THE TRUTH ABOUT TEACHING TO LEARNING STYLES, AND WHAT TO DO INSTEAD?

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PURPOSE

The eLearning Guild's membership base primarily comprises workplace learning and development (L&D) practitioners whose exposure to ideas around learning styles may often be limited to scattershot articles in the popular press, promotional material from instrument vendors, and informal conversation with peers. This report is meant to provide this audience with a practical survey of the academic experimental literature around learning styles, particularly as it relates to the idea of tailoring instructional approaches to particular learning styles or types of learners.

SUMMARY

Belief in the effectiveness of matching instructional approaches to "learning styles" persists despite a preponderance of evidence showing no relationship between teaching to learning styles, and learning outcomes. Well, that is not entirely accurate: Some studies have shown a negative effect, in which attempts to cater to some defined learning style actually harm learning. In addition to offering ideas for why many find the idea of learning styles so appealing, this report reviews the research literature on learning styles, offering recaps of several often-cited studies. In the aggregate, researchers have recommended that time and energy would be better spent matching instructional approach to content and type of material being taught rather than to any perceived individual preference or "style."

WHAT IS AT ISSUE?

In many conversations, the idea of whether learning styles exist gets conflated with the usefulness of tailoring instruction to those styles. It is not the intent of this report to explore the validity of styles themselves: Most researchers agree that everyone has preferences in how they want information presented and how they study. Coffield, Moseley, Hall, and Ecclestone (2004) discovered 71 different models for "learning styles," quite a few of them tied to a commercial instrument, workshop, or other product. In most cases, identification of one's style is self-selected; even when based on instrumentation, items tend toward "I prefer..." or "I learn best by...." It's no secret to those in the industry, though, that many learners don't know how they learn (Knoll, Otani, Skeel, and Van Horn,2017; Pashler, McDaniel, Rohrer, and Bjork, 2009). (Note: Pashler et al.'s "Learning Styles: Concepts and Evidence" appears throughout the literature alternately as having been published in 2008 and 2009. As 2009 is the date that appears on the actual journal, it is cited that way throughout this report.)

So: This literature review does not seek to explore whether "learning styles" exist. Researchers largely agree that everyone is different, everyone has preferences, and everyone has likes and dislikes (Cuevas 2015; Pashler et al. 2009; Riener and Willingham 2010). This report focuses on exploring the empirical research asking the question: Does tailoring instruction to individual "learning styles" have an effect on learning outcomes?

WHY THE APPEAL?

Pashler et al. (2009) attribute the development of type-based learning style assessments to the "eternal and deep appeal" (107) of discovering what type of person one is. (Clark Quinn, in personal communication, says this can be traced back to the beginnings of astrology.) The authors relate the emergence of interest in learning styles back to the popularity of the Myers-Briggs Type Indicator, developed in the 1940s, and tie it to the self-esteem movement of the 1970s. Fridley and Fridley (2010) trace learning-styles thinking back to Gardner's theory of multiple intelligences. Both teams, as well as Riener and Willingham (2010), note the role of K-12 endeavors in the proliferation and popularity of ideas around learning styles. Parents want to hear that their children are special and that instruction is being tailored to them. Teachers want to satisfy that belief. Schools want to promise that individual students' needs will be met. And as learning styles deal in preferences, not abilities, there is an underlying suggestion that all learners are equal, provided they are taught to those preferences (Pashler et al. 2009; Riener and Willingham 2010; Rohrer and Pashler, 2012, Scott 2010). (Franklin [2006] suggests that the notion of "kinesthetic" learning style was created as a way of validating athletically talented, but academically low-achieving, pupils.) This can also provide an excuse, in which blame is easily shifted from the learner to some failure to have been taught in that learner's "style," e.g., "I failed that certification exam because it was all in text and I'm an auditory learner" (Newton and Miah 2017; Pashler et al. 2009; Riener and Willingham 2010). It is not hard to see the appeal of an egalitarian approach that focuses all on strength and preference rather than lack of ability or effort, without regard to a learner's prior knowledge or the difficulty of a concept (Riener and Willingham 2010). Researcher and learning styles critic Daniel Willingham, blogging in 2017, writes: "It would be so nice if it were true. It predicts that a struggling student would find much of school work easier if we made a relatively minor change to lesson plans."

Fridley and Fridley (2010) and Franklin (2006) speak to the darker side of the appeal of learning styles, particularly in the K-12 arena: the demand for labels fueled by parents seeking special services for their child and administrators seeking the funding associated with a label. The authors suggest that society has come to believe that labels signal "pedagogical control" and provide us with "insight, understanding, and closure" (Fridley and Fridley 2010, 22).

Those in workplace training and development or in higher education may not be aware of the size and scope of commercial "learning styles" products available to educators. There are dozens of learning-styles instruments, workshops, workbooks, and other products: In seeking to understand the appeal of learning styles, do not underestimate the influence of proponents who have something to sell. Several authors, among them Coffield et al. (2004), Pashler et al. (2009), Scott (2010), and Cuevas (2015), express exasperation with the success of the learning-styles-inventory industry—note use of the word "industry"—in the face of virtually no empirical evidence to support the concept.

Finally, in a phenomenon of perhaps more interest to the eLearning Guild audience, Riener and Willingham (2010) and Cuevas (2015) note the tendency for vendors to leverage the idea of learning styles in selling the need for digital learning solutions. A recent web search revealed authoring tools promising interactions that would cater to "kinesthetic learners," online courses with colors and graphics good for "visual learners," and assurances that given for-sale multimedia approaches would ensure that solutions cater to all learning preferences. Cuevas (2015) attributes much research itself to efforts to support ideas around technology use: "Learning styles research has been popular in the field of educational technology, most likely because technology may expand the possibilities for delivering content in a variety of modes"(315).

And, frankly, the idea of matching instruction to preferences is simple. It seems intuitive. It makes it easy to categorize people and ideas, and it's easy to create materials that give the impression of some kind of customization. Finally, unlike much talk in academic fields, it's easily accessible to laypeople (Stahl 1999).

THE LITERATURE

Some Names to Know

Citations are offered throughout this text, and a complete list of references appears at the end. Where possible, the author has included material accessible online to the average practitioner who may not have easy access to university library resources such as academic journals. In reviewing literature, the same names come up time and again—some because of their extensive or particularly influential work, others because of an unusual approach or unique perspective. A number of them undertook literature reviews that encompass much more information than is covered in this report. A few important names:

Frank Coffield is a now-retired former professor of education at Durham University, Newcastle University, and the Institute of Education at University College London. In 2004 Coffield produced, in collaboration with Moseley, Hall, and Ecclestone, an exhaustive catalog of learning styles models, instruments, and theories. Years later, he offered an opinion piece in which he said it was time to "move on" from discussion of learning styles (Coffield 2013).

Harold "Hal" Pashler is distinguished professor of psychology at the University of California–San Diego. Pashler's "Learning Styles: Concepts and Evidence," written with McDaniel, Rohrer, and Bjork (2009), is possibly the most influential and among the most-cited works on experimental examination of learning styles. The literature review details criteria for the experimental design needed to provide evidence of the hypothesis that tailoring instruction to learning styles results in superior learning outcomes, then examines research using an experimental method to test that hypothesis. Much of the work in the learning styles field is judged according to the standards set by Pashler et al. in 2009.

Josh Cuevas is an associate professor in the Department of Education at the University of North Georgia. In 2015, Cuevas undertook an extensive review of the literature published post-Pashler et al. (2009). The piece is thorough and offers detailed analysis of assorted experiment designs and results. Cuevas's review is essential for anyone looking for a deeper dive into current empirical research about learning styles. The article also offers a quick review of the number of teacher education and educational psychology texts supporting the idea of learning styles while offering no reference to empirical evidence. Additionally, along with Bryan Dawson, Cuevas offer some of the most recent (2017) research-based work with learning styles, discussed in more depth later in this report. Cuevas is also noteworthy for calling out the preponderance of research on learning styles appearing in predatory journals—those that charge authors to publish their articles with little in the way of editorial oversight or peer review.

Daniel Willingham is a psychology professor at the University of Virginia. He has written extensively about his belief that the very idea of learning styles is a myth (2010), saying there is conflation between evidence of ability and evidence of what some call "style," and arguing that if the idea of learning styles is correct, then evidence wouldn't be so hard to collect. Willingham's work is very accessible: He offers a FAQ page with content he differentiates as technical or "user-friendly" that answers questions and directs readers to other resources.

Will Thalheimer, an author and researcher, has since 2006 offered a cash reward for proof that teaching to learning styles has a positive effect on outcomes. As of this writing, the offer still stands—with the reward now at $5,000. Over the years, Thalheimer has done a number of short recaps of the literature and written updates when something new appears, making academic work more available to the learning and development (L&D) community.

David Cook is a professor of medical education at the Mayo Clinic. In 2012, Cook revisited his own work and embarked on "an updated search for evidence" on learning styles, concluding after reviewing additional quantitative studies that teaching to a particular learning style does not affect learning outcomes.

Marc Marschark is a professor at the National Technical Institute for the Deaf, a college of Rochester Institute of Technology. Those interested in this topic might want to visit Marschark et al.'s 2013 piece, "Are Deaf Students Visual Learners?" (Answer: No.) There are several interesting points raised in his research, among them clarification that deaf students are no more "visual" because of sign language, even when they self-identify as visual learners: Marschark notes that learning sign language is in fact a verbal skill, as is reading.

Jacob Klitmøller is an associate professor in the Department of Psychology and Behavioural Sciences at Aarhus University in Denmark. Klitmøller undertook a detailed review of investigations focused on the Dunn and Dunn VAKT learning styles model in particular, examining both the quality of the conclusions and the quality of the experiment. Klitmøller's in-depth examination of ways some investigations may be flawed makes this an excellent resource for those who are newer to, or want to learn more about, analyzing the quality of empirical research.

Learning Styles: Background

Pashler et al. (2009) trace the concept of learning styles back to psychiatrist Carl Jung; his ideas on a typology based on personality were appropriated in the 1940s and published as a paper test, the Myers-Briggs Type Indicator. They add: "It seems that the idea of finding out 'what type of person one is' has some eternal and deep appeal, and the success of the Myers-Briggs test promoted the development of type-based learning-style assessments" (107).

Subsequent approaches to "learning styles" were far-ranging: Coffield et al. (2004) identified 71 different—and often competing—schemes, and it's worth noting that they did not claim

even that count was complete. Their definitive (173 pages) review of learning style models deals more with instruments and models themselves than with possible connections to teaching outcomes; it predates the experimental literature discussed by Pashler et al. (2009). The team's commentary on possibilities for application of ideas around the models is mostly in the realm of speculation, rather than empirical data.

Coffield et al. (2004) organized the schemes into "families" according to leading proponents, several of whom may be familiar to readers in workplace training (L&D) practice:

Learning styles and preferences are largely **constitutionally based** including the four modalities: VAKT[2].	Learning styles reflect deep-seated features of the **cognitive structure**, including 'patterns of ability'.	Learning styles are one component of a relatively **stable personality type**.	Learning styles are **flexibly stable learning preferences**.	Move on from learning styles to **learning approaches, strategies, orientations** and **conceptions of learning**.
Dunn and Dunn[3]	**Riding**	**Apter**	**Allinson and Hayes**	**Entwistle**
Gregorc	Broverman	**Jackson**	**Herrmann**	**Sternberg**
Bartlett	Cooper	**Myers-Briggs**	**Honey and Mumford**	**Vermunt**
Betts	Gardner *et al.*	Epstein and Meier	**Kolb**	Biggs
Gordon	Guilford	Harrison-Branson	Felder and Silverman	Conti and Kolody
Marks	Holzman and Klein Hudson	Miller	Hermanussen, Wierstra, de Jong and Thijssen	Grasha-Riechmann
Paivio	Hunt		Kaufmann	Hill
Richardson	Kagan		Kirton	Marton and Säljö
Sheehan	Kogan		McCarthy	McKenney and Keen
Torrance	Messick			Pask
	Pettigrew			Pintrich, Smith, Garcia and McCeachie
	Witkin			Schmeck
				Weinstein, Zimmerman and Palmer
				Whetton and Cameron

Figure 1: Families of Learning Styles, provided by Coffield et al. (2004, 18)

The Instruments

Each family identified by Coffield et al. (2004) is the source of at least one popular instrument; for instance, Gardner's multiple intelligences, the Myers-Briggs Type Indicator, Honey and Mumford's Learning Styles Inventory, and Kolb's (also) Learning Styles Inventory. Much of the experimental literature employs some variation of the "VAK" model based on sensory modalities. The more popular instruments include variations on the Dunn and Dunn VAKT (visual-auditory-kinesthetic-tactile) model, with different questionnaires available to different age groups; the Fleming VARK (visual-aural-read/write-kinesthetic) model; and

Richardson's VVQ (verbalizer-visualizer questionnaire). As noted earlier, most instruments use self-reporting, with questions asking respondents to state what they prefer and how they learn best. As so much literature, and so much conversation, centers around variations of the sensory modalities (Riener and Willingham 2010), this report will focus primarily on discussion around the considerable body of work that references the VAK and similar models.

Experimentation: Establishing Evidence

Assessing the likelihood that teaching to a preference or "style" will improve learning outcomes involves testing what is known as the matching (sometimes called "meshing") hypothesis. The hypothesis predicts a positive correlation between learning style preference and instructional mode (Cuevas and Dawson 2017; Pashler et al. 2009).

The term "ATI" (attribute-treatment interaction) appears in many discussions of the matching hypothesis (e.g., in Pashler et al. 2009 and in Massa and Mayer 2006), sometimes interchangeably. In the literature, ATI is often used in the more literal sense of "treatment" and appears, for instance, in psychotherapy conversations. Per personal correspondence with Cuevas, the matching hypothesis might most appropriately be considered a type of ATI. I bring this up to note that experimental data here is scant, too: Ridenour, Treloar, Biner, Henriksen, and Dean (1999) lament that many reports of so-called tests of the ATI don't include any experimental data.

Experiment Design

Perhaps the most famous review of the experimental—testing the matching (they call it "meshing") hypothesis—learning styles literature was published by Pashler et al. in 2009.

Rogowsky, Calhoun, and Tallal (2015) offer a succinct description of the desired experiment design:

> "In Step 1, participants must be divided into groups on the basis of their learning style. In Step 2, participants from each group must be randomly assigned to receive one of multiple instructional methods. In Step 3, participants must complete an assessment of the material that is the same for all students. For the learning styles meshing hypothesis to be supported, data analysis must reveal a specific type of interaction between learning style and instructional method. That is, learning is optimal when individuals receive instruction in their preferred learning style, and the instructional method that proves most effective for individuals with one learning style is not the most effective method for individuals with a different learning style (65).

To be clear about the requirements for establishing evidence:

> "The results of such a study would support style-based instruction if and only if the test scores revealed two findings: Visual learners do better if instruction is visual rather than verbal, and verbal learners do better if instruction is verbal rather than visual. If these two findings are not observed, it means that both kinds of learners did better with the same kind of instruction, which is a negative finding" (Rohrer and Pashler 2012, 634).

Pashler, McDaniel, Rohrer, and Bjork (2009)

In reviewing the literature, Pashler et al. (2009) located fewer than two dozen studies using a sound experiment design such as the one they described. Of these, only three showed anything resembling a positive result; and due to problems like missing data, these outcomes are not very convincing (Cuevas 2015; Pashler et al. 2009; Rohrer and Pashler 2012). Not only did Pashler et al. fail to find data to support the matching hypothesis, they found quite the contrary:

> "Pashler's team could not find one study of sufficient quality that supported any of the learning styles models commonly promoted and marketed to teachers. They did, however, find a number of studies with strong designs that showed negative findings contradicting the learning styles hypothesis. In short, there was almost no research whatsoever that supported the learning styles hypothesis, but there was some high-quality research that seemed to refute it" (Cuevas 2015, 312).

Pashler et al. note the widespread problems with experiment design: The evidence needed to support the matching hypothesis is just not there.

Pashler's team conclude their 2009 review with:

> "[S]everal studies that used the appropriate type of research design found results that contradict the most widely held version of the learning-styles hypothesis, namely, what we have referred to as the meshing hypothesis (Constantinidou and Baker 2002; Massa and Mayer 2006). The contrast between the enormous popularity of the learning-styles approach within education and the lack of credible evidence for its utility is, in our opinion, striking and disturbing" (117).

Experimental Research

Here is an overview of some of the most-cited and most influential studies testing that included examination of some variation on the popular VAK learning styles model, as it is the most prevalent in conversation and popular press reports in the L&D field. All sought to test whether matching instruction to preference made a difference in learning outcomes; all utilized an experiment design identical or similar to that outlined by Pashler's team. Most of those studies published prior to 2009 are discussed in Pashler et al. (2009). Detailed information about each study is available in the Appendix.

- **Constantinidou and Baker (2002):** Researchers found ''no relationship between a visual learning style and the actual learning of verbal items that are presented visually or auditorily'' (306).
- **Krätzig and Arbuthnott (2006):** This research showed "little consistency and match between what learners consider to be their learning style and what specially designed questionnaires say, and … no relationship between established learning style and objective test performance" (Lethaby and Mayne 2018). In their article, Krätzig and Arbuthnott write, "These results challenge the hypothesis that individuals learn best with material presented in a particular sensory modality" (238).
- **Massa and Mayer (2006):** Visualizers and verbalizers do not benefit from being given different kinds of instruction. For this content, all learners (i.e., both visualizers and verbalizers) benefited more from the addition of pictorial help, results "consistent with what Mayer (2001) calls the multimedia effect: People learn better from words and pictures than from words alone" (344). Results showed no support for ''the idea that different instructional methods should be used for visualizers and verbalizers'' (333–334).
- **Cook (2012):** "Evidence supporting the use of [learning styles] in face-to-face instruction and other contexts consists almost exclusively of research looking at associations, with virtually no practical application … and no indication that measuring and responding makes a difference in the lives of students or teachers. Furthermore, the same caveats regarding instructional methods, assessments, study design, and logistics apply regardless of the instructional approach. Thus, I agree with previous authors that assessing and adapting to [learning styles] add little value to instruction" (785).
- **Rogowsky, Calhoun, and Tallal (2015):** "Results demonstrated no statistically significant relationship between learning style preference (auditory, visual word) and instructional method (audiobook, e-text) for either immediate or delayed comprehension tests. Taken together, the results of our investigation failed to statistically support the meshing hypothesis either for verbal comprehension aptitude or learning based on mode of instruction" (64).

- **Knoll, Otani, Skeel, and Van Horn, (2017):** "[L]earning material is more important than learning style … [it is] reasonable to conclude that at least for this type of memory task, knowing one's learning style adds little to the effectiveness of learning" (558).
- **Cuevas and Dawson (2017):** No significant interaction effect between learning style and condition; none of the four learning styles (visual, auditory, read/write, or kinesthetic) predicted students' retention of the material.
- **Husmann and O'Loughlin (2018):** In this research, nearly 70 percent of students failed to employ study techniques that supported their own stated preferences. Moreover, the nearly 30 percent of students whose study strategies did align with their VARK scores did not perform any better on either lab or lecture segments of the course. "This research provides further evidence that the conventional wisdom about learning styles should be rejected by educators and students alike" (1).
- **Cuevas (2015), literature review:** Pashler et al. published their review of the experimental literature in 2009. University of North Georgia's Josh Cuevas picked up the mantle and, in 2015, published an extensive literature review of material published post-Pashler. Stating that Pashler et al. had provided a template for future researchers—the details of experiment design for testing the matching hypothesis—Cuevas searched for instances of researchers undertaking such rigorous investigation. He found fewer researchers were basing their work on the VAK: Many were using the Kolb inventory, with similar lack of evidence found to support the meshing (matching) hypothesis. Cuevas does not speculate about this change, but it is not a stretch to think researchers, after failing to find support for the matching hypothesis through so many earlier VAK-based studies, turned to other learning style models. In the post-Pashler literature, Cuevas did find some support for the matching hypothesis. While these researchers claimed positive results, there were problems with all the designs including, for instance, muddling of concepts, unclear specifications about styles being examined, and insufficient time spent on an intervention to support claims. Cuevas did find some interesting, potentially positive results from Mahdjoubi and Akplotsyi (2012): They did not look at the matching hypothesis but studied learner choice of activity based on VAK learning style and found that visual learners tended to take more photographs, auditory learners spoke more in groups, and kinesthetic learners were most active during free time. This suggests that learner choice based on some "type" may be worth further investigation.

  Cuevas did identify a few studies that refuted the matching hypothesis; like the other post-2009 studies, they tended to use something other than the VAK-type models. Of these, Cuevas notes: "Interestingly, a number of the researchers whose findings refuted the learning styles hypothesis began their experiments as supporters of the method and continued to argue for a learning styles instructional approach even though their data appeared to contradict that conclusion" (323). A few of these

studies: Choi, Lee, and Kang (2009) tested for interaction of learning style and achievement across five learning modules. Allcock and Hulme (2010) tested for both learning style and ability and found test scores were "consistently higher for the students who received differentiation by ability than they were for those differentiated by learning style, and those in the ability group improved more from pre- to post-test although not significantly. So both groups improved, but the learning styles instruction did not produce more learning, and actually produced slightly less than the ability group" (Cuevas, 2015, 324). Zacharias (2011) studied web-based versus face-to-face instruction and found learning style had no effect on student choice of format or performance regardless of format.

- **Klitmøller (2015), literature review:** Klitmøller undertook a review of the literature specific to the Dunn and Dunn VAKT (visual, auditory, kinesthetic, tactile) model—and found it wanting. "First, the findings in the studies reviewed did not, on the whole, support the matching hypothesis central to the Dunn and Dunn model. Although some studies did show partial support for matching teaching to some perceptual preference, more studies showed no interaction between preference and matched teaching" (18). Also, half the studies had results that directly contradicted the matching hypothesis of the model. For interested readers, Klitmøller offers additional commentary on the quality of much research around learning styles.

This section offered a recap of some of the more well-known studies addressing the matching hypothesis, most via an experimental design more or less congruent with the one Pashler et al. (2009) laid out. Truth be told, there are not that many more: While there is voluminous research on learning styles, much of it is descriptive, not experimental, with many attempts to show, for instance, a correlation between learning style and gender, age, or other demographic category. And Cuevas (2015) suggests there may be a number of studies never published because of negative findings. Also, much of this research takes the matching hypothesis for granted. For additional detail on experimental studies, including those using other learning style models such as Kolb, see Pashler et al. (2009), Cuevas (2015), and Klitmøller (2015).

Other Research

This section of the report offers an overview of some additional research that, while not specific to the matching hypothesis, may be of interest to readers.

Dekker, Lee, Howard-Jones, and Jolles (2012)

242 primary and secondary school teachers in the UK and the Netherlands who were interested in the neuroscience of learning completed an online survey containing 32 statements about the brain and its influence on learning, of which 15 were neuromyths.

Ninety-three percent of UK respondents and 96 percent of Netherlands respondents agreed with this statement: "Individuals learn better when they receive information in their preferred learning style (e.g., auditory, visual, kinesthetic)." Teachers who read popular science magazines achieved higher scores on general knowledge questions. More general knowledge also predicted an increased belief in neuromyths.

The researchers concluded:

> "These findings suggest that teachers who are enthusiastic about the possible application of neuroscience findings in the classroom find it difficult to distinguish pseudoscience from scientific facts. Possessing greater general knowledge about the brain does not appear to protect teachers from believing in neuromyths. This demonstrates the need for enhanced interdisciplinary communication to reduce such misunderstandings in the future and establish a successful collaboration between neuroscience and education" (1).

Macdonald, Germine, Anderson, Christodoulou, and McGrath (2017)

This study was similar to the work conducted by Dekker et al. (2012), but with a much larger sample of American adults (N=3,048) and American educators in particular (N=598). Learning styles theory was endorsed by 93 percent of the public and 76 percent of educators. More accurate performance on neuromyths was predicted by age (being younger), education (having a graduate degree), exposure to neuroscience courses, and exposure to peer-reviewed science. These researchers' findings suggest that training in education and neuroscience can help reduce, but does not eliminate, belief in neuromyths.

Marschark, Morrison, Lukomski, Borgna, and Convertino (2013)

Among the research questions, the authors sought to determine the extent to which deaf students might be considered visual learners in any sense beyond or different from hearing students. Study participants included deaf university students whose primary means of communication was sign language, and a similar number of hearing university students. Seven tests of visual-spatial functioning in learning domains were administered. The hearing students exhibited visual-spatial skills equal to or better than deaf students. This study found that deaf students are no more likely to be visual learners than hearing students, even though they identify themselves as such (1) and "taken together with previous findings, the present results indicate that assuming that deaf students are in some broad sense visual learners will be of only limited educational utility" (12); "The present findings suggest that deaf students' preference for visual presentation of information does not necessarily mean that it supports their learning any more than it does for hearing students" (11–12).

Newton and Miah (2017)

Researchers wanted to quantify belief in and use of learning styles, and to understand how academics view the potential harms associated with the use of learning styles. Fifty-eight percent of respondents said they believed in learning styles (the authors note this is a decrease from earlier, similar studies). However, only 32 percent of respondents reported actually using learning styles. "Academics agreed with all the posited weaknesses and harms of learning styles theory, agreeing most strongly that the basic theory of learning styles is conceptually flawed. … [But] 32 percent stated that they would continue to use learning stylesbased approaches despite being presented with lack of evidence" (1). The authors note that results suggest belief in learning styles is declining, but add: "[A] more pessimistic interpretation of the data would be to focus on our finding that one-third of academics in UK higher education have, in the last year, used a method that was shown to be ineffective more than a decade earlier" (7).

Research: Counterpoint

Aside from the few positive findings, mostly discounted by Pashler et al. (2009), Cuevas (2015), and Klitmøller (2015), there are a few dissenting voices worth mentioning. Pashler et al.'s literature review assessed Sternberg, Grigorenko, Ferrari, and Clinkenbeard's (1999) study design as meeting the template testing the matching hypothesis, but noted that the positive results reported were wanting. Later, in 2015 back-and-forth pieces in the American Journal of Psychology, Sternberg argues that Pashler et al.'s (2009) requirements for sound experimental design are too rigid and that Pashler's team drew conclusions too sweeping in the context of the research they reviewed. Pashler et al. (2015) rebutted that Sternberg should have, instead of critiquing the template for testing the matching hypothesis, provided "a research design that is missing one or more of our key ingredients but nevertheless shows the efficacy of instructional tailoring" (122–123). To my knowledge, Sternberg did not produce this alternate research design.

Furnham (2012) states: "The application of, and research into, learning styles and approaches is clearly alive and well" (77). Noting the many issues in the literature around identification of valid styles and accompanying instrumentation, he concludes with hopeful comments on the future possibilities for this "fascinating but frustrating arena" (78). Note: For those interested in learning more about instrumentation, Furnham's 2012 work offers an extensive, detailed, tabled overview of various learning-styles instruments and common critiques of each.

Again, this report does not attempt to prove, or disprove, the idea of learning styles. Many voices in the field—like Furnham, above—have said it may be that we just haven't identified the right construct for them yet. There are problems with many of the instruments, most of them relying on self-reporting of preferences that may change depending on context: Stahl (1999) compares questions on many of the instruments to those used in fortune telling, full

of vague phrases that seem meaningful but aren't. And lest this point be lost: This report focuses on the experimental literature that uses some variation of the VAK learning styles model. But others—Cuevas (2015), for instance—show that testing other models, like the Kolb Learning Styles Inventory, produces no more evidence in support of the matching hypothesis. Regarding the possibility that we will someday better quantify the idea of styles, even Pashler et al. (2009) report that there seems to be evidence to support something akin to visualizer-verbalizer styles. They note that, as so much past research has been poorly conducted, there is room for research that proves them wrong. But as of now, there is a paucity of evidence showing that customizing instruction to any notion of learning style makes any difference in learning outcomes.

DISCUSSION

So What? What's the Harm?

Fair question. Does it hurt anything for an instructor or instructional designer to offer materials that match different learning styles? Well, for starters, we're imposing strategies we know don't work, potentially harming both learning and the learner (Fridley and Fridley 2010; Riener and Willingham 2010). Consider, for instance, the child who does poorly in the classroom and is therefore categorized as being a "kinesthetic" learner:

"Then interventions are implemented as a result of that questionable categorization instead of teachers conducting a more thorough diagnosis and remediation program founded on more well-substantiated methods that would actually have some chance of helping those struggling students. In essence, despite the good intentions of their teachers, those students are left to flounder due to a hypothesis that may amount to little more than pseudoscience" (Cuevas 2015, 330).

It could harm motivation in other ways: Newton and Miah (2017) offer the example of the "visual learner" who believes there's no point in pursuing an interest in music. And it isn't just about children. A cursory look at eLearning courses will show the inclusion of distracting, irrelevant art in the name of making courses more "visual." In years working with employee populations such as groundskeeping staff, janitorial staff, and food service workers, I have often seen design issues brushed off as simply tailoring material to address the needs of these "tactile" learners, who are diagnosed as such apropos of nothing (Dekker et al. 2012; Pashler et al. 2009; Riener and Willingham 2010; Rohrer and Pashler 2012; Willingham, Hughes, and Dobolyi 2015).

Fridley and Fridley (2010) go further in saying the effects of labeling are "pernicious"—failing to celebrate differences among learners and providing "a rationale for students to remain the same" (25); Stahl (1999) describes this as "segregation" of students into groups where they will receive fairly one-dimensional instruction (2). Perpetuating talk of "styles" encourages self-labeling that can lead to problems as well, and not just among children. Consider the learners who believe they are "visual learners" and therefore refuse to pay attention during a lecture, or explain failing a certification exam because it was offered via text.

The problem can run both ways, too. I once worked with a classroom trainer who justified her extensive use of lecture (including reading text-heavy slides aloud) by claiming, based on no evidence, that she had "a lot of auditory learners" in her classes.

Finally, are learners really best served by attempting to cater to learning styles, particularly when we know that there is evidence to say it will help them learn any faster, or any more? Lilienfeld et al. (2010) say life, and work's challenges, do not always come at us aligned with

our preferences: "We agree with Frank Coffield (quoted by Henry 2007) who said, 'We do students a serious disservice by implying they have only one learning style, rather than a flexible repertoire from which to choose, depending on the context" (38).

Why Does Belief Persist?

Given Pashler et al.'s (2009) importance in the literature, it seems worth noting again that the team didn't set out to prove or disprove anything, but they do express surprise and frustration that an enormous amount of belief has grown up around the idea of matching learning styles to approach while there remains virtually no evidence to support it. The authors especially worry that beliefs, rather than evidence, are too often used as the foundation for educational practices and policies.

As discussed earlier, Pashler et al. (2009) trace the genesis of learning styles talk back to the publication of the Myers-Briggs personality type instrument, another item that has proven wildly popular—with little evidence to support it (Moore 2015; Pittenger 1993; Thalheimer 2006). Like Pashler et al., Cuevas (2015) also comments on the "appeal for industries and the general public to find out what 'type of person' someone is by slotting them into predetermined categories, and this concept has found its way into a wide variety of educational settings" (309)—and I would add, a number of work settings as well.

"But I've Seen It Myself!"

Informal debates online and elsewhere are populated with many anecdotes by teachers and trainers, or learners, insisting that they have firsthand success with matching approach to learning style. If it is so evident and intuitive, why is it so hard, through experimentation, to get evidence for it? For one thing, those firsthand accounts rarely control for variables: What is the learner's prior knowledge? What else did the learner try? Is this third explanation just the one that finally "took"? Is it the result of simply better presenting the content, rather than accommodating some preference? Is the material put in terms of more interest to the learner anyway? (Cuevas 2015; Fridley and Fridley 2010; Pashler et al. 2009.) Riener and Willingham (2010) remind us of the reality of other preferences: "If a student loves the piano, or basketball, or chess, or the biology of frogs, that student will no doubt learn material related to that subject faster than another one who does not share that fascination. We all agree that interest and attention are preconditions of learning and vary from student to student, depending on the subject" (33). Like Pashler et al., Klitmøller (2015) reminds us of the dangers of confirmation bias and one-off examples: To establish credible evidence, "studies must be of high enough quality to ensure that such findings can reliably be attributed to the differentiation of teaching methods and nothing else" (5–6).

There's also the very real possibility that, depending on content, everyone may benefit from a particular approach over another:

> "Nearly everybody would prefer a demonstration in science class to an uninterrupted lecture. This does not mean that such individuals have a visual style, but that good science teaching involves demonstrations. Similarly, nearly everybody would agree that one learns more about playing tennis from playing than from watching someone else play. Again, this does not mean that people are tactile/kinesthetic, but that this is how one learns to play sports. Many of these 'learning styles' are not really choices, since common sense would suggest that there would not be much variance among people" (Stahl, 1999, 3).

Follow the Money

Perhaps the strongest element supporting continued belief in using learning styles to design instruction is the relentless push of marketers ever-ready to sell an instrument or idea, existing against a wall of difficult-to-access and hard-to-read experimental, peer-reviewed research. Stahl (1999), Pashler et al. (2009), Fridley and Fridley (2010), RienerRiener and Willingham (2010), and Macdonald et al. (2017) all write of the costs associated with pursuits like testing and workshops, with commercial claims that "outstrip the scientific evidence" (Lilienfeld et al. 2010, 39). Josh Cuevas (2015) says:

"The commercial component of the field is so vast that there is little incentive for critical reflection based on objective empirical findings (citing Bishka, 2010). These commercial entities have been a powerful force behind the propagation of learning styles instruction, a curious dynamic at odds with the reality that educational psychologists, those who are best equipped to study the concept, generally regard it with great skepticism (Scott 2010). And the sheer volume of commercial materials contributes to the appearance of legitimacy. But lay people in the business world, administrators in education, and teachers in the classroom tend to be unfamiliar with psychometric evidence and remain unconvinced" (310). In this, as in many other instances, marketing influences decision-making in ways evidence does not.

In a development new to me since graduate school, one can now find academic pieces being discussed, or sometimes reproduced in whole, above an area open for reader comments. In one such case, I ran across an impassioned argument against Pashler et al.'s 2009 ideas regarding establishing evidence, one that sent me looking for research … that turned out not to say what the commenter claimed. On further investigation, I found that the commenter was vice president of a company that sold a popular learning styles instrument. Does that in itself mean the commenter isn't credible? Not necessarily. Does it mean her every comment is suspect? Maybe. And in this case, as so often happens, the research offered didn't show what the commenter claimed. Fair to assume, then, it was offered in bad faith? In my view, yes.

Given all this, it's not hard to see why a busy practitioner, faced with a flood of easy-to-digest products and promises and shiny brochures and even unsubstantiated claims in textbooks (Cuevas 2015), or far fewer hard-to-access, difficult-to-decipher articles in neuroscience and education journals, would fall on the side of commercial claims over evidence. Consider, for example, a teacher in spring 2018, confronted with a pile of promotional materials countered only by the lone research piece by Husmann and O'Loughlin—available for a download fee charged by the publisher.

It is tempting to offer all this information as if it exists purely in a world of academic inquiry among teachers struggling to do their best work. Many of the researchers, as noted above, speak of the cost and the commercialization of learning styles to the K-12 community. But the L&D community is not immune. Does the average L&D practitioner understand the enormous influence money may have on practice? Clark Quinn, author of 2018's *Millennials, Goldfish & Other Training Misconceptions: Debunking Learning Myths and Superstitions*, presents frequently on myths about learning—which includes conversation about learning styles. Quinn shared this feedback from one participant (who was also a vendor paying to exhibit at the event) who evaluated his session: "Not cool to debunk some tools that exhibitors pay a lot of money to sell at [conference name] only to hear from a presenter at the conference that in his opinion should be debunked. Why would I want to be an exhibitor at a conference that debunks my products? *I will not exhibit again if this speaker speaks at [conference name]*" (emphasis added). Endeavors need sponsors and advertisers, and they can't be expected to vet the veracity of every claim made by those who support them.

What to Do Instead?

Apart from the lack of evidence to support the matching hypothesis, another thing clear from the literature is authors' exasperation with the effort expended on an approach we know doesn't work. Riener and Willingham (2010) say, if nothing else, time would be better spent gathering information about learners' backgrounds and preexisting knowledge than on assessing everyone's "learning style." A number of authors offer suggestions for more useful approaches. Cook (2012) recommends crafting instruction around learners' prior knowledge of a topic and issues of learner motivation; Thalheimer (2014) asks us to extend our thinking in another way. Rather than look at accommodating styles, pay more attention to other learner needs: Novices to a topic area likely need something different than experienced learners. Wallace (2011) tells us to consider that motivational differences may require different instructional approaches. And as Pashler et al. (2009) note, "people hold beliefs about how they learn that are faulty in various ways, which frequently lead people to manage their own learning and teach others in nonoptimal ways" (117), perhaps time could be spent helping learners understand more about learning, and identifying their best ways of working and learning, and helping them develop Coffield's vision (Henry 2007) of a flexible repertoire from which to draw.

There are a number of strategies supported by more solid evidence (Riener and Willingham 2010) than we've obtained by examining the matching hypothesis, such as learning techniques like massed vs. distributed practice (Dunlosky et al. 2013; Knoll et al. 2017). Mayer (2001) has conducted considerable research in support of better practices in designing multimedia instruction. And while Cuevas and Dawson (2017) found little support for the matching hypothesis, they did find significant support for the dual coding hypothesis: "Dual coding predicts that all learners should benefit if visual information is layered over linguistic information," as this increases memory capacity compared to what is available for verbal-only information (16).

A Picture Is (Usually) Worth a Thousand Words

While much of the experimental research does refute the usefulness of matching instructional material to learning style, a number of studies supported the picture superiority effect: Time and again researchers found that, regardless of "style," learners performed better from pictures rather than text. Massa and Mayer (2006) found that pictorial help screens were more useful than text. Knoll et al. (2017) said: "Recall was higher for pictures than for words, even among participants who showed preference for verbal information" (558.) Cuevas and Dawson (2017) reported "a highly significant main effect of condition with those in the visual condition retaining twice as much information as those in the auditory condition regardless of learning style" (40). And Constantinidou and Baker (2002) reported the "visual presentation of objects (with or without the simultaneous auditory presentation of names) resulted in better learning, recall, and retrieval of information than the auditory presentation alone" (1).

Content Matters

A point of agreement across much of the literature is the idea that teaching would be more appropriately matched to content, not some concept of learning style (Cuevas 2015; Fridley and Fridley 2010; Lilienfeld et al. 2010; Pashler et al. 2009; Riener and Willingham 2010; Rohrer and Pashler 2012). Often, one type of instruction is better for all learners: Pashler offers the example of a science class where students are assigned to either lab or classroom. The "visual" learners assigned to the lab will perform better on the test than those assigned to the classroom even though that instruction doesn't match the style they prefer (Glenn 2009). And in terms of acknowledging different preferences and ability levels, Rohrer and Pashler (2012) remind us to keep an eye on common sense: The fact that some students may, in comparison to peers, have poor visual-spatial ability and strong verbal ability "does not imply that such students will learn anatomy better if their textbook has few diagrams" (635).

To that point, the considerable positive findings about the picture superiority effect bring us to related thinking about context: Sometimes hands-on lab work is better, sometimes pictures are better. But it can depend on the task. In 2007, a professor at Temple University,

in response to students' failure to retain information about heart sounds, began advocating for medical students to access heart sound tutorials—via audio files delivered on iPods (Carmichael 2007). In the words of Lilienfeld et al. (2010): "The best approaches to teaching and learning may depend on what students are trying to learn" (39).

Develop Neuroscience Literacy

Dekker et al. (2012) found the correlation of belief in neuromyths with understanding neuroscience a frustrating discovery: Results showed that reading popular media had both beneficial and negative effects. While it did provide greater understanding of neuroscience, it also helped to create misconceptions. The team noted that teachers seemed eager to develop their neuroscience literacy, and the authors suggest that perhaps more formal instruction and curated resources would be useful in supporting that interest and helping practitioners separate science from pseudoscience. Echoing Dekker et al.'s call for "enhanced interdisciplinary communication (1), a number of well-known names in the field (among them Coffield, Howard-Jones, and Pashler) advocated in a 2017 letter to the Guardian that, as part of Brain Awareness Week, neuroscientists should visit schools and offer talks, partly to raise awareness of neuromyths. For more information on neuroscience see work from Daniel Willingham, David Sousa, Una Frith, and Will Thalheimer.

Arguing Doesn't Seem to Be Working

So what to do? In the face of data showing that nearly half of teachers responding agreed with the statement "Even though there is no evidence base to support the use of learning styles, it is my experience that their use in my teaching benefits student learning" (Newton and Miah 2017), in a field where the idea of matching instruction to learning style has, despite all evidence to the contrary, become common knowledge (Riener and Willingham 2010), Newton and Miah urge us to tread lightly on attempts to debunk belief and shift toward other conversations. As Cuevas (2015) notes, even researchers "whose findings refuted the learning styles hypothesis began their experiments as supporters of the method and continued to argue for a learning styles instructional approach even though their data appeared to contradict that conclusion" (323). After all, it appears that belief isn't really affecting practice that much anyway, as the share of practitioners who reported actually using "learning styles" was much lower than those who said they believed in them (Newton and Miah 2017). People do have preferences; it's the tangling up of the idea of diagnosing these and attempting to match them to instructional approaches that leads to so much wasted time and effort and cost. Guiding practitioners toward a better understanding of neuroscience in general may be more effective than arguing, but Macdonald et al. (2017) note even that can only help reduce, not eliminate, belief in neuromyths. Advocating for and publicizing better practices—ones supported by evidence, and easier to comprehend and implement—should help.

Instructional designer and author Cathy Moore offers another way of looking at the problem. First, she reminds us that practitioners are usually operating from good intentions: They want to create effective instruction and believe in their hearts that matching instruction to some idea of "learning style" is the way to go about it. Trying to shoot down the beliefs of someone working from a moral imperative will likely not get you very far. And people don't like being told that they're wrong, or stupid, or have been perpetuating bad practice for years. Tobias (2001) agrees, citing Chall's (2000) description of a "romantic," rather than rational, view of education, and adds: "Sometimes an idea may appear so logical, and/or so deeply related to the values held by individuals, that it becomes an article of faith. Believers cling to their fancies irrespective of research findings" (25).

Moore recommends acknowledging the practitioner's conviction while gently directing them to a different decision. Work with their compassion to arrive at a better result. Here's an example from Moore (2015) of a conversation in which a stakeholder wants everything narrated to accommodate the "auditory learners":

> For example, research shows that people learn best when they can control the pacing, which is actually hard to do if we use a narrator for everything. So if we added a narrator for the subset of people who prefer narration, we'd take away the control over pacing that everyone needs. If we made the narration optional, we'd still have to spend a lot of the budget on it, which reduces our ability to use techniques that everyone needs.

(Moore explains: "We're suggesting that the believer's compassion can be extended to even more people by letting go of the focus on one group.")

For more on this strategy for more constructive conversations, Moore recommends Cook and Lewandowsky's *The Debunking Handbook*, available for free download.

CONCLUSION

So: Can learning be improved by matching the mode of instruction to the preferred learning style of the student?

No.

At least, not according to the idea of "learning style" as we currently define it. And while it may seem intuitive to practitioners, as Riener and Willingham (2010) note, then it shouldn't be so hard to prove. As stated at the outset of this report, the idea that people have preferences is not at issue. But research shows clearly, again and again, that people prefer certain things and, given a choice, will often gravitate toward them. (Snow [1989] notes that the things they prefer may very well shift depending on task and situation.) People who say they are "visual" learners may, when presented with options, very well prefer to look at pictures. But it doesn't mean they learn more with those things (Cuevas 2015; Marschark et al. 2013; Pashler et al. 2009).

In the end, there can be harm, and wasted time and money, but something good may have come out of "learning styles" talk that isn't much acknowledged in the research: It encourages instructors and designers to try approaches other than lecture. Glenn (2009) says:

> "One possibility is that the mere act of learning about learning styles prompts teachers to pay more attention to the kinds of instruction they are delivering. An instructor who attends a learning-styles seminar might start to offer a broader mixture of lectures, discussions, and laboratory work—and that variety of instruction might turn out to be better for all students, irrespective of any 'matching.'"

As L&D practitioners, it behooves us to expand our own toolkits and understanding of instructional strategies that do work, to come armed with evidence and better ideas, to incorporate them into our practice, and to help others become more fluent in recognizing and creating better learning solutions.

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APPENDIX

Here are more detailed overviews of studies referenced in the *Experiment Design and Other Research* sections.

Constantinidou and Baker (2002)

Purpose: To investigate the e ects of modality presentation on verbal learning performance: Does self-reported preference in information uptake predict ability to perceive and store information in different modalities?

Design: Twenty-six older adults and 26 younger cohorts. Researchers examined the relationship between adults' scores on Richardson's VVQ questionnaire and their verbal performance on a task that presented words through the auditory modality, the visual modality (as line drawings of the corresponding object), or both.

Results: Visual presentations produced better free recall than did purely verbal presentations.

Conclusion: Researchers found "no relationship between a visual learning style and the actual learning of verbal items that are presented visually or auditorily" (306).

Krätzig and Arbuthnott (2006)

Purpose: To examine whether learning style preference correlated with memory performance in each of three sensory modalities: visual, auditory, and kinesthetic.

Design, Study 1: Sixty-five participants completed objective measures of pictorial, auditory, and tactile learning and learning style self-assessments.

Results, Study 1: Objective test performance did not correlate with learning style preference.

Design, Study 2: Authors examined in more detail the information participants used to answer the learning style self-assessment.

Results, Study 2: Participants answered the inventory using general memories and beliefs rather than specific examples of learning in different modalities.

Conclusion: There is "little consistency and match between what learners consider to be their learning style and what specially designed questionnaires say, and secondly, that there is no relationship between established learning style and objective test performance. … These results challenge the hypothesis that individuals learn best with material presented in a particular sensory modality" (238).

Ruth Clark, a name familiar to many in the L&D field, discusses the Krätzig and Arbuthnott study in her 2010 book, *Evidence-Based Training Methods*:

> "When all of the measures were compared, there were absolutely no relationships! A person who rated themselves an auditory learner was just as likely to score higher on the kinesthetic scale of the learning style test and show best memory for visual data. The research team concluded that 'in contrast to learning style theory, it appears that people are able to learn effectively using all three sensory modalities" (11).

Massa and Mayer (2006)

Purpose: To test the hypothesis that visualizers would perform better with pictorial help, while the performance of verbalizers would be better with text-based help.

Design: Via completion of a battery of instruments, participants (62 college students and 61 non-college adults) were divided into "visualizers" or "verbalizers." In the first two experiments, subjects completed an online lesson on electronics: one with all-text help screens and the other with all-pictorial help screens. They then took a multiple choice test on the material, answering questions such as "How does a battery work?" and "Describe what happens inside a wire when electricity flows through it." A third experiment presented some learners with both text and pictorial help and the rest with no help.

Results: Visualizers and verbalizers do not benefit from being given different kinds of instruction. For this content, all learners (i.e., both visualizers and verbalizers) benefited more from the addition of pictorial help, results "consistent with what Mayer (2001) calls the multimedia effect: People learn better from words and pictures than from words alone" (344).

Conclusion: There was no support for "the idea that different instructional methods should be used for visualizers and verbalizers (333–334).

Note: Pashler et al. (2009) single out Massa and Mayer's research as exceptionally well designed.

Literature Post-Pashler

Cook (2012)

Cook's 2012 work is of note as he revisited his own early work and did an about-face on his own prior conclusions:

> "Evidence supporting the use of [learning styles] in face-to-face instruction and other contexts consists almost exclusively of research looking at associations, with virtually no practical application for instruction or education administration and no indication that measuring and responding makes a difference in the lives of students or teachers. Furthermore, the same caveats regarding instructional methods, assessments, study design, and logistics apply regardless of the instructional approach. Thus, I agree with previous authors that assessing and adapting to [learning styles] add little value to instruction" (785).

Cuevas (2015)

Pashler et al. published their review of the experimental literature in 2009. Cuevas picked up the mantle and, in 2015, published an extensive literature review of material published post-Pashler. Stating that Pashler et al. had provided a template for future researchers—the details of experiment design for testing the matching hypothesis—Cuevas searched for instances of researchers undertaking such rigorous investigation. He found that fewer researchers were basing their work on the VAK; many were using the Kolb inventory, with similar lack of evidence found to support the meshing (matching) hypothesis. Cuevas does not speculate about this change, but it is not a stretch to think researchers, due to failure to find support for the matching hypothesis through so many earlier VAK-based studies, turned to other learning style models. In the post-Pashler literature, Cuevas did find some support for the matching hypothesis, with Alghasham (2012) looking at "active" and "reflective" learners, Popescu (2010) working with an amalgam of constructs from various models, and Hung (2012) using a five-dimension model. While these researchers claimed positive results, there were problems with all the designs—including, for instance, muddling of concepts, unclear specifications about styles being examined, and insufficient time spent on an intervention to support claims. Cuevas did find some interesting, potentially positive results from Mahdjoubi and Akplotsyi (2012): They did not look at the matching hypothesis, but studied learner choice of activity based on VAK learning style and found that visual learners tended to take more photographs, auditory learners spoke

more in groups, and kinesthetic learners were most active during free time. This suggests that learner choice based on some "type" may be worth further investigation.

Cuevas did identify a few studies that refuted the matching hypothesis; like the other post-2009 studies, they tended to use something other than the VAK-type models. Of these Cuevas notes: "Interestingly, a number of the researchers whose findings refuted the learning styles hypothesis began their experiments as supporters of the method and continued to argue for a learning styles instructional approach even though their data appeared to contradict that conclusion" (323). A few of these studies: Choi, Lee, and Kang (2009) tested for interaction of learning style and achievement across five learning modules. Allcock and Hulme (2010) tested for both learning style and ability and found test scores were "consistently higher for the students who received differentiation by ability than they were for those differentiated by learning style, and those in the ability group improved more from pre- to post-test although not significantly. So both groups improved, but the learning styles instruction did not produce more learning, and actually produced slightly less than the ability group" (Cuevas 2015, 324). Zacharis (2011) studied web-based versus face-to-face instruction and found learning style had no effect on student choice of format, or performance regardless of format.

Rogowsky, Calhoun, and Tallal (2015)

Purpose: The authors explicitly sought to directly test the meshing (matching) hypothesis itself using the design outlined by Pashler et al. (2009). They had two research questions:

1. What is the extent to which learning style preferences (auditory, visual) equate to learning aptitudes (listening comprehension, reading comprehension)?
2. What is the extent to which learning style preferences and/or learning aptitudes predict how much an individual comprehends and retains based on mode of instruction (audiobook, e-text)?

Design: Twenty-five participants age 25–40 were first assigned as "auditory" or "visual" learners using the Building Excellence (BE) Online Learning Styles Assessment Inventory for ages 17 and older.

Question 1: Participants were given a verbal comprehension aptitude test in both oral and written forms.

Question 2: Participants were assigned to one of two groups that received the same instructional material from a nonfiction book, but each in a different instructional mode (digital audiobook, e-text), and then completed a written comprehension test immediately and after two weeks.

Results, Test 1: Results failed to show a statistically significant relationship between learning style preference (auditory, visual word) and learning aptitude (listening comprehension, reading comprehension).

Results, Test 2: Participants were found to have no significant advantage when taught using their preferred learning style.

Conclusion: "Results demonstrated no statistically significant relationship between learning style preference (auditory, visual word) and instructional method (audiobook, e-text) for either immediate or delayed comprehension tests. Taken together, the results of our investigation failed to statistically support the meshing (matching) hypothesis either for verbal comprehension aptitude or learning based on mode of instruction (digital audiobook, e-text)" (64).

Note: This piece goes into a good deal of depth about the research method and findings, and readers may find it worth reviewing. It is available online.

Klitmøller (2015)

Klitmøller undertook a review of the literature specific to the Dunn and Dunn VAKT (visual, auditory, kinesthetic, tactile) model—and found it wanting. "First, the findings in the studies reviewed did not, on the whole, support the matching hypothesis central to the Dunn and Dunn model. Although some studies did show partial support for matching teaching to some perceptual preference, more studies showed no interaction between preference and matched teaching" (18). Also, half the studies had results that directly contradicted the matching hypothesis of the model. For interested readers, Klitmøller offers additional commentary on the quality of much research around learning styles.

Knoll, Otani, Skeel, and Van Horn (2017)

Purpose: To test the hypothesis that the popularity of learning styles is maintained because they are associated with subjective aspects of learning, such as judgments of learning.

Design: A VVQ questionnaire was completed by 52 female students. One hundred percent of respondents believed in the existence of learning styles and their impact on learning performance. One hundred percent of respondents clearly identified themselves as either visual or verbal learners. Participants studied lists of pictures and lists of words, then were tested on recall and their judgment of learning.

Results: Learning style had no effect on performance. Recall was higher for pictures than for words (picture superiority effect).

Conclusion: No other effects were significant, indicating that learning material is more important than learning style. Based on these results, it is "reasonable to conclude that at least for this type of memory task, knowing one's learning style adds little to the effectiveness of learning" (558).

Note: The Knoll et al. piece is lengthy and challenging, with close detail about data, and offers more than many authors on study limitations and suggestions for further study. This report provides only a quick overview; readers are encouraged to access and review it for themselves.

Cuevas and Dawson (2017)

Purpose: "The first research question was whether students whose learning style was matched to the instruction method would outperform those whose learning style did not match the instructional method. Because two distinct conditions were applied, one auditory and one visual, the design allowed us to test the learning styles hypothesis against the alternate theory of dual coding" (47).

Design: Two hundred and four university students were surveyed on their preferred learning style, then presented with information they were told to process via either imagery or linguistic means.

Results: No significant interaction effect was found between learning style and condition; none of the four learning styles (visual, auditory, read/write, or kinesthetic) predicted students' retention of the material. Additionally, the researchers report a "highly significant main effect of condition with those in the visual condition retaining twice as much information as those in the auditory condition regardless of learning style" (40).

Conclusion: The most basic prediction of the learning styles hypothesis should be rejected.

Husmann and O'Loughlin (2018)

As this report was being written, the latest entry in the learning styles literature appeared in *Anatomical Sciences Education*, authored by faculty at the Indiana School of Medicine. While different from other literature reviewed here, it provides an interesting twist on the investigations done by others. Where most other research (and opinion) about learning styles deals with learning in the classroom or in an online learning environment—that is, "instruction" delivered to a learner—Husmann and O'Loughlin examined what students did when learning on their own.

Purpose: To answer the question "Are undergraduate anatomy students more likely to utilize study strategies that align with their hypothetical learning styles (using the VARK analysis from Fleming and Mills) … and, if so, does this alignment correlate with their outcome in an anatomy course?"

Design: Four hundred twenty-six anatomy students completed a VARK learning styles assessment and a study strategies questionnaire.

Results: Nearly 70 percent of students failed to employ study techniques that supported their preferences. Moreover, the nearly 30 percent of students whose study strategies did align with their VARK scores did not perform any better on either lab or lecture segments of the course.

Conclusion: "This research offers further evidence that current wisdom about learning styles should be rejected by educators and students alike" (1).

ABOUT THE AUTHOR

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