NO: 56

23 May 2021

JoSS
JOY OF SHARING SCIENCE

An Independent Initiative of Uskudar American Academy Volunteer Students

Editor: Güney Baver Gürbüz

The Joy of Sharing Science is a weekly newspaper that explores the physics/biology/chemistry/computer science behind interesting real-life phenomena in a concise and easily understandable way. Each week, 4 phenomena concerning physics, biology, chemistry, and computer science will be published. The aim of this project is to explore the science hidden in plain sight, evoke curiosity, and elevate scientific literacy.

Advisor: Yasemin Sarıhan, Head of Science Department UAA
Editor: Güney Baver Gürbüz, *Junior Student*
Issue Authors:

Özge Dinç	*Junior Student*
Deniz Cenikli	Sophomore *Student*
Ada Zağyapan	*Sophomore Student*

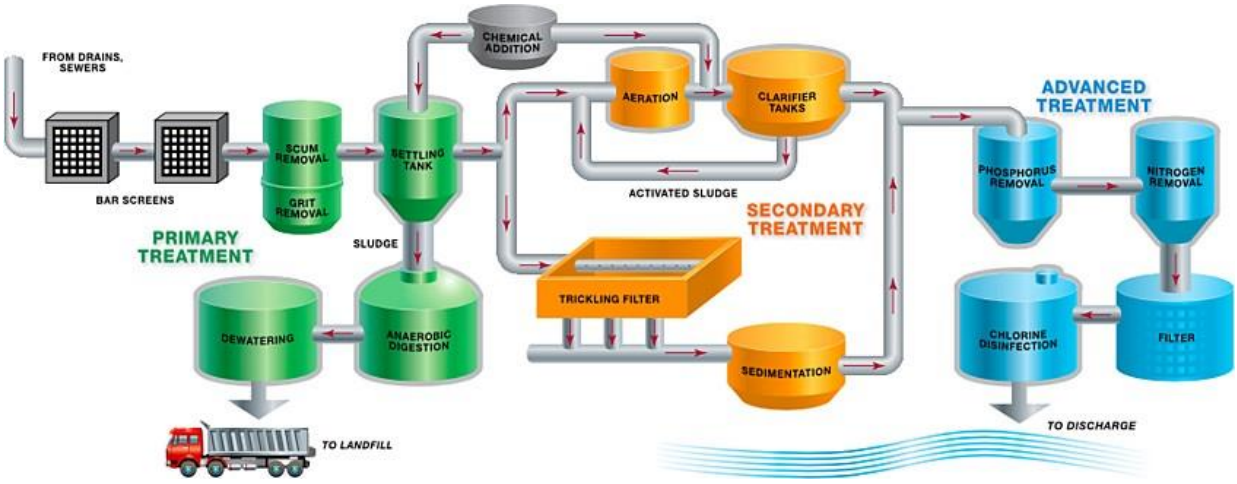
From the Editor:

In this issue, our topics range from Usage of Chlorine in daily life and Titration to the Effects of Genes on Behavior.

To start with, our biology author Deniz Cenikli will mention Chlorine in daily life from a broad perspective and its side effects. After her, Ada Zağyapan will explain the effects and impacts on genes on human behavior as well as the common misconception about the genes. Moving on with Chemistry, our author Özge Dinç will briefly introduce you Titration, its essence and effects on various industries

To our dear audience, I hope that you will have lots of fun while reading JoSS and learn new phenomenal and interesting concepts. Don't forget that science is the process that takes us from confusion to understanding. On that matter, JoSS will always be here for you to help.

Chlorine In Daily Life and Its Side Effects



Deniz Cenikli

Chlorine (Cl_2) is a greenish-yellow gas at room temperature ("Chlorine"). It is the seventeenth element that is located in the third period and the seventeenth group of the periodic table ("Chlorine"). Since it is a group seventeen element, it is a halogen meaning that it produces salt in a reaction with metals. Not only can it produce ionic compounds, but it can also share an electron with other non-metals and form covalent compounds ("Properties and Uses of the Halogens - Group 7 Halogens - GCSE Chemistry Single Science Revision - WJEC - BBC Bitesize"). Additionally, as a result of having seven valence electrons, chlorine is one of the most reactive non-metals as it needs only one electron to have a full octet, in other words, to be stable. Because of the high rate of reactivity, as it is common in all halogens, chlorine is most likely to be found combined with other elements including itself in nature (Helmenstine). In other words, it is a diatomic element. Although its side effects on human health are caused by some of these properties, they make its utilization in numerous areas in daily life possible.

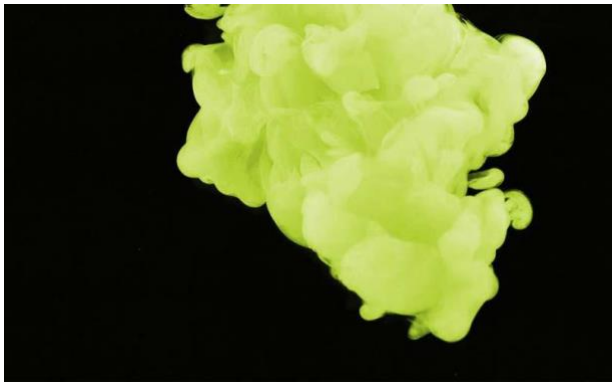


Figure 1: Chlorine as a gas

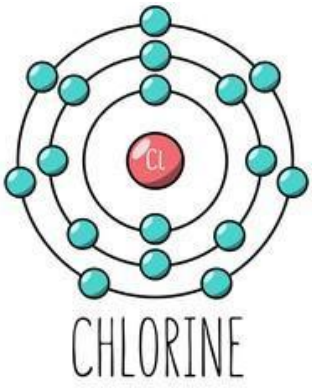


Figure 2: Chlorine's atomic structure

To begin with, chlorine is involved in various areas of human life such as in antiseptics, wastewater treatment, cleaning products, and some of the industrial sectors. One of the most well-known functions of chlorine is to be a disinfectant in swimming pools ("How Chlorine Keeps Pools Safe for Summertime Fun"). When water is chlorinated meaning that chlorine is added to water, hypochlorous acid is formed. This acid kills bacteria and waterborne microorganisms as well as prevents them from breeding by oxidizing their cellular material, in other words, by breaking the chemical bonds within their cell membranes and proteins (Recalde). This process of oxidation is also beneficial for water treatment in sewage facilities ("Chlorine"). Another commonly known application of chlorine is in cleaning products such as detergents and household bleach. Chlorine bleach is formed as a result of the mixture of water and sodium hypochlorite (Sandoval). Again, as previously explained, chlorine bleach destroys microbes by oxidizing molecules in them. A final utilization of chlorine is seen in the industries of paper, textile, and plastic. Chlorine is used as a whitening tool in paper production since it can remove an organic polymer called lignin that reduces the durability of paper and causes papers to turn yellow ("Chlorine-Free Paper"). Similarly, chlorine's ability to whiten materials owing to its ability to oxidize stains is useful for the textile industry. Not only does it give the color white to cloth, but it also brightens the cloth by reacting with chromophores that control the color of dye in fabrics ("Basis of Colour"). Additionally, in the plastic industry, chlorine is beneficial to the manufacturing of polyvinyl chloride (PVC) which is a plastic polymer that is used in pipes and window frames ("British Plastics Federation").

Figure 3.1: Uses of Chlorine (bleach)

Figure 3.2: Uses of Chlorine (antiseptic)

Although chlorine has many uses in daily life, it has some negative side effects. Firstly, high exposure to chlorine causes dryness in the skin which might result in skin dryness, and irritant dermatitis since chlorine might be identified as a foreign invader similar to bacteria and viruses by the immune system (“How Can I Still Swim If I'm Allergic to Chlorine or Have a Chlorine Sensitivity?”). Additionally, exposure to chlorine may provoke eye and airway irritation ("The Facts about Chlorine"). Moreover, chloramines that are produced as a result of the contact of chlorine and organic matter such as sweat or urine might cause coughing (“Water Treatment Solutions”). An example of some of these detrimental effects was observed in World War One when chlorine gas was used by Germans in the Battle of Ypres in 1915 (Harkup). Secondly, the ingestion of chlorine dissolved in water may result in corrosive tissue damages, ulcerations, and problems in the gastrointestinal system ("The Facts about Chlorine"). Other damaging side effects of chlorine are chemical burns, diarrhea, and infections in the ear (“Chemical Irritation of the Eyes and Lungs”).

Figure 4: Skin irritation (irritant dermatitis)

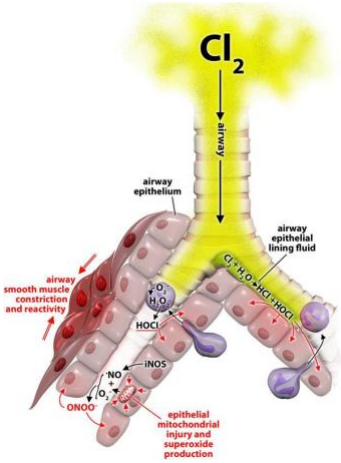


Figure 4: Chlorine effects on airway

In conclusion, from bleaching and cleaning to industrial processes and water treatment, chlorine is used within a wide range in daily life despite its negative impacts on human health such as irritation, intestinal problems, and coughing. Also, there are examples of these negative side effects throughout history. Hence, all precautions should be taken in advance to lower the insanitary impacts of chlorine that is frequently used in daily life.

References:

"Basis of Colour." *Chemistry of Dyes*, http://www.chm.bris.ac.uk/webprojects2002/price/colour.htm. Accessed 21 Nov. 2021.

Bpf. "British Plastics Federation." *Polyvinyl Chloride PVC: Properties, Benefits & Applications*, https://www.bpf.co.uk/plastipedia/polymers/pvc.aspx. Accessed 21 Nov. 2021.

California, State of. "Chlorine-Free Paper." *Chlorine-Free Paper*, https://www.calrecycle.ca.gov/paper/chlorinefree#:~:text=Chlorine%20is%20used%20to%20give,are%20made%20from%20unbleached%20paper. Accessed 21 Nov. 2021.

"Chemical Irritation of the Eyes and Lungs." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 15 May 2019, https://www.cdc.gov/healthywater/swimming/swimmers/rwi/chemical-irritants.html. Accessed 21 Nov. 2021.

"Chlorine." *Centers for Disease Control and Prevention*, 26 June 2018, https://www.cdc.gov/niosh/topics/chlorine/default.html. Accessed 21 Nov. 2021.

"Chlorine." *National Center for Biotechnology Information. PubChem Compound Database*, U.S. National Library of Medicine, https://pubchem.ncbi.nlm.nih.gov/element/Chlorine#section=InChI. Accessed 21 Nov. 2021.

"Gas in the Great War." *Gas in The Great War*, https://www.kumc.edu/school-of-medicine/academics/departments/history-and-philosophy-of-medicine/archives/wwi/essays/medicine/gas-in-the-great-war.html. Accessed 21 Nov. 2021.

Harkup, Kathryn. "Chlorine: The Gas of War Crimes." *The Guardian*, 16 Sept. 2016, www.theguardian.com/science/blog/2016/sep/16/chlorine-the-gas-of-war-crimes. Accessed 21 Nov. 2021.

Helmenstine, Todd. "Chlorine Facts." *Science Notes*, 31 May 2015, https://sciencenotes.org/chlorine-facts/. Accessed 19 Nov. 2021.

"How Can I Still Swim If I'm Allergic to Chlorine or Have a Chlorine Sensitivity?" *U.S. Masters Swimming*, https://www.usms.org/fitness-and-training/articles-and-videos/articles/how-can-i-still-swim-if-im-allergic-to-chlorine-or-have-a-chlorine-sensitivity. Accessed 21 Nov. 2021.

"How Chlorine Keeps Pools Safe for Summertime Fun." *ChemicalSafetyFacts.org*, 21 Aug. 2020, https://www.chemicalsafetyfacts.org/chlorine-keeps-pools-safe-summertime-fun/. Accessed 21 Nov. 2021.

"How Does Bleach Work?" *Wonderopolis*, https://wonderopolis.org/wonder/how-does-bleach-work. Accessed 21 Nov. 2021.

Lesson 12: Chlorination and Dechlorination, https://water.mecc.edu/courses/ENV149/lesson12_print.htm. Accessed 21 Nov. 2021.

Margie Recalde, OD. "Hypochlorous Acid: Harnessing Nature's Germ Killer." *Optometry Times*, Optometry Times, 15 Nov. 2020, https://www.optometrytimes.com/view/hypochlorous-acid-harnessing-natures-germ-killer Accessed 21 Nov. 2021.

Nall, Rachel. "Chlorine Rash: Treatment and Prevention." *Healthline*, Healthline Media, 8 Mar. 2019, https://www.healthline.com/health/chlorine-rash#causes. Accessed 21 Nov. 2021.

"Properties and Uses of the Halogens - Group 7 Halogens - GCSE Chemistry (Single Science) Revision - WJEC - BBC Bitesize." *BBC News*, BBC, https://www.bbc.co.uk/bitesize/guides/zfqny4j/revision/2. Accessed 21 Nov. 2021.

Sandoval, Melissa. "How Bleach Works." *HowStuffWorks*, HowStuffWorks, 24 Nov. 2009, https://home.howstuffworks.com/bleach.htm. Accessed 21 Nov. 2021.

"The Facts about Chlorine." *New York State Department of Health*, 5 Aug. 2004, www.health.ny.gov/environmental/emergency/chemical_terrorism/chlorine_tech.htm. Accessed 21 Nov. 2021.

"Uses, Benefits, and Safety of Chlorine." *Chemical Safety Facts*, https://www.chemicalsafetyfacts.org/chlorine/. Accessed 19 Nov. 2021.

"Using Bleach in Laundry." *The American Cleaning Institute (ACI)*, https://www.cleaninginstitute.org/cleaning-tips/clothes/detergents/using-bleach-laundry. Accessed 21 Nov. 2021.

"Water Treatment Solutions." *Lenntech Water Treatment & Purification*, https://www.lenntech.com/processes/disinfection/chemical/disinfectants-chlorine.htm. Accessed 21 Nov. 202

Essence and Applications of Titration in Industries

Özge Dinç

Titration is a necessary process across a swath of industries. Given the scale of titration in industry, knowing what is at the chemistry level is an important aspect.

Titration is the name for a programmed reaction meant to determine the concentration of a solution with a known composition. A solution called a titrant (one reactant) with a precisely known composition and concentration is slowly added to the solution of unknown concentration (called the analyte).

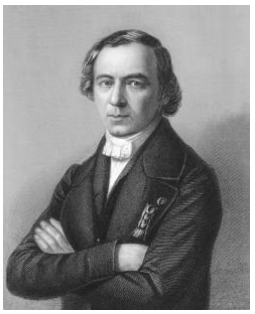
The key is also knowing how the molecules forming the respective solutions interact in terms of their molar ratios. For example, in the titration of a known volume of acetic acid of unknown concentration with sodium hydroxide (shown below only as of the hydroxide ion OH^-), water and acetate ion is gradually formed:

$CH_3CO_2H + OH^- \longrightarrow CH_3CO_2^- + H_2O$

If you know the concentration of sodium hydroxide added, you can determine the number of moles of acid consumed in a series of involved but straightforward calcul

In titrations, usually, an indicator is used to usually signal the endpoint of the titration, indicating that the amount of titrant balances the amount of analyte present, according to the reaction between the two.

History of Titration:



The first method of volumetric analysis was devised and found by the French chemist Jean Baptiste Andre Dumas as he was trying to determine the proportion of nitrogen combined with other elements in the organic compounds.

Applications in the Industry

Nowadays, due to the increase in demand, the classical method of titration in the industrial sector has been replaced by auto-titrators, i.e., machines that progressively feed in the titrant and measure whatever property is used to determine the endpoint. That enables a variety of industries to have titration in their process.

1. **Food Industry:**

Making delicious food is undoubtedly a complex task, which comes with a long list of regulations to which the food and beverage industries are strictly subjected. These regulations are fairly reasonable as contaminated food products can cause serious problems to both consumers and producers. Titration is frequently used in the food industry to keep the acid, base, and salt content in the food products under supervision.

2. **Cosmetic Industry:**

The 21st-century cosmetic industry is worth $200 billion in business around the world, and like many other chemical products of our daily use, this industry also depends on titration to a great extent for the quality of their products. Since the product is to be used by the consumer directly on their skin, cosmetic industries need to make sure that the product should not cause any harm to the consumers. Titration facilitates the appropriate concentration and amount of ingredients used in the manufacturing of cosmetic products.
Hair dyes, skin creams, shampoos, conditioners, cleansers, and shaving creams all

contain some mixtures of acids and bases. For instance, bases like ammonium hydroxide are often used to adjust the pH in these products via titration. Commercially available depilatory creams are of great concern to both the producers and end consumers as they act by entering deep into the skin surface and are most likely to cause allergic reactions such as rashes and bleeding burns. A little misjudgment in the amounts of caustic chemicals can become a major problem, and it can cause the companies to lose millions of dollars in lawsuits.

3. **Wine Industry:**

From vineyards to glass, the process of making wine includes series of chemical reactions and process that guarantees the elegant taste, color, and texture of the wine. For winemakers, the quality of the wine is of paramount importance. Mastering the art of making an exceptional wine comes with the science of titration. For instance, it is essential to measure the concentration of several acids such as tartaric, malic, or citric acid because the acid content impacts the taste, color, and microbial stability of the grape juice from which the wine is to be made. In the wine industry, these acidic concentrations are known by the term "titratable acidity." The process includes titrating degassed wine with NaOH solution at different paces until the endpoint of 8.2 pH is reached. Another most important step in making wine is to evaluate and control the levels of sulfur dioxide content in the wine. Sulfur dioxide is used as a microbial agent to control the spoilage of wine by destroying bacteria that may cause unwanted secondary fermentation, both during the vintage and winemaking and also during the storage. It also acts as an antioxidant preserving the color of the wine.
Sulfur dioxide in wine is traditionally analyzed by Ripper titration using a color indicator Although advanced techniques such as gas chromatography or liquid chromatography are usually available to most wineries for practical reasons, titration is critical to ensure the consistency of the product quality.

4. **Pharmaceutical Industry:**

Like many other branches of chemistry, titration has long been a standard method of analysis in the pharmaceutical industry. It facilitates the content determination of active ingredients and raw materials for drug manufacturing. From the formulation of a drug to its production, the role of volumetric analysis can be categorized primarily in four different processes as follow:

Purity Analysis of Pharmaceutically Active Ingredients: Titration is used to determine the content of active ingredients in pharmaceutical products, e.g. acetylsalicylic acid in Aspirin, or vitamin C in multivitamins tablets, and for the content determination and purity control of drug additives used for the synthesis of medicinal compounds.

Content Analysis by Redox Titrations: Oxidation-reduction (redox) titrations are also used for checking the purity of raw materials, fillers, and preservatives. A good example of this is the bromatometric determination of methyl- 4-benzoate, a p-hydroxybenzoic acid ester. This compound is used as a preservative in ophthalmic preparations and ointments for external application.

Precipitation Titrations: Based on their structure, some active ingredients precipitate with a suitable titrant to form consumable medication. Examples of this are benzalkonium chloride and clotrimazole.

pH-Stat Titrations: The pH-stat titration is performed to characterize drugs, to check the purity of enzyme products, and to investigate the kinetics of chemical reactions. pH-stat means the stationary pH value, i.e. the pH value is held constant for a certain period of time.

5. **Biodiesel Manufacturing:**

With the increase in population and consequent environmental concerns, the demand for renewable resources of energy is also growing day by day. Biodiesel, also known as green diesel, is one of the highly invested alternatives for conventional fuel. It is a form of diesel fuel typically made by reacting lipids such as animal fats, plant extracts, or vegetable oils with an alcohol producing a methyl, ethyl, or propyl ester. The amount of catalyst required to speed up the formation depends on the Free Fatty Acid (FFA) content of the lipids can be determined by using a simple titration method. If the FFA content comes out to be less than one percent, a base catalyst reaction is performed, whereas if the FFA content is more than 1 percent, the acid catalyst is used in the reaction.

All in all, Titration, also known as titrimetry, is a form of quantitative analysis that allows chemists to determine unknown concentrations of the particular reagents present in a sample. Its practicality is very essential for a variety of industries in manufacturing and other applications.

References:

Akshit. “Titration Uses in Real Life.” *StudiousGuy*, StudiousGuy, 11 July 2021, https://studiousguy.com/titration-uses/.

Beck, Kevin. “Where Is Titration Used in Industry?” *Sciencing*, 9 Mar. 2020, https://sciencing.com/list-5772040-titration-used-industry-.html.

“Jean-Baptiste Dumas.” *Download Million Images for Free,* https://stringfixer.com/tr/Jean-Baptiste_Dumas.

“Titrating with Bottle-Top Burettes.” *BRAND*, https://www.brand.de/en/applications/titration.

The Effect of Genes on Behavior

Ada Zağyapan

Does human behavior have genetic components? Genetics' influence on human behavior is an intriguing yet controversial topic. Due to ethical and legal issues, controlled experiments on human behavior are difficult to keep up. Nevertheless, the proof for genetic components in psychology is profound. Behavior is the combined product of heredity and environment, and differences in behavior are apportioned between these two factors. Therefore, behavior definitely has heritable components. However, to what extent does genetics affect human psychology and behavior?

A Misconception

Contrary to a common misconception, genes do not cause behavioral characteristics; they only influence them. Although genes may be associated with

specific characteristics, a single gene cannot be entirely chargeable for the foremost complicated behavior. Each gene isn't linked to only one trait; one gene may influence many personality features.

Nevertheless, human behavior still highly depends on genes. A single gene can have significant repercussions on manners. A typical cell expresses approximately 10,000 different gene products. Therefore, if the outcome of a single gene is expressed differently because of a genetic alteration, there will be some serious ramifications: Many cells will be affected and consequences for the organism will range from slightly altered performance to lethality.

Some Examples of Genes' Effect on Behaviors

An example of gene influence on behavior would be the oxytocin (OXT) and vasopressin (AVP) pathway genes. Oxytocin is a hormone and neurotransmitter involved in childbirth and breast-feeding. Vasopressin is a peptide hormone formed within the hypothalamus. OXT and AVP are genes that provide instructions for making oxytocin and vasopressin hormones. These hormones arbitrate communal manners in mammals, including humans. They certain behavior, especially regarding dysfunctions in the social brain such as autism that are marked by deficiencies in social communication and skills. They play a key role in social and commutive behaviors; which are two aspects highly effective in Autism Spectrum Disorder (ASD). Furthermore, variants in the adjacent oxytocin-vasopressin gene regions have been found to be associated with ASD diagnosis.

Another typical example of the effect of genes -specifically, gene mutations- on psychology is Huntington's disease. Huntington's disease is a gradual brain dysfunction that causes uncontrolled movements, emotional issues, and cognition loss. Its cause is mutations in the HTT gene, which supplies commands to produce a protein called huntingtin. People with Huntington's disease experience physical alterations regarding a loss of movement control as well as cognitive and behavioral issues. The behavioral changes often include indifference characterized with a loss of motivation

to start or finish activities. It is a dominant disease, which means someone who inherits it from a parent has more than a 50% chance to eventually develop the disease.

Huntington's disease causes the impairment and death of cells in various areas of the brain. Because each area links to one or various of behaviors, deterioration in an area leads to changes in the behavior it regulates.

A brain region, called the caudate nucleus, is where some of the most intense neurological damage occurs with Huntington's disease. The caudate nucleus is like an information processing center of the brain. It regulates and organizes information it receives from other parts of the brain, and then sends that information to the frontal lobes, which regulate various cognitive functions.

The disrupted information flow from the caudate nucleus to the frontal lobes may make it difficult for people with Huntington's disease to organize or prioritize activities or to multi-task. Damage to the caudate may also damage a patient's ability to control their feelings as well as movement, resulting in outbursts over seemingly minor events.

All these behavioral disruptions and alterations in the brain are due to genetics and the fact that whether a person has inherited Huntington's or not. Therefore, genes play a significant role in diseases like Huntington's disease as well.

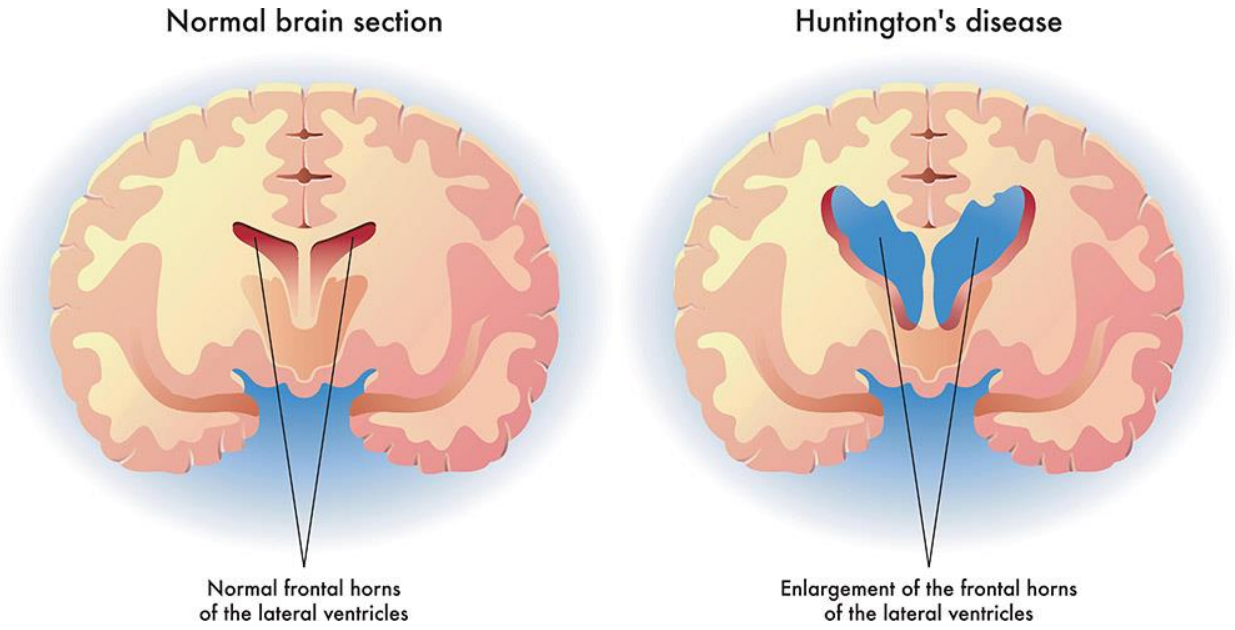


Image 1: The brains of people who have and don't have Huntington's disease.

What Is The Correlation? The IMAGEN Study Helps

Looking at these factors and diseases, can an accurate correlation between psychology and genetics be provided? The IMAGEN study offers excellent help. Imaging genetics offers the possibility of detecting associations between genotype and brain structure as well as function, with effect sizes gradually increasing correlations between genotype and human behavior. However, study results are often limited due to small sample sizes and methodological differences, reducing the reliability of findings.

The IMAGEN cohort with 2000 young adolescents assessed from the age of 14 onwards tries to eliminate some of these limitations by offering a longitudinal approach and sufficient sample size for analyzing gene-environment interactions on brain structure and function. It aims to support imaging genetics with adolescents, which offers the opportunity to determine associations between an individual's genotype and brain structure/function, explicating associations between genotype and behavior. Although study results aren't often sufficient due to small sample sizes and methodological differences, it is an extremely well-characterized study, which has helped explain neurobiological systems on complex behavior and offers the possibility to elucidate genotype-phenotype and genotype-behavior interactions.

Image 2: The display of the IMAGEN project.

In summary, human behavior is exceptionally dependent on hereditary factors. Only one simple gene can yield severe consequences in human behavior. However, genes don't cause psychological traits; they influence them by being combined with environmental factors. There are many daily-life examples of genes' impact on psychology; and hopefully, the correlation between genetics and behavior will be clarified with the help of genetic and psychological research.

References:

Ebstein, Richard P., et al. “The Contributions of Oxytocin and Vasopressin Pathway Genes to Human Behavior.” Hormones and Behavior, vol. 61, no. 3, 2012, pp. 359–379., doi:10.1016/j.yhbeh.2011.12.014.

“Genetic Influences on Behavior - IResearchNet.” Psychology, 25 Oct. 2017, psychology.iresearchnet.com/social-psychology/personality/genetic-influences-on-behavior.

Goodman, Elaine. “HD Symptoms – Behavioral Changes.” Huntington's Disease News, 1 May 2018, huntingtonsdiseasenews.com/hd-symptoms-behavioral-changes.

“Huntington Disease: MedlinePlus Genetics.” MedlinePlus, U.S. National Library of Medicine, 18 Aug. 2020, medlineplus.gov/genetics/condition/huntington-disease/.

Maričić, Lea Mascarell, et al. “The IMAGEN Study: a Decade of Imaging Genetics in Adolescents.” Molecular Psychiatry, vol. 25, no. 11, 2020, pp. 2648–2671., doi:10.1038/s41380-020-0822-5.

“Oxytocin: The Love Hormone?” Medical News Today, MediLexicon International, www.medicalnewstoday.com/articles/275795#the_love_hormone/.

“Vasopressin (Antidiuretic Hormone).” Image for Cardiovascular Physiology Concepts, Richard E Klabunde PhD, www.cvphysiology.com/BloodPressure/BP016#:~:text=Vasopressin.

Wine, Jeff. Genes and Behavior, web.stanford.edu/~wine/202/g-and-b.html#human/.

Figure References:

[Cover] “Can Genetics Explain Human Behavior?” The Scientist Magazine®, www.the-scientist.com/reading-frames/can-genetics-explain-human-behavior--66318.

[1] “Huntington's Disease.” Healthdirect, Healthdirect Australia, www.healthdirect.gov.au/huntingtons-disease.

[2] “International Collaboration.” IMAGEN, imagen-europe.com/how-youve-helped/international-collaboration/.