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LESSON:

Tracing the Origins of Autism: A Spectrum of New Studies

Summary: Students learn about the scientific process and differentiate two common types of epidemiological studies, case–control and cohort. Then they identify advantages and disadvantages of each study type with respect to learning about autistic spectrum disorders (ASDs).

Lesson Type: This lesson uses in-depth information from the *EHP* Focus article.

***EHP* Article:** "Tracing the Origins of Autism: A Spectrum of New Studies"
EHP Student Edition, October 2006, p. A412–A418
http://www.ehponline.org/members/2006/114-7/focus.html

Objectives: By the end of this lesson, students should be able to

1. describe why multiple types of studies are used in science;
2. define a case–control study;
3. define a cohort study;
4. identify advantages and disadvantages to case–control and cohort studies; and
5. estimate the potential number of autism cases in a cohort study with 100,000 babies.

Class Time: 1.5–2 hours, less if reading is assigned as homework

Grade Level: 10–12

Subjects Addressed: General Science, Health, Environmental Health, Biology

Prepping the Lesson (15 minutes)

INSTRUCTIONS:

1. Download the entire October 2006 *EHP Student Edition* at http://www.ehponline.org/science-ed/, or download just the article "Tracing the Origins of Autism: A Spectrum of New Studies" at http://www.ehponline.org/members/2006/114-7/focus.html.
2. Review the Background Information, Instructions, and Student Instructions.
3. Make copies of the Student Instructions.

MATERIALS (per student):

- 1 copy of *EHP Student Edition,* October 2006, or 1 copy of "Tracing the Origins of Autism: A Spectrum of New Studies"
- 1 copy of the Student Instructions

VOCABULARY:

- autism spectrum disorder (ASD)
- biomarker
- case–control study
- cohort study
- control group
- epidemiological study
- epidemiology
- environmental factor
- environmental trigger
- epigenetic factor
- etiology
- genetic factor

- genetic predisposition
- genomics
- heterogeneous
- phenotypic profile
- prenatal

BACKGROUND INFORMATION:

As described in the article associated with this lesson, autism spectrum disorders (ASDs) appear to be on the rise and occur in some 30–60 children per 10,000. In fact, ASDs are more common in young pediatric populations than diabetes, spinal bifida, and Down syndrome, according to the National Institute of Mental Health (http://www.nimh.nih.gov/publicat/autism.cfm).

There are currently five ASDs, all of which have similar symptoms but range in their severity. Autism (more severe) and Asperger syndrome (milder) are the two most common ASDs. Symptoms of ASDs include:

- impairment of communication skills, such as reduced, impaired, or lack of language use. The tone of voice does not reflect what the child is saying; the voice can be high-pitched, sing-songy, or flat;
- withdrawal from social interactions or great difficulty socializing;
- repetitive behaviors, such as rocking or repeatedly flapping arms or hands; the child may walk on toes;
- unusual responses to sensory experiences including crying, verbal outbursts, or loss of physical control; the child may be very sensitive to sounds, taste, textures, or smells, and changes in routine can be extremely upsetting;
- an intense preoccupation with numbers, technology, symbols, or science; and
- seizures, in 25% of autistic children.

According to the National Institute of Mental Health, ASDs can be "reliably detected by the age of 3, and in some cases as early as 18 months." Early signs may actually appear in infants. For example, parents have reported symptoms such as their infant intensely focusing on one object for a long period of time, or appearing unresponsive. ASDs can also appear suddenly in children who seemed to have been developing normally, such as a toddler who talks, babbles, and plays with mom and dad suddenly becoming silent, withdrawn, and even self-abusive. Although ASDs can be reliably diagnosed by the age of 3, it is estimated that 50% of children with ASDs are diagnosed right before kindergarten, long after signs appear.

RESOURCES:

Daniels, JL. 2006. Autism and the environment. Environ Health Perspect 114:A396, http://www.ehponline.org/docs/2006/114-7/editorial.html

Environmental Health Perspectives, Environews by Topic page, http://ehp.niehs.nih.gov. Choose Children's Health, Neurology

[No author]. 2005. NIEHS extramural update: autism and the environment? Environ Health Perspect 113:A405, http://www.ehponline.org/docs/2005/113-6/extram-speaking.html

Hertz-Picciotto I, Croen LA, Hansen R, Jones CR, van de Water J, Pessah IN. 2006. The CHARGE study: an epidemiologic investigation of genetic and environmental facts contributing to autism. Environ Health Perspect 114:1119–1125, http://www.ehponline.org/docs/2006/8483/abstract.html

National Institute of Mental Health, Autism spectrum disorders (pervasive developmental disorders), http://www.nimh.nih.gov/publicat/autism.cfm

Implementing the Lesson

INSTRUCTIONS:

1. Have the students read the article "Tracing the Origins of Autism: A Spectrum of New Studies" individually, in small groups, or as a class. You could also assign the reading as homework. Students could practice taking notes or highlighting important information as they read.
2. Instruct the students to re-read the first five paragraphs of the article and complete Step 2. Discuss and generate a class list of the questions, complications, and unknowns about ASDs.
3. Next, have the students complete the questions in Steps 3 and 4, either individually or in small groups. You may want to instruct the students to focus on the first three sections of the article (the introduction, the CHARGE study, and the ABC study) to answer the questions about case–control and cohort studies. The other studies that are discussed in the article are hybrid case–control–cohort studies that could be discussed as a group once the students clearly understand the difference between case–control and cohort studies.
4. Review and discuss the answers as a class. Be sure to continuously refer to how these studies relate to the scientific process. For example, the case–control and cohort studies fill in the gaps of each study design. Both are needed to help create a whole picture of what is happening with respect to autism.

NOTES & HELPFUL HINTS:

- Depending on your students' reading skill and science experience, you may need to provide additional assistance helping them read the article and identifying the key information. Giving students the answers right away is not recommended. Instead, guide them by asking questions. Eventually they will learn these skills and be able to apply them on their own.
- There are other articles found in this issue that provide more information about ASDs and may be of interest to students. Each article is from a slightly different perspective. One article (EHPnet) describes the six initiatives supported by the CAN (Cure Autism Now) Foundation, and another (NIEHS News) discusses a genetic mutation linked with autism. The articles can be downloaded from the *EHP Student Edition* website at http://www.ehponline.org/science-ed/.

Aligning with Standards

SKILLS USED OR DEVELOPED:

- Classification
- Communication (note-taking, oral, written—including summarization)
- Comprehension (listening, reading)
- Computation
- Critical thinking and response
- Experimentation (design)
- Tables and figures (reading)
- Unit conversions

SPECIFIC CONTENT ADDRESSED:

- Autism spectrum disorders
- Epidemiological studies
- Scientific method

NATIONAL SCIENCE EDUCATION STANDARDS MET:

Science Content Standards

Unifying Concepts and Processes Standard

- Systems, order, and organization
- Evidence, models, and explanation
- Change, constancy, and measurement
- Evolution and equilibrium
- Form and function

Science as Inquiry Standard

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Life Science Standard

- Molecular basis of heredity

Science and Technology Standard

- Understanding about science and technology

Science in Personal and Social Perspectives Standard

- Personal and community health
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

History and Nature of Science Standard

- Science as a human endeavor
- Nature of scientific knowledge
- Historical perspectives

Assessing the Lesson

Step 2: The first five paragraphs of the article highlight some of the questions, complications, and unknowns about autism spectrum disorders (ASDs). List three examples. You can write them in the form of statements or questions.

Students may list any of the following questions/complications/unknowns. They may also identify others not listed here. Just make sure their answers are logical and accurate.

- How exactly do we define ASDs?
- Is the increase a result of changes in diagnostic criteria, or is the increase real?
- What is the relative importance of genetic and environmental factors?
- What are the mechanisms that cause ASDs?

Step 3: The remainder of the article discusses a variety of epidemiological studies (research done with human populations) on ASDs. Answer the following questions.

a. Why do you think so many studies are happening at the same time? (Consider your answer in the context of science and the scientific method.)

Reasons may include: in science you need to accumulate a body of knowledge to answer a question; different studies may address different questions or aspects of the same question; as studies show similar results, confidence increases; you need many studies to rise above the "noise" of natural variability.

b. Define a case–control study.

With respect to ASDs, a case–control study is when a group of children with ASDs (cases) is compared to a group of children the same age without ASDs (controls).

c. A cohort is a group of people who share a similar important life event, such as birth year. Some of the ASD cohort studies collect data (such as hair and blood samples) from women who are pregnant and then collect data on the babies once they are born, as well as over time, as they grow older. So, a cohort study looks at all of the births that occur during specific years (e.g., 2005 through 2007), often in similar regions, such as births from a specific hospital or in the same state.

Why do you need so many more samples in a cohort study compared to a case–control study? Consider i) the difference between the case–control and the cohort study designs; and ii) how frequently ASDs occur per number of people, and the idea that you need enough cases to have a statistically valid result.

i) First, since you are studying ASDs you want to make sure that you have children in your study with these disorders. In a case–control study you select children who have already been identified with or without ASDs, so you are guaranteed to have autistic children in your sample. In a cohort study, sampling often begins before the child is born, so there is no way to know ahead of time which children will have ASDs. If you don't have enough samples in the cohort study, you run the risk of not having any children with ASDs in your study.

ii) If ASDs occur in approximately 60 children per 10,000, you will need many thousands of children in a cohort study to ensure you at least get several with ASDs. But are 3–6 autistic children in a study enough to draw valid conclusions from the study? Scientists use statistics to determine whether they need 10, 20, 60, or 100 autistic children in their study.

d. The Autism Birth Cohort (ABC) Study is planning to collect data on 100,000 babies. Assuming approximately 60 children per 10,000 have autism, how many children would you expect to have autism in the study's sampling of 100,000 babies? Show your calculations, including units that cancel.

60 autistic children/10,000 ~~children~~ $\times$ 100,000 children = ? autistic ~~children~~

$60 \times 100{,}000/10{,}000 = 6{,}000{,}000/10{,}000 = 600$

or $60/10{,}000 \times 100{,}000 = 0.0006 \times 100{,}000 = 600$

Step 4: Fill in the table below listing the advantages and disadvantages of case–control and cohort studies.

	Advantages	Disadvantages
Case–Control	You can have a large number of children with ASDs enrolled in the study. You can take biological samples and make comparisons between children with and without ASDs. You can collect historical data (e.g., during pregnancy) using questionnaires/interviews and medical records.	You are collecting data on children who already have ASDs. You cannot go back and see if there were environmental exposures during childhood that triggered the ASD. For historical data you have to depend on medical records (which may not include information on potential exposures). Interviews and questionnaires that ask people to recall information have a high risk of bias or incorrect information because our memories are not always reliable.
Cohort	You can track potential environmental exposures from before and after birth to see if they relate to ASDs. You can have time-series data to see if exposures during pregnancy or during some stage of growth after birth have a greater impact on ASDs. Time-series data may reveal information about the pathogenesis (the development of a disorder). Results can be used to identify people within a given population who are more at risk for ASDs.	You need to have very large sample sizes to ensure you have children with ASDs in the study, which is time-consuming and expensive. You run the risk of not having enough autistic children in the study to make the results statistically valid.

Authors and Reviewers

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Give us your feedback! Send comments about this lesson to ehpscienceed@niehs.nih.gov.

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STUDENT INSTRUCTIONS:

Tracing the Origins of Autism: A Spectrum of New Studies

Step 1: Read the article "Tracing the Origins of Autism: A Spectrum of New Studies."

Step 2: The first five paragraphs of the article highlight some of the questions, complications, and unknowns about autism spectrum disorders (ASDs). List three examples. You can write them in the form of statements or questions.

Step 3: The remainder of the article discusses a variety of epidemiological studies (research done with human populations) on ASDs. Answer the following questions.

a. Why do you think so many studies are happening at the same time? (Consider your answer in the context of science and the scientific method.)

b. Define a case–control study.

c. A cohort is a group of people who share a similar important life event, such as birth year. Some of the ASD cohort studies collect data (such as hair and blood samples) from women who are pregnant and then collect data on the babies once they are born, as well as over time, as they grow older. So, a cohort study looks at all of the births that occur during specific years (e.g., 2005 through 2007), often in similar regions, such as births from a specific hospital or in the same state.

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