JoVE: Science Education

Dichotic Listening

--Manuscript Draft--

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Overview:

It is a well-known fact that the human ability to process incoming stimuli is limited. However, the world is complicated, and there are always many things going on at once. Selective attention is the mechanism that allows humans and other animals to control which stimuli get processed and which become ignored. Think of a cocktail party: a person couldn't possibly process all of the conversations taking place at once. However, everyone has the ability to selectively listen to one conversation, leading all the rest to become nothing more than background noise.

This experiment demonstrates standard procedures for investigating selective auditory attention with paradigm called dichotic listening.

Procedure:

1. Apparatus and Stimuli.

    1.1. Use two sets of headphones and two pieces of hardware for playing auditory stimuli.

    1.2. Select two different recordings with informational content that can be tested for comprehension. These recordings are the stimuli for dichotic listening. Comprehension questions are also necessary.

        1.2.1. A good source for this kind of material is publicly available reading comprehension texts and questions from exams like the Scholastic Aptitude Test. For this demonstration, the three pieces of text and their associated questions selected can be found in **Appendix 1**.

    1.3. Record one person reading both of the selected pieces, and create three individual audio files.

    1.4. Print out the questions for each passage for the participant to complete after hearing the relevant recordings.

2. Procedure.

    2.1. Keep in mind that the goal of this experiment is to compare the ability to retain information for selectively attended stimuli compared to unattended stimuli. Set up the experiment to include two listening and test sessions.

        2.1.1. The first session is a baseline, with only a single audio passage intended to measure baseline listening comprehension without a second stimulus present.

Comment [JF1]: Note, the attached appendix includes two samples from the SAT. I can prerecord them or similar ones being read, and/or we can record during shooting. I don't suspect we will want to play the whole thing or show the whole text in the video. But we can easily play some and show some as text.

2.1.2. The second session involves two different passages played simultaneously, one to each ear, with instructions to attend to one of them.

2.2. Explain the instructions for the baseline condition to the participant. They are as follows:

2.2.1. "In a moment, I will ask you to put one headphone in each of your ears. I will press play, and a short passage will be read aloud to you through the headphone in your right ear. Nothing will come from the other. Please pay attention and listen carefully while the passage is read. Afterwards, you will be asked to answer some questions about the passage."

2.3. Play one of the passages through the headphone attached to the right ear. For control purposes, the participant should have a headphone in the left ear as well, but nothing should play through it.

2.4. Once the passage has finished playing, give the participant the set of questions associated with it, and allow them 15 min to answer as many as possible.

2.5. For the dichotic condition, explain the procedure to the participant, as follows:

2.5.1. "In a moment, I will ask you to place a headphone in each of your ears again. And again, a passage will be read aloud through the headphone played to your right ear. Please play close attention to that passage because you will be asked questions about it after. But this time, a different passage will be read aloud through the headphone in your left ear. You should do your best to ignore that passage, and direct your attention to your right ear."

2.6. Once the participant has the headphones placed in their ears, press play simultaneously on each.

2.7. When the passages are done, give the participant the questions for the two passages. They should be in the same document and randomly intermixed. Explain this to the participant:

2.7.1. "Now, I'd like you to answer as many questions as you can about the passages you just heard. About half of the questions are from the passage I asked you to pay attention to. But the other half will be from the other passage. Please do your best. And if you feel like you don't know an answer, just guess."

2.8. Allow 30 min for the participant to answer the questions. Once the participant has left, score the answers.

2.9. Once the questions are scored, calculate the proportion correct associated with each individual passage. Graph the scores.

Representative Result:

The graph in **Figure 1** shows the percent of questions answered correctly by condition. The red dotted line (at 20%) shows expected guessing performance (chance), given that each question included five choices. The participant was able to answer more questions correctly for the attended compared to the unattended passage, reflecting the ability to attend selectively to a single stimulus when more than one is present. But the participant also answered more questions correctly in the one passage baseline condition compared to the attended condition. This demonstrates the difficulty of attending selectively, and the limited capacity of human attention.

Applications:

Dichotic listening has been used for many purposes to understand the nature and capacities of selective attention. For example, it has been used with a concurrent visual task to investigate the extent to which visual and auditory attention compete with one another — an important issue for understanding when and how humans are able to multitask.

One of the most influential applications of the paradigm has been in the study of the human brain's lateralization for processing language. The human brain is divided into two hemispheres. Generally speaking, the right hemisphere is wired to the left side of the body, and the left hemisphere is wired to the right **(Figure 2).** This means that auditory stimuli played exclusively to one ear will be routed, first, to the opposite brain hemisphere. It is also known that the left hemisphere is generally specialized for language processing. The prediction, therefore, is that stimuli played to the right ear should be processed more effectively than stimuli played to the left ear. This has been confirmed in many dichotic listening studies, and it makes dichotic listening a useful paradigm for investigating language deficits thought to be associated with left hemisphere brain damage, as often occurs after a stroke, but without using a brain scan.

Legend:

Figure 1: Results from dichotic listening experiment.

Figure 2: The auditory pathways unlabeled.

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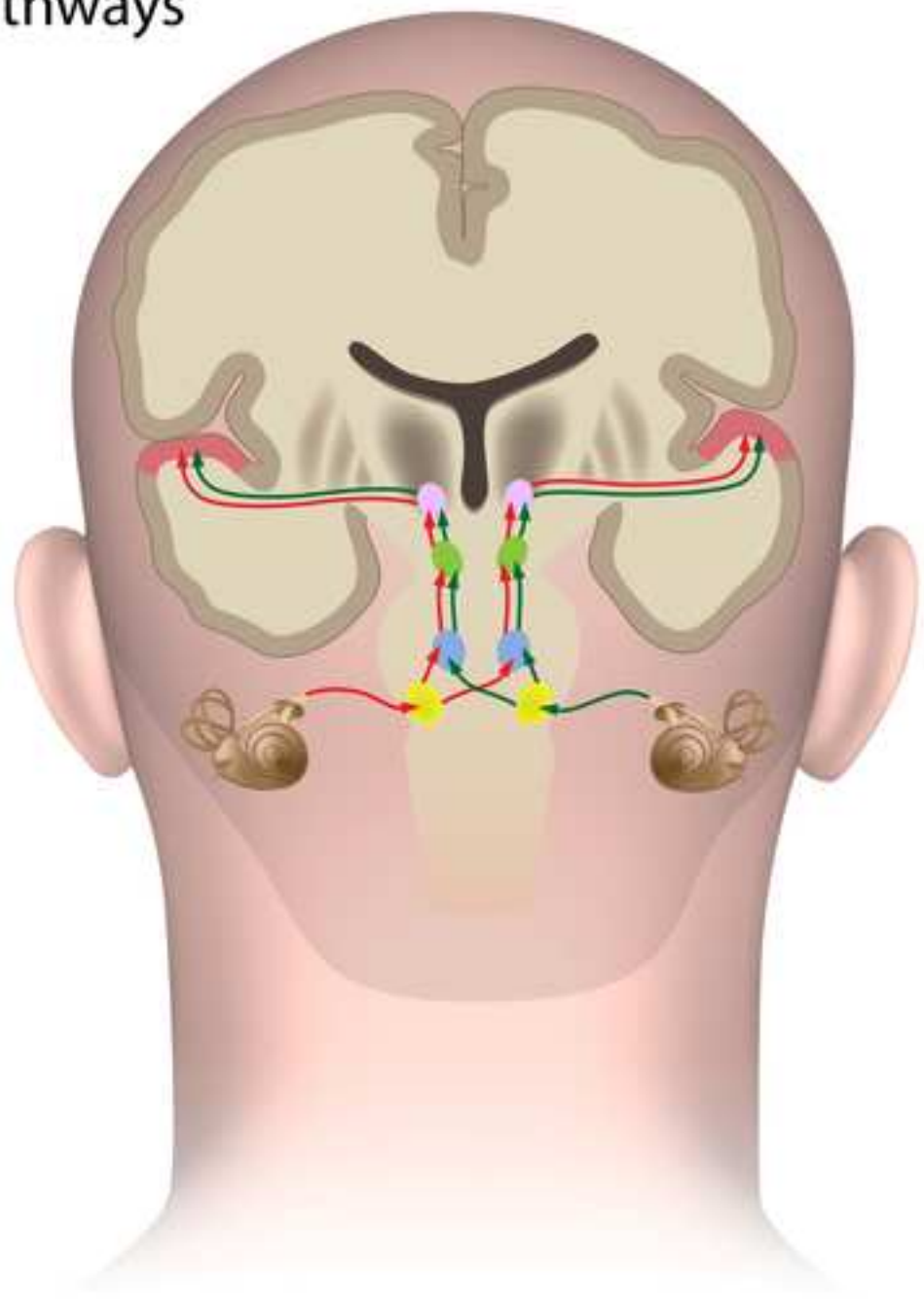
The Auditory Pathways



Medial geniculate

Inferior colliculus

Superior olive

Cochlear nucleus

Appendix 1

Adapted from: *The Social Function of Science,* John D Bernal (1939)

TEXT #1 with Comprehension Questions

The pioneers of the teaching of science imagined that its introduction into education would remove the conventionality, artificiality, and backward-lookingness, which were characteristic of classical studies, but they were gravely disappointed. So, too, in time had the humanists thought that the study of the classical authors in the original would banish at once the dull pedantry and superstition of mediaeval scholasticism. The professional schoolmaster was a match for both of them, and has almost managed to make the understanding of chemical reactions as dull and as dogmatic an affair as the reading of Virgil's Aeneid.

The chief claim for the use of science in education is that it teaches a child something about the actual universe in which he is living, in making him acquainted with the results of scientific discovery, and at the same time teaches him how to think logically and inductively by studying scientific method. A certain limited success has been reached in the first of these aims, but practically none at all in the second. Those privileged members of the community who have been through a secondary or public school education may be expected to know something about the elementary physics and chemistry of a hundred years ago, but they probably know hardly more than any bright boy can pick up from an interest in wireless or scientific hobbies out of school hours.

As to the learning of scientific method, the whole thing is palpably a farce. Actually, for the convenience of teachers and the requirements of the examination system, it is necessary that the pupils not only do not learn scientific method but learn precisely the reverse, that is, to believe exactly what they are told and to reproduce it when asked, whether it seems nonsense to them or not. The way in which educated people respond to such quackeries as spiritualism or astrology, not to say more dangerous ones, such as racial theories or currency myths, shows that fifty years of education in the method of science in Britain or Germany has produced no visible effect whatsoever. The only way of learning the method of science is the long and bitter way of personal experience, and until the educational or social systems are altered to make this possible, the best we can expect is the production of a minority of people who are able to acquire some of the techniques of science and a still smaller minority who are able to use and develop them.

1. The author implies that the 'professional schoolmaster' has
A. no interest in teaching science
B. thwarted attempts to enliven education
C. aided true learning
D. supported the humanists
E. been a pioneer in both science and humanities.

2. The author’s attitude to secondary and public school education in the sciences is
A. ambivalent
B. neutral

C. supportive
D. satirical
E. contemptuous

3. The author blames all of the following for the failure to impart scientific method through the education system except
A. poor teaching
B. examination methods
C. lack of direct experience
D. the social and education systems
E. lack of interest on the part of students

4. If the author were to study current education in science to see how things have changed since he wrote the piece, he would probably be most interested in the answer to which of the following questions?
A. Do students know more about the world about them?
B. Do students spend more time in laboratories?
C. Can students apply their knowledge logically?
D. Have textbooks improved?
E. Do they respect their teachers?

5. Astrology is mentioned as an example of
A. a science that needs to be better understood
B. a belief which no educated people hold
C. something unsupportable to those who have absorbed the methods of science
D. the gravest danger to society
E. an acknowledged failure of science

6. All of the following can be inferred from the text except
A. at the time of writing, not all children received a secondary school education
B. the author finds chemical reactions interesting
C. science teaching has imparted some knowledge of facts to some children
D. the author believes that many teachers are authoritarian
E. it is relatively easy to learn scientific method.

TEXT #2 with Comprehension Questions

In the following passage from a newspaper commentary written in 1968, an architecture critic discusses old theaters and concert halls.

After 50 years of life and 20 years of death, the great Adler and Sullivan Auditorium in Chicago is back in business again. Orchestra Hall, also in Chicago, was beautifully spruced up for its sixty-eighth birthday. In St. Louis, a 1925 movie palace has been successfully transformed into Powell Symphony Hall, complete with handsome bar from New York's demolished

Metropolitan Opera House.

Sentimentalism? Hardly. This is no more than a practical coming of cultural age, a belated recognition that fine old buildings frequently offer the most for the money in an assortment of values, including cost, and above all, that new cultural centers do not a culture make. It indicates the dawning of certain sensibilities, perspectives, and standards without which arts programs are mockeries of everything the arts stand for.

The last decade has seen city after city rush pell-mell into the promotion of great gobs of cultural real estate. It has seen a few good new theaters and a lot of bad ones, temples to bourgeois muses with all the panache of suburban shopping centers. The practice has been to treat the arts in chamber-of-commerce, rather than in creative, terms. That is just as tragic as it sounds. The trend toward preservation is significant not only because it is saving and restoring some superior buildings that are testimonials to the creative achievements of other times, but also because it is bucking the conventional wisdom of the conventional power structure that provides the backing for conventional cultural centers to house the arts.

That wisdom, as it comes true-blue from the hearts and minds of real estate dealers and investment bankers, is that you don't keep old buildings; they are obsolete. Anything new is better than anything old and anything big is better than anything small, and if a few cultural values are lost along the way, it is not too large a price to pay. In addition, the new, big buildings must be all in one place so they will show. They'll not only serve the arts, they'll improve the surrounding property values. Build now, and fill them later.

At the same time, tear down the past, rip out cultural roots, erase tradition, rub out the architectural evidence that the arts flowered earlier in our cities and enriched them and that this enrichment is culture. Substitute a safe and sanitary status symbol for the loss. Put up the shiny mediocrities of the present and demolish the shabby masterpieces of the past. That is the ironic other side of the "cultural explosion" coin. In drama, and in life, irony and tragedy go hand in hand.

Chicago's Auditorium is such a masterpiece. With its glowing, golden ambiance, its soaring arches and super-stage from which whispers can be heard in the far reaches of the theater, it became a legend in its own time. One of the great nineteenth-century works of Louis Sullivan and Dankmar Adler and an anchor point of modern architectural history, it has been an acknowledged model of acoustical and aesthetic excellence. (Interestingly, the Auditorium is a hard theater in which to install microphones today, and many modern performers, untrained in balance and projection and reliant on technical mixing of sound, find it hard to function in a near-perfect house.)

Until October 1967, the last performance at the Auditorium was of Hellzapoppin' in 1941, and the last use of the great stage was for bowling alleys during the Second World War. Closed after that, it settled into decay for the next 20 years. Falling plaster filled the hall, and the golden ceiling was partly ruined by broken roof drains. Last fall, the Auditorium reopened, not quite in its old glory, but close to it. The splendors of the house were traced in the eight-candlepower glory of carbon-filament lightbulbs of the same kind used in 1889 when the theater, and

electricity, were new. Their gentle brilliance picked out restored architectural features in warm gilt and umber.

We have never had greater technical means or expertise to make our landmarks bloom. The question is no longer whether we can bring old theaters back to new brilliance, but whether we can fill them when they're done. As with the new centers, that will be the acid cultural test.

1. The principal function of the opening paragraph is to
(A) introduce the concept of conventional arts centers
(B) illustrate the trend toward revitalization of cultural landmarks
(C) explore the connection between classical architecture and the arts
(D) provide an explanation for the theater's resurgent popularity
(E) contrast the beauty of old theaters with ordinary modern buildings

2. In lines 13-14, the phrase "new . . . make" most
directly suggests that
(A) modern architects lack the artistic reputations of their predecessors
(B) the commercial treatment of culture encourages art that is mass-produced
(C) culture evolves out of tradition and cannot be instantly created
(D) historically significant venues positively influence the creative process
(E) new cultural centers should be constructed in collaboration with artists

3. The description in lines 20-21 ("temples . . . centers")
best serves to
(A) scorn the architects' commitment to historically accurate renovations
(B) mock the timeworn theatrical works showcased in modern cultural centers
(C) deprecate the appearance and character of many new theaters
(D) downplay the government's efforts to support the arts
(E) poke good-humored fun at commercial establishments

4. As described in lines 17-23, the "practice" refers to the
(A) commercialization of culture
(B) preservation of cultural treasures
(C) construction of shopping centers
(D) government funding of the arts
(E) distortion of theatrical works

5. In lines 27-30, the author uses the word "conventional"
several times in order to
(A) reveal the performers' frustration with modern theaters
(B) disparage the present-day treatment of the arts
(C) parody the creative efforts of contemporary artists
(D) emphasize the absurdity of a purely aesthetic approach to the arts
(E) exaggerate the importance of tradition in the arts

6. The fifth paragraph (lines 31-39) primarily serves to
(A) criticize the way in which cultural buildings are viewed as commodities
(B) assess the positive impact of the architects' backlash against mediocrity
(C) contrast the business practices of real estate brokers with those of bankers
(D) enumerate the costs and benefits of restoring historic landmarks
(E) question the importance of the arts to society

7. The author's comment about microphones implies that
(A) the near-perfect acoustics in a new theater divert attention from the building's aesthetic flaws
(B) audience members seated in the theater's balcony cannot fully appreciate the nuances of the performers' intonations
(C) the performances of modern-day actors tend to be overly dependent on technology
(D) the absence of technically sophisticated equipment has jeopardized the sound quality of performances
(E) old theaters can remain viable because they readily accommodate the new sound technology that enhances a performance

8. Which challenge is emphasized by the author as he concludes?
(A) Designating theaters as historical landmarks
(B) Renewing a respect for architecture
(C) Providing opportunities for new artists
(D) Reviving classical plays
(E) Attracting appreciative audiences

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