Do Visual, Auditory, and Kinesthetic Learners Need Visual, Auditory, and Kinesthetic Instruction?

By Daniel T. Willingham

Question: *What does cognitive science tell us about the existence of visual, auditory, and kinesthetic learners and the best way to teach them?*

The idea that people may differ in their ability to learn new material depending on its modality—that is, whether the child hears it, sees it, or touches it—has been tested for over 100 years. And the idea that these differences might prove useful in the classroom has been around for at least 40 years.

What cognitive science has taught us is that *children do differ in their abilities with different modalities, but teaching the child in his best modality doesn't affect his educational achievement*. What does matter is whether the child is taught in the *content*'s best modality. All students learn more when content drives the choice of modality. In this column, I will describe some of the research on matching modality strength to the modality of instruction. I will also address why the idea of tailoring instruction to a *student*'s best modality is so enduring—despite substantial evidence that it is wrong.

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Discussions of visual, auditory, and kinesthetic learners* are common in educational literature, teacher-preparation programs, and professional development workshops. The theory that students learn more when content is presented in their best modality seems to make sense, seems to be supported by classroom experiences, and offers the hope of maximizing each child's learning by planning different lessons for each type of learner. For example, within one kindergarten class, the auditory learner could listen to stories about different holidays around the world, while the visual learner examined pictures of holiday celebrants, and the kinesthetic learner handled costumes and artifacts associated with the holidays. But is the theory correct? And, whether or not the theory is correct, might it not also be true that *all* of the kindergartners would learn the most about holidays by listening to stories, looking at pictures, *and* handling costumes?

Before we tackle the research on using modalities to enhance student learning, let's review a few things that cognitive scientists know about modalities.

1. Some memories are stored as visual and auditory representations—but most memories are stored in terms of meaning.

Cognitive psychologists have used formal laboratory tasks to investigate the role of modality in memory. An important finding from that research is that memory is usually stored independent of *any* modality. You typically store memories in terms of meaning—not in terms of whether you saw, heard, or physically interacted with the information. For example, your knowledge that a fire requires oxygen to burn is unlikely to be stored as a visual or an auditory memory. The initial experience by which you learned this fact may have been visual (watching a flame go out under a glass) or auditory (hearing an explanation), but the resulting representation of that knowledge in your mind is neither visual nor auditory.

How did cognitive scientists figure this out? An important clue that memories are stored by their meaning is the types of errors people make on memory tests. People who listen to a story will later confidently "recognize" sentences that never appeared in the story—so long as these new sentences are consistent with the story's meaning (Bransford and Franks, 1971). The same phenomenon is observed with purely visual stimuli. People rapidly lose the memory of the precise images that make up a picture story (e.g., whether a character faced left or right), but they retain the meaning or gist of the story (Gernsbacher, 1985).

These findings do not mean that you *can't* store auditory or visual information. You can, and you do. For example, if I ask you "Which is a darker green: a Christmas tree or a frozen pea?" you'll likely report that you would answer this question by visually imagining the two objects side by side and evaluating which is a darker green. If I ask you whether Bill Clinton or George W. Bush has a deeper voice, you will likely report that you would answer by generating an auditory memory of each.

The mind is capable of storing memories in a number of different formats, and laboratory research indicates that a single experience usually leads to more than one type of representation. When subjects view a picture story, they *do* have a visual representation of what the pictures look like, in addition to the meaning-based representation. They usually don't remember the visual representation for long, however, largely because when they see the pictures, they are thinking about what they mean in order to understand the story. If, in contrast, they were asked to remember visual details of the pictures and to ignore the story they tell, they would have a better memory for the visual details and the meaning-based representation would be worse. (This principle is another example of a generalization made in a previous column: What's stored in memory is what you think about. To read that column, see "Students Remember ... What They Think About," in the Summer 2003 issue of *American Educator*.

2. The different visual, auditory, and meaning-based representations in our minds cannot serve as substitutes for one another.

Our minds have these different types of representations for a reason: Different representations are more or less effective for storing different types of information. Visual representations, for example, are poor for storing meaning because they are often consistent with more than one interpretation: A static image of a car driving on a snowy hill could just as well depict a car struggling up the hill or slipping backwards down the hill. And some concepts do not lend themselves well to pictures: How would one depict "genius" or "democracy" in a picture? On the other hand, the particular shade of green of a frozen pea would be stored visually because the information is inherently visual.

Because these different memory representations store different types of information, you usually cannot use one representation to substitute for another. This point is illustrated in an experiment by Chad Dodson and Arthur Shimamura (2000). They asked subjects to listen to two word lists and to judge whether or not each word on the second list (new words) had appeared on the first list (studied words), as shown below. The interesting twist was that each word on both lists was spoken by either a man (depicted by **boldface**) or a woman (depicted by *italics*). If a word had appeared on both lists, it might be spoken in the same voice ("Window") or in different voices ("Doctor"). The question is whether changing the gender of the voice (and, therefore, the auditory experience) influenced memory for the studied words.

LIST 1	LIST 2
Shell	**Doctor**
Radio	*Fleet*
Doctor	*Midnight*
Table	*Thread*
Window	**Reason**
	Window

Dodson and Shimamura found that whether the gender of the voice repeated or switched made no difference at all in remembering the word (75 percent versus 73 percent accuracy). That is, subjects were just as likely to remember "Doctor" as

"Window." But when subjects judged that a word was on the first list, they also had to say whether a man or woman had said it. For this judgment, subjects were more accurate if the same gender voice spoke the word on the first and the second list (57 percent) than if the voice switched genders (39 percent). This experiment indicates that subjects do store auditory information, but it only helps them remember the part of the memory that is auditory—the sound of the voice—and not the word itself, which is stored in terms of its meaning.

3. Children probably do differ in how good their visual and auditory memories are, but in most situations, it makes little difference in the classroom.

Let's return to classroom education. We've said that some memories are stored visually, some auditorily, and some in terms of meaning. And it's likely that some students should have a relatively better visual memory or auditory memory. Shouldn't that mean that some students will more easily remember material that is presented in their stronger modality? It does, but what advantage would this superior memory provide for the student in a classroom? Teachers almost always want students to remember what things mean, not what they look like or sound like. For the vast majority of education, vision and audition are usually just vehicles that carry the important information teachers want students to learn. There are some limited types of materials for which an exact visual or auditory representation is helpful. The child with a good visual memory might have an edge over his peers in learning the location of capitals on a map of Europe, for example. That task is inherently visual. The child with a good auditory memory might learn the correct accent for a foreign language more quickly. (And the child with a good kinesthetic memory may have an edge in sports, handwriting, or painting.) But most of what we want children to learn is based on meaning, so their superior memory in a specific modality doesn't give them an advantage just because material is presented in their preferred modality. Whether information is presented auditorily or visually, the student must extract and store its meaning.

What does the research say about teaching to a child's strongest modality?

Because the vast majority of educational content is stored in terms of meaning and does not rely on visual, auditory, or kinesthetic memory, it is not surprising that researchers have found very little support for the idea that offering instruction in a child's best modality will have a positive effect on his learning. A few studies show a positive effect of accounting for students' best modality, but many studies show no effect (Kampwirth and Bates, 1980; Arter and Jenkins, 1979). The most comprehensive review was conducted by Kenneth Kavale and Steven Forness (1987); it is especially relevant for teachers because it includes many studies that tested the effectiveness of specific instructional approaches (as opposed to laboratory-based exercises). Kavale and Forness analyzed 39 studies using a technique called meta-analysis, which allows the combination of data from different studies. By combining many studies into a single statistical analysis, the researchers have greater power to detect a small effect, if one exists.

The initial results indicated that teaching in the child's best modality might have a small impact on learning, but closer inspection of the studies qualified that conclusion. The studies showing the largest effects had methodological problems. For example, a common error in studies of modality is a failure to ensure that the lesson plans and materials are equivalent in every way except modality (since that is the only way to be sure that any effect found is due to modality). Some studies have used materials specially-prepared for the visual and auditory conditions and then compared those to "regular teaching materials." It is possible that the specially prepared materials were more interesting or better organized than the "regular teaching" materials. This type of mistake calls the results into question because no one can tell if the results were caused by the change of modality or by the use of better materials. (The results may demonstrate that children learn more when teachers use better materials.) When Kavale and Forness limited the meta-analysis to studies with few or no such methodological problems, the modality effect disappeared.[†]

Kavale and Forness's meta-analysis provides substantial evidence that tailoring instruction to students' modality is not effective; across these many well-designed studies, such tailoring had no educational effect. But readers should bear in mind that it is impossible to prove a negative: We cannot be certain that modality theory is incorrect because it is always possible that we haven't looked for just the right sort of evidence. An inventive theorist could always create a new version of the theory with predictions that hadn't yet been tested. Nonetheless, the meta-analysis included a large number of studies that tested many different hypotheses (see "How Has Modality Theory Been Tested?" for examples).

Although it is technically true that the theory hasn't been (and will never be) disproved, we can say that the possible effects of matching instructional modality to a student's modality strength have been extensively studied and have yielded no positive evidence. If there was an effect of any consequence, it is extremely likely that we would know it by now.

Teachers should focus on the content's best modality—not the student's.

We have seen that the mind uses different representations to store different types of information and that these representations are poor substitutes for one another. That indicates that teachers should indeed think about the modality in which they present material, but their goal should be to find the content's best modality, not to search (in vain) for the students' best modality. If the teacher wants students to learn and remember what something looks like, then the presentation should be visual. For example, if students are to appreciate the appearance of a Mayan pyramid, it would be much more effective to view a picture than to hear a verbal description.

Many topics may call for information in more than one modality. In a unit on the Civil War, in addition to lectures and reading, it might be appropriate to include recordings of martial music used to inspire the troops, visual representations (maps) of battlefields, and perhaps a chance to handle the pack and equipment the troops carried so that students could appreciate their heft. Similarly, if students are to learn the form of an English sonnet, they should hear the stress forms of iambic pentameter, and then see a visual representation of it.

There are other ways in which modality of instruction can influence the effectiveness of a given lesson—but the influence applies to all children (see "The *Content*'s Best Modality Is Key"). Experiences in different modalities simply for the sake of including different modalities should not be the goal. Material should be presented auditorily or visually because the information that the teacher wants students to understand is best conveyed in that modality. There is no benefit to students in teachers' attempting to find auditory presentations of the Mayan pyramids for the students who have good auditory memory. Everyone should see the picture. The important idea from this column is that *modality matters in the same way for all students*.

If modality theory is so wrong, why does it feel so right?

The belief in modality theory is very common among teachers. More than 25 years ago, Arter and Jenkins (1979) reported that more than 90 percent of special education teachers believed it. Today, the prevalence of books describing the theory and lesson plans suggesting ways to implement it suggest that it still enjoys widespread acceptance. Why is the theory so widely accepted if there is no research evidence to support it?

One factor is that it fits with a more general assumption that many teachers hold: There are genuinely important differences among students in how they learn. Modality gives us an easily understood way to think about the differences among children and it offers a hopeful message—a relatively easy adjustment to teaching practice may provide a boost to kids who are struggling. Further, everyone else believes it. Although false, the truth of modality theory has become "common knowledge."

I think that these factors may contribute to the belief, but I also think that most teachers wouldn't believe the theory if it did not seem consistent with their own experience. There are two ways that a teacher might see what looks like evidence for modality theory in the classroom. First, a teacher who believes the theory may interpret ambiguous situations as support for the theory. For example, a teacher might verbally explain to a student—several times—the idea of "borrowing" in subtraction without success. Then the teacher draws a diagram that more explicitly represents that the "3" in the tens place really represents "30." Suddenly, the concept clicks for the student. The teacher thinks "Aha. He's a visual learner. Once I drew the diagram, he understood." But the more likely explanation is that the diagram would have helped any student because it is a good way to represent a difficult concept. The teacher interprets the student's success in terms of modality theory because she has been told the theory is correct and because it seems to explain her experience. But cognitive scientists have long known that we all notice and remember examples that confirm our beliefs and, without meaning to, ignore and forget evidence that does not.

Modality theory may also seem correct because, as we have discussed, children probably do differ in their abilities with different types of memories. I remember my daughter commenting (out of the blue, as 4-year-olds will) that her preschool teacher said "white" in a way that made the "h" faintly, but distinctly, audible. I was impressed that she had noticed this difference, remembered it, and could reproduce it. So my daughter may have a good auditory memory, and that might help her in certain tasks, such as remembering regional accents, should she decide to be an actress. It does not mean that I want her teachers to ensure that she receives primarily auditory input in her coursework, because her superior auditory memory will not help her when she needs to remember meaning. But it is easy to see how one might (mistakenly) believe that complex material would be easier for her to master if presented auditorily. Further, as the sidebar "The Content's Best Modality Is Key" indicates, there are various ways in which modality does strengthen instruction (for all kids)—and it's easy to imagine that the effect has to do with a student's modal preference when in fact the effect is due to the content's best modality.

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*The notion of kinesthetic learners is a big part of modality theory. However, this article will focus on the other two modalities because what's commonly considered a "kinesthetic learning experience" is almost always a misnomer. Kinesthetic information comes from the joints and muscles and tells the brain about the location of body parts. Kinesthetic learning is the process of making movements automatic; it's the type of learning you do as you slowly master typing, riding a bike, or mincing garlic. In the classroom, a "kinesthetic learning experience" is usually taken to mean any activity that involves movement, e.g., dissecting a worm or using blocks to explore fractions. But the learning that comes from these activities almost always goes along with changes in mental activity—the learning is not really part of the kinesthetic experience. For example, if I handle a Greek costume (rather than watch you handle it), I am the one who decides which part of it to explore, whether or not to try it on, and so on. True kinesthetic learning experiences, like practicing handwriting, do not make up much of the curriculum. To avoid continual qualifications about what is or is not a true kinesthetic learning experience, I will refer mainly to visual and auditory modalities. The conclusions drawn also apply to kinesthetic learning experiences. (back to article)

†This meta-analysis was not without controversy. Rita Dunn, who has proposed a theory consistent with modality effects (e.g., Dunn and Dunn, 1992; 1993; Dunn, Dunn and Perrin, 1994) wrote a rather acrimonious criticism of the Kavale and Forness study (Dunn, 1990), to which they replied (Kavale and Forness, 1990). Dunn later published her own meta-analysis (Dunn et al., 1995), which appeared to provide strong support for a large modality effect. Kavale and his colleagues (1998) noted, however, that only one of the studies reviewed had appeared in a peer-reviewed journal. All the others were unpublished doctoral dissertations, and 21 of these were from Dunn's home institution, St. John's University. This is a problem because of *confirmation bias*—a tendency in researchers to unconsciously slant the design of a study and its interpretation to favor the outcome they hope to observe (Wason, 1960; Mahoney and DeMonbreun, 1981). That's why having impartial, expert reviewers is vital to research. Almost none of the studies included in Dunn's meta-analysis underwent scrutiny by outside reviewers, which makes it hard to take seriously. (back to article)

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