpha, indicating no statistical significance (Table XI). Although in this sample size, there was no statistical significance between the data, there was a difference in the percentage (Table X).

Table X: Participants Answered Correctly Percentages

	Correct	Incorrect
GSNJS	22%	77%
Online	11%	89%

Table XI: Statistical Data for GSNJS Scholars vs. Online Participants

	p-value	alpha = 0.05
Table Top	0.1616681	> 0.05

KIKI-BOUBA - PERCEPTION

Introduction

The kiki-bouba effect was first noted by Wolfgang Köhler in the 1920s and later popularized by V.S Ramachandram and Edward Hubbard in 2001. It is a psychological phenomenon where people consistently associate certain speech sounds with specific visual shapes, even when the words are completely imaginary (20). In various studies, participants from different cultures and language backgrounds were asked which shape is “kiki” and which is “bouba.” Across the various demographics, participants overwhelmingly matched sharp, angular shapes with “kiki” and soft, round shapes with “bouba.” This trend, considered an example of sound symbolism, challenges the traditional belief that language is completely arbitrary (21).

Methods

In this study, participants were shown an image of two shapes, a softer-edged shape on the left and a sharper-edged one on the right (Appendix VIII). Below, they were presented the question, “If you were to name the two shapes above, which seems most fitting to you?” and then given two options. One option had “kiki” on the left and “bouba” on the right, while the other had “bouba” on the left and “kiki” on the right. The majority of participants from both the online group and GSNJS were expected to name the sharper-edged shape “kiki” and softer-edged shape “bouba.”

Results

93% of online participants chose bouba for the round object on the left, and kiki for the sharp object on the right. 100% of GSNJS scholars made this decision (Table XII). Conversely, only 7% of online participants and 0% of GSNJS scholars flipped this distinction. GSNJS scholars were more likely to choose the expected result.

There was only a small difference in the results, with 3 online participants choosing Kiki on the left and 0 GSNJS scholars choosing Kiki on the left, so no further statistical analysis was conducted.

Table XII: Participants Kiki, Bouba Assignment Percentages

	Bouba - Left, Kiki - Right	Kiki - Left, Bouba- Right
GSNJS	100%	0%
Online	93%	7%

ANCHORING EFFECT - JUDGMENT

Introduction

Anchoring and adjustment heuristics, first introduced by Tversky and Kahneman in 1974, describes a cognitive bias where people's estimates are heavily influenced by initial reference values, or "anchors" (22). A classic example is when participants were asked to estimate 1 x 2 x 3 x 4 x 5 x 6 x 7 x 8 vs. 8 x 7 x 6 x 5 x 4 x 3 x 2 x 1. When the sequence started with small numbers, the median was 512. When the sequences started with large numbers, the median was 2250. This phenomenon shows that no matter how irrelevant and absurd the anchor value is, people's perception of the range is still distorted and leads to skewed estimates (23).

Methods

In this study, participants were asked two sets of questions (Appendix IX). In the first question of each set, participants were asked a "higher or lower" question, comparing the subject to a randomly assigned extreme and irrelevant value (either low or high). In the second question, the participants were then asked to estimate the true value. Both question answers were open ended. Participants were expected to answer estimates skewed either higher or lower depending on the initial anchor presented. Compared to the online participants, GSNJS scholars predicted to have a tighter range for the estimations, closer to the true averages.

Results

Several responses were removed due to incoherence, incompletion, or outliers. On average, both online participants and GSNJS scholars were susceptible to the anchor, with more online participants influenced by the high anchor of Gandhi's age, more Scholars influenced by the low anchor of temperature of Tanzania, more Internet participants influenced by the high anchor of the temperature of Tanzania, and no significant difference for the low anchor of Gandhi's age (Table XIII). Compared to the average values of the age of death for Gandhi (78 years) and the mean temperature of Tanzania (78 degrees F), there were no trends noted, as GSNJS scholars performed less accurately for the age of death for Gandhi but performed more accurately for the mean temperature of Tanzania (Table XIIII).

Four two-tailed t-tests were conducted to analyze the results. Although the p-value when comparing the GSNJS scholars' Gandhi question set was greater than the alpha, the same results were not seen in the Tanzania question set (Table XIV). As a result, there is not enough evidence to show that GSNJS scholars had a smaller spread of values, and therefore were less affected by the anchoring effect.

Table XIII: Participants Average Estimates Per Question & Anchor

	Gandhi (Low)	Gandhi (High)	Tanzania (Low)	Tanzania (High)
GSNJS Estimate	66	74	75	89
Online Estimate	68	83	79	92

Table XIV: Statistical Data for GSNJS Scholars vs. Online Participants

	p-value	alpha = 0.05
GSNJS - Gandhi	0.0713	> 0.05
Online - Gandhi	0.00930	< 0.05
GSNJS - Tanzania	0.000575	< 0.05
Online - Tanzania	0.00776	< 0.05

DECOY EFFECT - JUDGEMENT

Introduction

The decoy effect, identified by Huber, Payne, and Puto in 1982, is a phenomenon in which the presence of an inferior option (the decoy or asymmetrically-dominated option) makes another choice appear more attractive (24). This effect is often used in marketing to encourage upselling. A classic example is when offering three popcorn options–small, medium, and large– the medium (decoy) is priced slightly lower in cost than the large, attracting buyers to choose the large option instead of the small. However, when the middle option is not there, buyers tend to choose the small more often (25).

Methods

In this study, participants were asked to choose from drink options at a movie theater, in a multiple-choice format (Appendix X). Half of the participants were asked to choose from small ($3) or large ($7) options. The other half was asked to choose from small ($3), medium ($6.50, decoy option), and large ($7). A higher proportion of participants, both GSNJS scholars and the online participants, were expected to choose the large option when the medium decoy was present than only small and large.

Results

When comparing the half given two options (small and large) to the other half given three options, both the GSNJS Scholars and the online participants had a 13% positive difference in choosing the large option between the half given two options and the half introduced with the decoy (Table XV).

Two two-tailed t-tests were conducted and the p-values were greater than the alpha, indicating no significant difference when comparing the presence of a decoy in both groups (Table XVI). Although in this sample size, there was no statistical significance between the data, there was a difference in the percentage (Table XV).

Table XV: Participants 2 Options vs. 3 Options Choice Percentages

	Small	Medium	Large
GSNJS - 2 Options	87%	N/A	13%
GSNJS - 3 Options	57%	17%	26%
Online - 2 Options	54%	N/A	46%
Online - 3 Options	32%	9%	59%

Table XVI: Statistical Data for GSNJS Scholars vs. Online Participants

	p-value	alpha = 0.05
GSNJS Decoy	0.275	> 0.05
Online Decoy	0.380	> 0.05

NAÏVE PHYSICS - JUDGEMENT

Introduction

Naïve physics, first studied experimentally by Paolo Bozzi (26), tests people's intuition and understanding of motion and basic physics. The most commonly tested problems include dropping objects, pendulum motion, directional movement, etc. (Appendix XI). From prior experiments, it was found that many participants incorrectly chose the outcome of the theoretical problems due to incorrect assumptions (e.g confusing reference frames, not taking into consideration momentum, factoring in air resistance, etc.). This phenomenon shows the general misunderstandings in physics, which causes poor predictions in hypothetical situations (27).

Methods

Participants were first shown a picture of a plane (Appendix XII) and asked "In the diagram above, the plane is flying horizontally to the right at a constant altitude and a constant speed. If a ball is dropped from the indicated point of origin, which path do you think the ball will follow once dropped from the plane? Select the letter that corresponds to your answer". They were given five answer choices that corresponded with the diagram. Participants were expected to choose A, because of false assumptions of air resistance, which was not present in the system. They were also expected to choose B or C as incorrect answers as well. Compared to online participants, GSNJS scholars were expected to perform better, due to greater interest and experience in the subject.

Results

The general population correctly answered with "D" 26% of the time and 54% reported taking a physics course. The GSNJS scholars correctly answered with "D" 74% of the time and 98% reported taking a physics course (Table XVII).

A two-tailed t-test was conducted to analyze the results, and the p-value was less than the alpha, indicating that the GSNJS scholars performed significantly better compared to the online participants (Table XVIII).

Table XVII: Participants Correct Answer and Physics Course Percentages

	Correct Answer (D)	Took Physics Course
GSNJS	74%	98%
Online	26%	54%

Table XVIII: Statistical Data for GSNJS Scholars vs. Online Participants

	p-value	alpha = 0.05
Correct Answer	0.0000014	< 0.05

ILLUSORY SUPERIORITY EFFECT - SELF-PERCEPTION

Introduction

The Illusory Superiority effect, coined by Van Yperen and Buunk in 1991, is a cognitive bias where people tend to hold a higher opinion of themselves and their intelligence when compared to their peers (28). Most studies of this effect ask participants to rate themselves on various skills based on competence and sometimes also assess how desirable those skills are. Surveys consistently find that the majority of people rate themselves as above average–an outcome that is statistically impossible. It is understood that this tendency to overestimate their skills is to preserve or even enhance participants' self-esteem (29).

Methods

In this study, participants were first shown a list of skills relevant to a GSNJS Scholar (Appendix XIII). The skills covered a range of soft and hard skills. The participants were asked about more interpersonal skills such as working with others and communication, as well as skills more focused on their academic ability in fields like science and math. Participants were asked to rate their skill level compared to the average GSNJS Scholar on a scale from 1 (very unskilled) to 5 (very skilled). It is hypothesized that GSNJS Scholars will rate themselves higher on soft skills, while their ratings for hard skill may show some more variability.

Results

On average, people from the Internet rated themselves a 3.5, and 20% rated themselves above 4. GSNJS Scholars rated themselves a 3.8 and 39% rated themselves above a 4 (Table XIX).

A two-tailed t-test was conducted to analyze the results, and the p-value was less than the alpha, indicating the GSNJS scholars had a statistically significantly higher average rating compared to the online participants (Table XX).

Table XIX: Participants Percentage of Ratings Above 3 and 4

	Above 3	Above 4
GSNJS	93%	39%
Internet	74%	20%

Table XX: Statistical Data for GSNJS Scholars vs. Online Participants

	p-value	alpha = 0.05
Average Rating	0.0178	< 0.05

FORER EFFECT - SELF-PERCEPTION

Introduction

The Forer effect stems from an experiment conducted by Bertram Forer, who gave a "personality survey" to psychology students (30). Although every student received the same personality description, most rated it as highly accurate and personally meaningful. This phenomenon occurs when the "personal" statements are perceived as uniquely applicable. Forer explains that all psychological traits are present in everyone to some extent. A person's uniqueness comes from the relative magnitudes of these traits. Without understanding this nuance, merely recognizing a trait can feel surprisingly accurate and impressive. This is exacerbated by a cognitive bias called subjective validation, where the brain focuses on specific information within vague statements in an effort to confirm personal relevance, creating a stronger sense of being understood (31*)*.

Methods

Upon the completion of the project's survey, participants were given a personality description composed of 13 vague statements (Appendix XIV), presented as a formulation based on their responses. They were then asked to rate the accuracy of this personality description on a scale of 1 (poor) to 5 (excellent), relative to their actual personality. Unbeknownst to them, all participants received the exact same response. The correct answer would have been a 1, as the statements were so general that they held no real diagnostic value. We hypothesized, however, that both the GSNJS scholars and the online participants would respond with relatively high scores. This is likely due to the human desire to feel understood—a tendency that transcends differences in academic achievement.

Results

83% of GSNJS scholars gave the personality description a score of 4 or 5, indicating a very high level of accuracy, whereas only 63% of the online participants gave ratings within that range. Additionally, the GSNJS scholars gave it a notably higher average rating of 4.13, while online participants rated it only a 3.59 (Table XXI).

A two-tailed t-test was conducted to analyze the results, and the p-value was less than the alpha, indicating the GSNJS scholars had a statistically significantly higher average rating compared to the online participants (Table XXII).

Table XXI: Participants Above 3 Ratings and Average Ratings

	Above 3	Average Rating
GSNJS	83%	4.13
Online	63%	3.59

Table XXII: Statistical Data for GSNJS Scholars vs. Online Participants

	p-value	alpha = 0.05
Correct Answer	0.0175	< 0.05

DISCUSSION

The purpose of this study was to determine whether high-performing New Jersey Governor's School scholars were more or less susceptible to various cognitive illusions–spanning perception, attention, memory, judgment, and self evaluation–compared to the general population. Original hypotheses varied by task, reflecting the specific psychological domain involved. Using a questionnaire containing a wide variety of cognitive tricks and illusions, this study found mixed levels of susceptibility across different aspects of psychology.

Analysis of data from the McGurk Effect, DRM False Memory, Tabletop Illusion, and the Naive Physics tasks suggests that Governor's School Students were less susceptible to the illusions found in these tasks. This reduced susceptibility may be attributed to the nature of the tasks, which demands a high level of attention to detail. The McGurk Effect necessitates a distinction between auditory and visual stimuli, and the DRM False Memory illusion challenges memory accuracy by presenting semantically related words and phrases. Additionally, the Naïve Physics task involves using logic as well as prior scientific knowledge. Given their strong academic backgrounds, GSNJS scholars may be more attuned to subtle discrepancies and more motivated to process information carefully, leading to more accurate interpretation, in addition to their overall higher academic intelligence. In contrast, the online participants may not consistently possess the same level of motivation or aptitude.

In other tasks, such as Priming of Ambiguous Pictures, Change Blindness, the Moses Illusion, the Anchoring Effect, Kiki/Bouba, and the Decoy Effect, performance was generally similar amongst both GSNJS scholars and the online participants. These cognitive illusions often rely less on academic skills or intelligence and more on universal psychological tendencies. For instance, the Decoy Effect highlights innate decision-making biases, making individuals across different groups equally swayed in certain situations (Table XV). Additionally, the Change Blindness task reflects the limits of selective attention, a phenomenon widely common amongst individuals regardless of cognitive ability (Table VII). Although GSNJS scholars may possess

above-average academic aptitude, the results suggest that certain heuristic biases and perceptual limitations are broadly shared and not easily mitigated by academic performance alone.

Interestingly, the cognitive illusions that GSNJS scholars were more susceptible to related to the participant's self-perception; this includes the Illusory Superiority task where scholars were twice as likely to rate themselves above 4, and the 1q Effect where scholars rated their description 0.54 points more accurate than online respondents. In the Illusory Superiority Effect, GSNJS scholars had a higher instance of reporting themselves as above average compared to the general population (Table XIX). These results indicate that the GSNJS scholars consider themselves highly intelligent and academically skilled; additionally, they have been frequently affirmed of their unique attributes, thus contributing to their self-perception. When analyzing the results from the Forer Effect task, it was found that many of the students agreed with the personality description, despite its ambiguity (Table XXI). GSNJS scholars are adolescents and they are still in a period of cognitive and identity development. Confirmation bias may have played an additional role as scholars may have heavily resonated with the general description because of their inherent desire for personal validation and self-understanding. As a result, the survey appeared credible and participants were more likely to let their trust for the source overpower the generic nature of the results of the assessment. Online participants, on the other hand, were more skeptical of the survey and could see the contradictions within the description. An explanation for this phenomenon could be as simple as further brain development due to age (32). Thus, the age difference may play an important role in these results.

Overall, it can be concluded that although GSNJS scholars demonstrate higher levels of academic achievement and cognitive skills than the general population, they are still ultimately susceptible to the majority of the cognitive illusions found in the survey distributed. Though it may seem intuitive that high-performing students would have advantages to tasks requiring memory, attention, and other academically-essential qualities, the data reveals that there are some patterns in brain functioning that are simply unavoidable.

Limitations

This study faced several challenges in its design and execution, suggesting that in the future the methods could benefit from methodological improvements to enhance accuracy. While the GSNJS scholars completed the test in a controlled environment, there was less control over the online participants. Their testing conditions—including environment, distractions, and honesty—were unknown, potentially affecting the reliability of the results. A lack of strict control over this group potentially altered the results collected. If this study was conducted again, a random sampling of the population could take the test in Drew University, monitored by those who are conducting the research, so that they can ensure that the test is taken seriously. The demographic disparity between groups was also striking: the control group had a mean age of 40, whereas the GSNJS scholars were high school juniors. This age difference could have influenced responses, as the two samples differ significantly in background and cognitive development. In a future study, a random sampling taken from high school students could be used instead, so that it would accurately compare the results between the two populations. Additionally, both groups used their own technological devices, which may have introduced discrepancies related to internet strength, test-taking devices, access to headphones, and other technical factors. In the

future, computers and headphones could be provided to the scholars and the online participants to ensure that there are no discrepancies. Furthermore, many questions required an open-ended response to disguise the illusion being tested. However, this resulted in some ambiguous responses and answers that were difficult to interpret at times. There is also a possibility that GSNJS scholars, having engaged with researchers before, during, or after the test, may have been more aware about the true nature of the test—potentially skewing the results. To fix this flaw, the test could be given to scholars the first or second day, to ensure that there would be limited discussion about what the project involved. Scholars also took the survey at 10 p.m., so the time may have altered their ability to process clearly and pay attention to detail. Changing to administering the survey earlier may yield more accurate results across both populations tested. Finally, this study's small sample size limited its statistical power and generalizability. Adding more participants to both groups would help alleviate this problem. Overall, this study faced limitations in controlling participants and in future replications should aim for a stricter regulatory environment.

Future Research

This study revealed some differences between GSNJS scholars and the general population, but there remain numerous opportunities to expand and research further in the future. One variable not yet examined is gender. Given established differences in male and female brain structure and cognitive processing, future studies could investigate whether these differences influence susceptibility to cognitive illusions (33). Another potential area for future investigation is age. As previously mentioned, there was a distinction in age between online participants and Governor's School scholars: the general public was significantly older than the scholars. To isolate and better understand the effect of age, a separate study focused solely on age-related differences would be beneficial. Finally, considering that many of these illusions are experience-based, grouping participants by areas of interest could provide insight into the role experience plays. For example, researchers might explore whether musicians are less susceptible to memory illusions or if artists are less susceptible to visual illusions. Ultimately, categorizing participants based on factors such as gender, age, and experiential background could provide a deeper understanding of how various demographics interact with cognitive illusions.

Conclusion

The goal of this study was to analyze high-performing students' susceptibility to cognitive illusions relative to the general population. After testing on various mental tasks–such as perception, attention, decision making, and memory tasks–it was determined that GSNJS scholars predominantly performed in a similar manner as online respondents. Overall, the researchers hypothesized that GSNJS scholars would perform better (task-dependent), and therefore, the findings did not support our hypothesis. Specifically, the results demonstrate that GSNJS scholars were only exceptional in memorization and perception tasks. This demonstrates that high-performing students are more likely to process information meticulously, while the general population pays less attention to fine detail. Alternatively, academically-inclined students perform worse on tasks requiring self-perception, indicating that an inflated sense of ability is common among high-performing students.

Ultimately, this study allows researchers to understand human behavior, gaining insights into the underlying mechanism behind perception, memory, and decisions-making–especially in the context of how cognitive biases and assumptions shape human perspective. This has a wide variety of applications beyond the field of psychology, as these cognitive skills are critical in areas such as finance, medicine, and law. Understanding these illusions and biases can help us recognize the influence they have and help us develop effective strategies to mitigate their impact.

ACKNOWLEDGEMENTS

We extend our heartfelt gratitude to everyone who supported us throughout this project. It would not have been possible without the generous assistance of our sponsors and donors, including the Office of the Secretary of Higher Education of New Jersey, the Overdeck Family Foundation, Novartis, Bristol Myers Squibb, GSNJS alumni, and the parents of alumni. We are especially grateful to the directors of GSNJS, Dr. Stephen Dunaway and Dr. Adam Cassano, for their continued support. A special thank you goes to our Principal Investigator, Dr. Patrick Dolan, for his invaluable guidance, leadership, and encouragement throughout the project. We would also like to acknowledge our Research Assistant, Brenna Hezel, for serving as a vital liaison between our team and Dr. Dolan, and for helping streamline the research process. Finally, we thank our peers and colleagues for their thoughtful feedback, motivation, and collaboration. This achievement would not have been possible without each and every one of you.

REFERENCES

1. Campbell S. Theory and Practice in Plato's Psychology of Mathematics Education. https://www.exeter.ac.uk/research/groups/education/pmej/pome18/s_campbell_theory_and_practice_in_plato.htm.
2. Ayres A. 2019. Cognitive Revolution in Psychology - Video & Lesson Transcript Studycom. https://study.com/academy/lesson/cognitive-revolution-in-psychology.html.
3. Ulric Neisser. 1967. Cognitive Psychology. New York: Appleton-Century-Crofts.
4. Pohl, R.F. (Ed.). (2004). Cognitive Illusions: A Handbook on Fallacies and Biases in Thinking, Judgement and Memory (1st ed.). Psychology Press. https://doi.org/10.4324/9780203720615
5. Gauen C. 2023 Feb 17. How Your Mind Plays Tricks on You. The Source. https://source.washu.edu/2023/02/how-your-mind-plays-tricks-on-you/.
6. Mondloch T. 2022 Nov 23. White Eyes, Huge Lies: the Pitfalls of Cross-Race Eyewitness Identification. Race & Social Justice Review. https://race-and-social-justice-review.law.miami.edu/white-eyes-huge-lies-the-pitfalls-of-cross-race-eyewitness-identification/.
7. Eysenck HJ, Eysenck SGB. 1965. The Eysenck Personality Inventory. British Journal of Educational Studies. 14(1):140. doi:https://doi.org/10.2307/3119050.
8. Tiippana K. 2014. What Is the McGurk Effect? Frontiers in Psychology. 5(725). doi:https://doi.org/10.3389/fpsyg.2014.00725. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4091305/.
9. Payne L. 2023 Sep 7. McGurk Effect | Definition, Examples, & Applications | Britannica. wwwbritannicacom. https://www.britannica.com/science/McGurk-effect.
10. Giorgio Gronchi, Righi S, Gavazzi G, Giganti F, Maria Pia Viggiano. 2023. Intuitive Thinking Predicts False Memory Formation Due to a Decrease in Inhibitory Efficiency. Frontiers in Psychology. 14. doi:https://doi.org/10.3389/fpsyg.2023.1195668.
11. Pardilla-Delgado E, Payne JD. 2017. The Deese-Roediger-McDermott (DRM) Task: a Simple Cognitive Paradigm to Investigate False Memories in the Laboratory. Journal of Visualized Experiments. 119(119). doi:https://doi.org/10.3791/54793. https://pmc.ncbi.nlm.nih.gov/articles/PMC5407674/.
12. Goolkasian P, Woodberry C. 2010. Priming Effects with Ambiguous Figures. Attention, Perception, & Psychophysics. 72(1):168–178. doi:https://doi.org/10.3758/app.72.1.168.
13. Brugger P, Brugger S. 1993. The Easter Bunny in October: Is It Disguised as a Duck? Perceptual and Motor Skills. 76(2):577–8. doi:https://doi.org/10.2466/pms.1993.76.2.577. https://www.ncbi.nlm.nih.gov/pubmed/8483671.
14. Levin DT, Simons DJ. 1997. Failure to Detect Changes to Attended Objects in Motion Pictures. Psychonomic Bulletin & Review. 4(4):501–506. doi:https://doi.org/10.3758/bf03214339.
15. Rensink RA, O'Regan JK, Clark JJ. 1997. To See or Not to See: the Need for Attention to Perceive Changes in Scenes. Psychological Science. 8(5):368–373. doi:https://doi.org/10.1111/j.1467-9280.1997.tb00427.x. https://journals.sagepub.com/doi/10.1111/j.1467-9280.1997.tb00427.x.
16. Speckmann F, Unkelbach C. 2020 Dec 21. Moses, Money, and Multiple-choice: the Moses Illusion in a Multiple-choice Format with High Incentives. Memory & Cognition. doi:https://doi.org/10.3758/s13421-020-01128-z.

17. Park, H., & Reder, L. (1981). Moses Illusion - Heekyeong Park and Lynne M. Reder. https://www.andrew.cmu.edu/user/reder/publications/04Park_Reder_Moses.pdf
18. Shepard, R. N. (1990). Mind sights: Original visual illusions, ambiguities, and other anomalies, with a commentary on the play of mind in perception and art. W H Freeman/Times Books/ Henry Holt & Co.
19. Tyler CW. (2011). Paradoxical Perception of Surfaces in the Shepard Tabletop Illusion. i-Perception. 2(2):137–141. doi:https://doi.org/10.1068/i0422
20. Huang H. 2019 Jun 28. What's the Neuroscience behind the Bouba/Kiki Effect? NBB in Paris. https://scholarblogs.emory.edu/nbbparis/2019/06/28/whats-the-neuroscience-behind-the-bouba-kiki-effect/.
21. Ćwiek A, Fuchs S, Draxler C, Asu EL, Dediu D, Hiovain K, Kawahara S, Koutalidis S, Krifka M, Lippus P, et al. 2021. The bouba/kiki effect is robust across cultures and writing systems. Philosophical Transactions of the Royal Society B: Biological Sciences. 377(1841). doi:https://doi.org/10.1098/rstb.2020.0390. https://royalsocietypublishing.org/doi/full/10.1098/rstb.2020.0390.
22. Tversky A, Kahneman D. 1974. Judgment under Uncertainty: Heuristics and Biases. Science. 185(4157):1124–1131. doi:https://doi.org/10.1126/science.185.4157.1124.
23. Furnham A, Boo HC. 2011. A Literature Review of the Anchoring Effect. The Journal of Socio-Economics. 40(1):35–42. doi:https://doi.org/10.1016/j.socec.2010.10.008.
24. Huber J., Payne J.W., Puto C. (1982) Adding Asymmetrically Dominated Alternatives: Violations of Regularity and the Similarity Hypothesis. The Journal of Consumer Research, http://people.duke.edu/~jch8/bio/Papers/Huber%20Payne%20Puto%201982%20JoCR.pdf
25. Radova K. 2022 May 6. The Decoy Effect - Everything You Need to Know. InsideBE. https://insidebe.com/articles/the-decoy-effect/.
26. Naive Physics: an Essay in Ontology. 2025. Buffaloedu. https://ontology.buffalo.edu/smith/articles/naivephysics.html.
27. McCloskey M. (1982). Naive theories of motion. Washington (DC): National Institute of Education, National Science Foundation. 53 p. Report No.: SE 039 483.
28. Kruger J. 1999. Lake Wobegon Be Gone! the "Below-Average Effect" and the Egocentric Nature of Comparative Ability Judgments.. Journal of Personality and Social Psychology. 77(2):221–232. doi:https://doi.org/10.1037/0022-3514.77.2.221.
29. Pilat D, Krastev S. 2023. Dunning–Kruger Effect - Biases & Heuristics. The Decision Lab. https://thedecisionlab.com/biases/dunning-kruger-effect.
30. Forer, B. R. (1949). The Fallacy of Personal Validation: A Classroom Demonstration of Gullibility. The Journal of Abnormal and Social Psychology, 44(1), 118–123.
31. The Barnum Effect (n.d.). https://psych.fullerton.edu/mbirnbaum/psych101/barnum_demo.htm
32. Kolb B, Forgie M, Gibb R, Gorny G, Rowntree S. 1998. Age, Experience and the Changing Brain. Neuroscience & Biobehavioral Reviews. 22(2):143–159. doi:https://doi.org/10.1016/s0149-7634(97)00008-0.
33. Zaidi ZF. 2010. Gender Differences in Human Brain: A Review. The Open Anatomy Journal. 2(1877-6094):37–55. doi:https://doi.org/10.2174/1877609401002010037.

Appendix:

I. *Consent Form:*

Welcome to the Personality Survey!

This survey is designed to determine the personality types of Governor's School students in a manner that provides unique insight into the thinking and decision making used in their cognitive processes. Many of these questions may seem simple or basic; however, in most cases, we are testing both accuracy and reaction time, so please work as quickly as possible without sacrificing accuracy. Please keep your eyes on your screen and your headphones in at all times to eliminate potential distractions. Your overall time for the survey, as well as timings for certain individual question sets, will be recorded.

The survey should take approximately 15-20 minutes and involves simple questions intended to assess the most common personality characteristics. If at any point during the test, should you wish to discontinue participation, you may do so without penalty. All answers you provide are completely anonymous. Please refrain from discussing your results. Your decision to participate is entirely voluntary. By pressing "continue," you are hereby agreeing to these conditions and providing consent. Thank you!

II. *Personality Questions:*

List of personality questions throughout survey:

Does your mood often fluctuate?
Do you always practice what you preach?
Are you a talkative person?
Are you good with money?
Would being in debt worry you?
Can you get a party going?
Would you take drugs which may have strange or dangerous effects?
As a child, were you ever bratty to your parents?
Do other people think of you as being very lively?
Do you sometimes put off until tomorrow what you ought to do today?
Do you think marriage is old-fashioned and should be done away with?
Do you think people spend too much time safeguarding their future with savings and insurance?
Have you ever taken anything that belonged to someone else?
What type of learner do you consider yourself? (Check all that apply.)

- Choices: Auditory, Visual, Kinesthetic

Have you ever broken or lost something that belonged to someone else?
Have you ever taken advantage of someone?
Are you a worrier?
Were you ever greedy by helping yourself to more than your fair share of something?
If you say you will do something, do you always keep your promise no matter how inconvenient it might be?

How often do you go to the movies?
What is your favorite movie genre?
Which area of science is your favorite?
Are you an irritable person?
Have you ever said something bad or nasty about anyone?
Have you ever blamed someone for doing something you knew was really your fault?
Do you enjoy meeting new people?
Are all your habits good and desirable?
Do you like plenty of bustle and excitement around you?
Have you ever cheated at a game?
Are your feelings easily hurt?
Do good manners and cleanliness matter much to you?

III. *McGurk Illusion:*

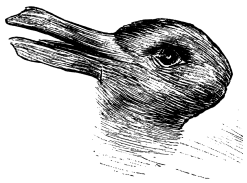
Link to Demonstration: https://www.youtube.com/watch?v=2k8fHR9jKVM

IV. *DRM/False Memory:*

List of semantically related words:

Nurse
Sick
Lawyer
Medicine
Health
Hospital
Dentist
Physician
Ill
Patient
Office
Stethoscope
Surgeon
Clinic
Cure

V. *Priming Pictures:*





VI. *Change Blindness:*

Link to video: https://www.youtube.com/watch?v=16vqQe9dnqg&t=3s

Q1A: “Please watch the video. This video has several intentional editing mistakes. Pay attention to any changes you may notice.”

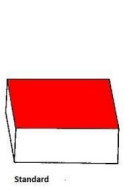
Q1B: “Please watch the video.”

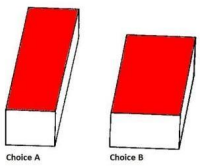
Q2: With which character do you sympathize?

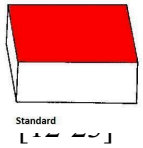
- Woman with short hair
- Woman with ponytail

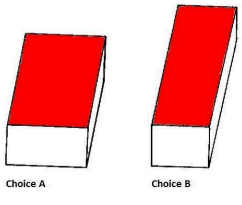
Q3: Did you notice anything unusual about the video you just watched? If yes, what did you notice?

VII. *Shepard Table Top Illusion:*



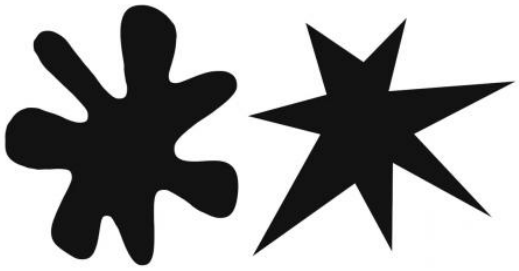






Q: Select the table with the same shaded dimension (area in red) as the standard. A is the correct answer

VIII. *Kiki / Bouba:*



IX. *Anchoring:*

Gandhi Questions:

"Was Mahatma Gandhi older or younger than 9 years when he died?"
"Was Mahatma Gandhi older or younger than 140 years when he died?"

Tanzania Questions:

"Is the mean temperature in Tanzania higher or lower than 51℉?"
"Is the mean temperature in Tanzania higher or lower than 106℉?"

X. *Decoy:*

If you were purchasing your favorite drink at the movie theater, which size would you choose?

If you were purchasing your favorite drink at the movie theater, which size would you choose?

XI. *Naive Physics:*

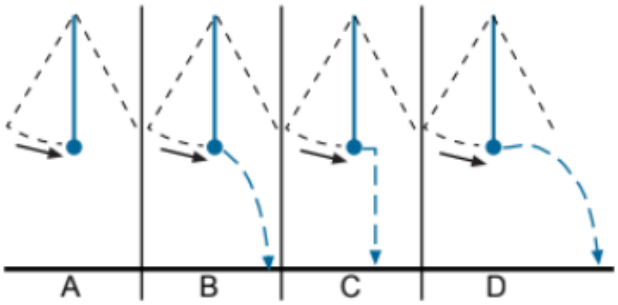


Fig. 13.8. Diagram for the pendulum problem (A) with the correct response (B) and two incorrect responses (C and D).

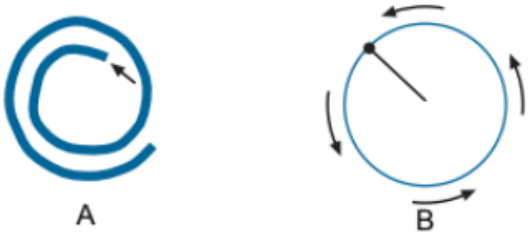
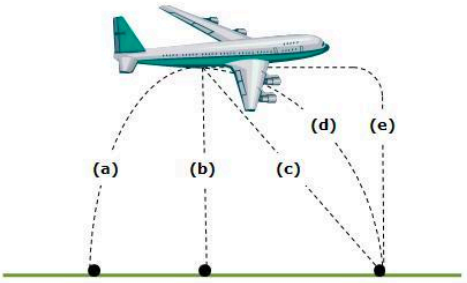


Fig. 13.1. Diagrams for the spiral tube problem (A) and the ball and string problem (B).

XII. *Plane Illusion:*



In the diagram above, the plane is flying horizontally to the right at a constant altitude and a constant speed. If a ball is dropped from the indicated point of origin, which path do you think the ball will follow once dropped from the plane? Select the letter that corresponds to your answer.

XIII. *Illusory Superiority Effect:*

List of skills related to a GSNJS Scholar:

"Ability to understand issues"
"Ability to work independently"
"Ability to work with a research team"
"Compassion for other people"
"Creativity"
"Critical thinking"
"Discussion participation"
"Knowledge about science"
"Leadership"
"Motivation to achieve"
"Communication"
"Skills in mathematics"
"Statistics"
"Reading comprehension"

XIV. *Forer Effect:*

Personality Description Paragraph:

"You have a need for other people to like and admire you, and yet you tend to be critical of yourself. While you have some personality weaknesses, you are able to compensate for them with your strengths. You have considerable unused capacity that you have not turned to your advantage. Disciplined and self-controlled on the outside, you tend to be worrisome and insecure on the inside. At times you have serious doubts as to whether you have made the right decision or done the right thing. You prefer a certain amount of change and variety and become dissatisfied when hemmed in by restrictions and limitations. You also pride yourself as an independent thinker; and do not accept others' statements without satisfactory proof. But you have found it unwise to be too frank in revealing yourself to others. At times you are extroverted, affable, and sociable, while at other times you are introverted, wary, and reserved. Some of your aspirations may seem unrealistic but you have a strong motivation and drive."