an issue of learning

the effect of visual split attention in classes for

DEAF AND HARD OF HEARING STUDENTS

By Susan M. Mather and M. Diane Clark

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A deaf or hard of hearing student sits in class surrounded mostly by hearing classmates. The teacher passes out an explanatory handout showing how to divide by negative numbers, or the fading of Roman civilization, or the schedule for an upcoming field trip. While the papers slide from hand to hand, the teacher clutches her own copy and talks. The interpreter stands or sits to the left, or the right, or at the far edge of the room.

The teacher discusses the handout, the information on the board, and his or her own knowledge of the subject. The interpreter translates. Perhaps a student asks a question. Perhaps still another student makes a comment. The deaf and hard of hearing students watch—a slight time delay meaning that they are always a little behind their classmates. However, this is not their biggest problem. More problematic are the teacher, the handout, the interpreter, the information on the board, and their vocal classmates who explore the subject matter using both hearing and vision, both sensory channels bringing information to each young "hearing" brain for effortless processing. In contrast, the deaf and hard of hearing students, relying primarily on the single channel of vision, experience cognitive overload.

One of the ongoing challenges teachers of students who are deaf or hard of hearing face is managing the visual split attention implicit in multimedia learning. When a teacher presents various types of visual information at the same time, visual learners have no choice but to divide their attention among those materials and the teacher and interpreter who present the material. These situations may not allow students to separate visual input meaningfully and to effectively learn the material.

In contrast to hearing students who use dual channels—auditory and visual—for the input of classroom information, deaf and hard of hearing students tend to rely primarily on a single channel—the visual channel. Using this channel, they process

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Video clip captures by Wei Wang/courtesy of Susan M. Mather

all the information that arrives not only in the classroom but also throughout their daily lives. This situation then requires splitting visual attention between visual linguistic information (in the form of sign language or lipreading), visual instructional materials, and sometimes the interpreted comments of hearing peers. If these activities are not integrated, deaf and hard of hearing children experience an increase in the cognitive load required as they shift their visual attention from an instructor to the materials (see Figure 1). This splitting of attention can adversely affect their classroom performance.

Teachers must understand that for many learners who are deaf or hard of hearing, visual learning is a stand-alone input model, and traditional classrooms have historically focused on learners who can take in information both visually and auditorily.

A Study of the Visual Looking at Deaf Students in "Auditory-oriented" Classes

Mather (2005) used an ethnographic approach to investigate the differences between auditory- and visually oriented classrooms. Here, *auditory-oriented classrooms* were defined as classrooms where the primary mode of communication was speaking and listening, and if eye contact occurred, it existed between the teacher and the individual students. In contrast, *visually oriented classrooms* were defined as settings where the primary mode of communication was sign language and lipreading, which required continuous eye contact not only between the instructor and the students but also among all students in the classroom.

Within these two environments, class management and turn-taking mechanisms differed. In an auditory-oriented classroom, instructors could identify more than one voice at a time and the students were able to recognize the change in speaker and switch attention. In contrast, instructors of deaf and hard of hearing students could not allow more than one student to answer at a time, as direct eye contact was necessary between the instructor and the responding student as well as among the other students who shifted attention from the instructor to the student who was responding. Understanding the deaf and hard of hearing students' reliance on the visual system,

instructors helped members of the class to shift their eye gaze to the responding student. This process necessarily slows the pace of turn taking in classrooms involving deaf or hard of hearing students and requires different physical layouts, rules, and procedures.

Auditory-oriented classrooms are traditionally rectangular in shape, whereas visually oriented classrooms are typically square. The seating arrangements for auditory-oriented classrooms usually comprise several rows facing the front of the classroom, seating as many as 30 students. However, visually oriented classrooms have a more limited capacity, and the seating is arranged in a semicircle so that visual contact can be made with each person in the room.

Mather (2005) found that for deaf and hard of hearing students to participate effectively in class, whether auditory-oriented or visually oriented, students need to have access to a 360-degree view of the classroom. Accordingly, once a deaf or hard of hearing student enters a classroom, the instructor should make classroom accommodations to achieve the 360-degree view. For instance, in an interpreted class of 35 to 40 students, the instructor should use the U-or V-shape seating arrangement so that the deaf or hard of hearing student can have sight lines to the instructor, the interpreter, and his or her peers. If the

Attention-getting Behaviors in Visually Versus Auditory-oriented Classrooms

The burden of deaf and hard of hearing students dividing their attention to incorporate visual input into an auditory-oriented class can be lessened by using some well-designed instructional strategies as outlined below.

LANGUAGE PATTERN	VISUALLY ORIENTED CLASSROOM	AUDITORY-ORIENTED CLASSROOM
Getting Attention		
Before the class instruction starts	Getting each of the students visually ready	Announcing the subject material audibly and beginning class simultaneously
To get an individual student's attention	Individual eye gaze and visual/tactile summons (e.g., tapping shoulder, waving hand, asking another student to call the student)	Calling a student's name
To get a group's attention	Group-indicating gaze and visual/tactile summons	Vocal regulators (e.g., cues such as "um" or "okay")
Teacher's question-asking period		
Pace of questioning and answering	Overlap discouraged	Overlap at teacher's discretion
Number of students' answers	One at a time	As many as four students at various times
Recognizing who is answering	Visual recognition (e.g., hand raising)	Vocal recognition
Question patterns	Non-grammatical question markers (e.g., lower brows indicating a wh-question marker or raised brows indicating a yes/no question marker)	Vocal inflection indicating a yes/no or wh-question

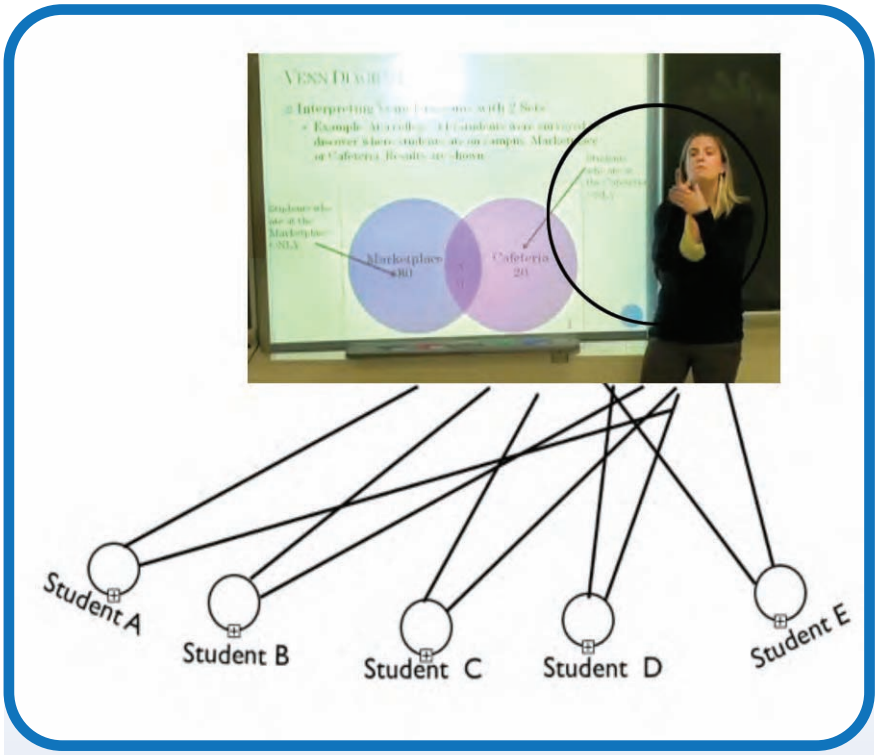


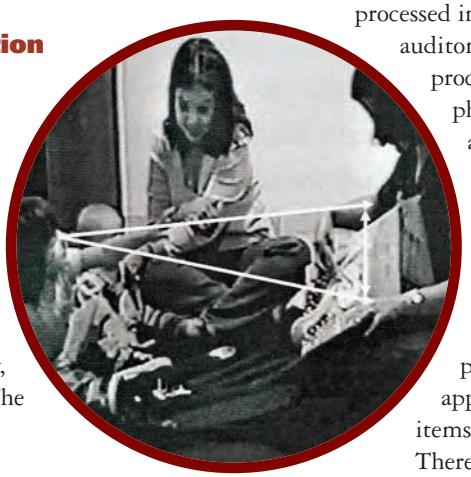
Figure 1. Signing and Board Work are Not Integrated

When signing and board work are not integrated, students must constantly shift their gaze from the instructor—who is supplying information through signing—to the information on the board.

deaf or hard of hearing student sits in the front row, he or she is unable to view his or her peers during classroom discussion and most likely will be unable to participate in these discussions.

Splitting Attention
The Effect on Memory

These issues—classroom design and the nature of a single channel for visual input—have theoretical implications related to attention, memory, and cognitive load. The impact of having one channel—the visual system—impacts cognitive load regardless of classroom design. Models of working memory include three basic assumptions: dual channels, each with limited capacity, and active processing to maintain the information. Dual channels present separate input for both auditory and visual information (Baddeley, 1998; Paivio, 1986) that are processed in parallel. Here, the auditory input is processed in a phonological buffer and the visual information is processed with a visual sketchpad. This phonological buffer has a limited capacity for processing approximately seven items (Miller, 1956). There is active verbal processing or rehearsal (e.g., repeating the information to oneself) that helps to "refresh the buffer" and maintain the information in working memory (Jonides, Lacey, & Nee, 2005).



Above: Here, a mother integrates her signing with the picture in the book to enable her child's visual access to both simultaneously. (Rodriguez-Fraticelli, 2001)

Instructional design can inadvertently increase cognitive load (Chandler & Sweller, 1992). For example, in an investigation of split attention in situations where hearing students shifted visual attention between looking at an animation and reading the on-screen text, Sweller (1999) found that having input from two different sources in the same channel increased cognitive load. Additionally, Moreno and Mayer (1999) found that students learned better when an instructor used both audio and video instruction simultaneously, in contrast to having the student read text while viewing a visual display. In other words, when hearing students were presented with two sources of sensory input, they were able to learn better than average if one source was visual while the other was auditory; however, they learned less than average if both of the sources of input were visual. What is the impact of this finding for many deaf and hard of hearing learners who do not use dual channels?

An Intervention
Attending to the Visual

Mather, Rodriguez, and Andrews (2006) noticed that deaf parents of pre-school deaf children would adjust their signing space to enable their children's visual access to their signing and the picture at the same time. Parents would also integrate their signing into the pictures, sometimes signing directly on the pages of the book. (See illustration at left.)

Visual access can be thought of as establishing an accessible cone triangle (formerly called a sight triangle), i.e., the individual watching, the teacher or interpreter signing, and the classroom material or learning prop. Mather (2009) found that not every student shared the same cone triangle; this varied on where he or she sat.

Mather (2009) set up several five-day courses for high school and college instructors from different fields (e.g.,

math, biology, geography, English) and educational interpreters who wished to improve their teaching skills. The first two half-days, she explained the differences between auditory- and visually based classrooms. On the third day, teachers learned how to use visually based strategies, such as purposeful eye gaze, visual readiness, attention-getting strategies, and maintaining classroom discussion during hands-on activities. Mather also discussed various theories of working memory, cognitive overload, and the effects of split attention. She explained the importance of ensuring each student had a clear cone triangle and visual access to the instructor and classroom materials (see Figure 2). On the fourth day, each instructor became a lecturer, using props such as PowerPoint or 3-D objects while the rest of the instructors, in the role of students, watched and gave feedback. On the fifth day, the instructors were able to integrate their signing along with props more effectively.

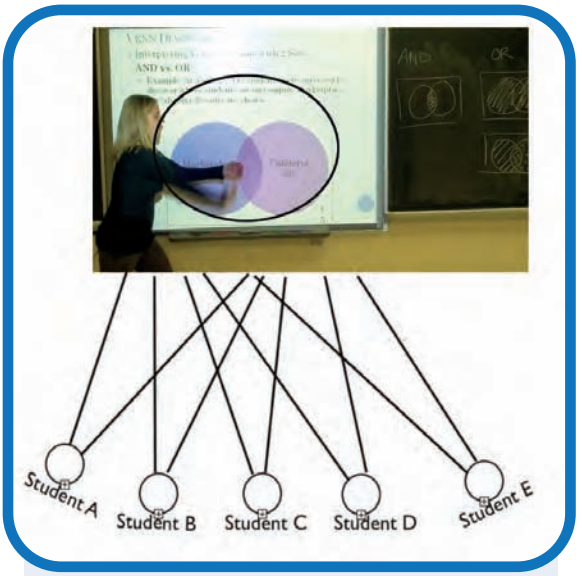


Figure 2. Integrating Signing and Board Work

The students above (except for A and E) have a full view of both the instructor and the information on the board. The instructor has moved her body and integrated her signing into the visual display. For the deaf and hard of hearing students, fewer shifts of attention are required.

Deaf and hard of hearing individuals who are mainstreamed generally struggle to achieve academic parity with their hearing peers (Marschark & Hauser, 2008). These lower levels of academic achievement may be related to the nature of auditory-based classrooms. Unfortunately the auditory-based classroom—the traditional class model—unfairly increases the cognitive load for deaf and hard of hearing students by requiring them to constantly engage in splitting their visual attention. This split attention overloads working memory. Recognizing this and incorporating some visually based learning strategies could go a long way towards eliminating traditionally low levels of academic achievement for deaf and hard of hearing students.

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