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VARK IS A FOUR-LETTER WORD: ABANDONING UNIMODAL APPROACHES IN FAVOUR OF MULTIMODALITY WHEN DESIGNING FOR LEARNING

Amy Benians and Terri Brian

Enduringly popular, learning styles frameworks that categorise learners according to their preferences for particular modalities lack scientific and pedagogical grounding. Although it appeared that Tracey Tokuhama-Espinosa's 2018 book, *Neuromyths: Debunking False Ideas About The Brain* signalled the end of learning styles as educational models, experienced educators still seek to apply them, both as learning design frameworks and to describe learning preferences amongst their diverse learner cohorts. This often results in the attempt to provide unimodal instruction based on perceived learner preferences or to differentiate learning material by providing it in multiple formats (auditory contents for auditory learners, visual materials for visual learners, and so on). In this article, we will argue that learning styles frameworks (specifically, the VARK model) have been misappropriated from their original intention and that such unimodal approaches are generally ineffective, often promoting harmful teaching practices and limiting learners. Numerous reviews have examined learning styles and have found a lack of evidence to support their continued use in education (for example, see Coffield et al., 2004 for a systematic review). This article rejects learning styles as educational and learning design models in favour of more contemporary, evidence-based, multimodal approaches such as dual coding, multimedia learning theory, and Universal Design for Learning (UDL).

FROM NEUROSCIENCE TO NEUROMYTH

Historically, there has been widespread interest in the application of neuroscientific research findings to educational practice. The field of neuroscience is complex, however, and the accurate transfer of research findings to an educational context is often difficult. This has enabled many misconceptions to occur (Ansari et al., 2011). In 2002, the Organisation for Economic Co-operation and Development (OECD) raised concerns with regards to these misconceptions and the resulting proliferation of so-called "neuromythologies" (OECD, 2002, p. 43). The influence of these myths in education is seen to be problematic because it wastes resources which could be better spent on the development of evidence-based practices (Pasquinelli, 2012; Sylvan & Christodoulou, 2010). As an example, learning styles theory promises improved academic performance based on the identification of individual modality preferences for informational processing. This promise is not supported by evidence, and contrasts with current understandings of the neuroscience of learning. Research shows, however, that despite a lack of evidence, belief in the learning styles neuromyth remains high globally amongst educators of all levels (Newton & Salvi, 2020). The perspective of modality-specific learning styles, as with other learning-style taxonomies, is in principle a 'type' theory; that is, learners must be classified according to their learning preferences, and this information is then inappropriately used for making instructional decisions (Aslaksen et al., 2020).

A BRIEF HISTORY OF LEARNING STYLES

The evolution of learning styles as a type theory can be traced from the post-war period when psychologists such as Kurt Lewin and colleagues conceptualised 'styles of thinking.' In so doing, they attempted to categorise the human population into groups with distinct cognitive styles that predicted certain personality traits. By the 1960s, educational psychologists had started using these cognitive styles to predict individual learning abilities. More recently, the widespread application of personality assessments such as the Myers–Briggs test has promoted the development of type-based learning-style assessments (Lake et al., 2019). Over time, two general categories of theoretical models of learning styles have emerged: those based on learners' sensory modality preferences, such as VAKT (Visual, Auditory, Kinesthetic, and Tactile) (Dunn & Dunn, 1989) and VARK (Visual, Auditory, Reader/Writer, and Kinesthetic) (Fleming & Mills, 1992); and those based on cognitive preferences for processing new information, for example Kolb's (2014) Learning Style Inventory. The sensory modality learning style inventories dominate in the current educational landscape, and we will therefore focus the following critique on the VARK model.

THE VARK MODEL

Developed by Lincoln University academics Neil Fleming and Colleen Mills, VARK was initially intended as a metacognitive tool and as a "catalyst for reflection" for use by both learners and teachers (Fleming & Mills, 1992, p. 137). The 16-item questionnaire attempts to assist learners to identify their sensory modality preferences and, in turn, to encourage openness to adopting other learning strategies. According to the VARK website, the results of the questionnaire are intended to "indicate a 'rule of thumb' and should not be rigidly applied. The questionnaire is not intended to 'box' [learners] into a mindset that [they] have been 'diagnosed'. Rather, it is designed to initiate discussion about, and reflection upon, [their] learning style – metacognition" (VARK Learn, n.d.). Advocates suggest that when used in this "metacognitive fashion" (Fleming & Mills, 1992), VARK can encourage self-reflection, and form the basis for developmental conversations. Fleming and Mills (1992) comment that "students find [VARK] provides a framework that is consistent with their rational, intuitive notions about how they address information in learning situations. They therefore have no difficulty accepting the notion that adjustments ... in accordance with their modality preferences ... could benefit their learning effectiveness" (p. 145). This suggests that learners can use knowledge of their sensory modality preferences to enhance learning effectiveness, adapt their learning strategies, and focus on strengthening areas of perceived weakness (Felder, 2020; Syofyan & Siwi, 2018).

Learning styles proponents have advocated that, if applied as frameworks for learning design, they can be used to plan and deliver instruction to match learner preferences (Felder, 2020; Kolb & Kolb, 2018), and to focus teaching on strengthening the modalities in which learners are weaker (Fleming & Mills, 1992; Syofyan & Siwi, 2018). Zhou (2011), for example, suggests that deliberate mismatching of learning styles and teaching methods should help learners "learn in new ways and to bring into play ways of thinking and aspects of the self not previously developed" (p. 76). Also worth noting here is Fleming and Mills' (1992) acknowledgement that it is "simply not realistic to expect teachers to provide programmes that accommodate the learning style diversity present in their classes" (p. 138).

WHAT IS THE PROBLEM WITH VARK?

The idea that learning can be improved if learners are classified and taught according to their preferred VARK learning style is based on over-simplistic neuroscience research findings, namely that visual, auditory, and kinesthetic information is processed in different parts of the brain. These separate networks, however, are highly interconnected, and there is profound cross-modal activation and transfer of information between sensory modalities (Calvert et al., 2000; Murray & Shams, 2023). It is incorrect, therefore, to assume that only one

sensory modality is involved with information processing (Aslaksen et al., 2020). The suggestion that learning and teaching methods should be adjusted to match a learner's preferred sensory modality arose largely from Dunn and Dunn's (1989, 1992) idea that learning preferences are biologically determined and fixed, limiting the ability of learners to adjust to other modalities. Dunn and Dunn argue that, for this reason, the style of instruction should be matched to the learner's preferred modality and predict that, if learning is designed in this way, it will be beneficial to learning. The notion of matching instruction to the learner's preferred sensory modality is described by Pashler and colleagues (2008) as the "*meshing hypothesis*." On initial inspection, modality-specific instruction *appears* to be supported by a multitude of small studies that have amassed a body of evidence. However, few of these studies have applied an appropriate research design, and there is no supporting evidence for the meshing hypothesis (Cuevas, 2015; Kavale & Forness, 1987; Pashler et al., 2008). Subsequent more carefully-designed studies have also not produced supporting evidence in support of learning styles and, instead, suggest taking an entirely opposite multimodal approach (Aslaksen and Lorås, 2018; Cuevas & Dawson, 2018; Newton & Salvi, 2020; Rohrer & Pashler, 2012). However, an educator who may see learning styles as "a good thing" will find an abundance of educational articles favourably reporting the use of learning styles. Newton (2015) concluded that if an educator were to seek out articles that reinforce their existing beliefs, without a critical review of the literature, this confirmation bias would perpetuate both their beliefs and the use of learning styles in education, despite a lack of evidence for any improvements in learning.

Are VARK learning styles actually harmful to learning? These learning preferences are often conflated with learning ability, yet merely provide an oversimplistic means of categorisation. By labelling a student using some observable features, a number of other features are often incorrectly inferred (Willingham et al., 2015). Scott (2010) argues that educators who label and define learners with a fixed learning style may engage in harmful stereotyping behaviours that can perpetuate cultural differences and inequities. Equally, a learner may use them to blame external and uncontrollable elements for their lack of success: "I'll never do well in this subject"; "It's the teaching style or delivery method"; "I can't change my style" (Willlingham et al., 2015). Tokuhama-Espinosa (2018) also argues that learning styles can have a negative impact if a learner adopts a fixed idea about their learning style. For example, the 'visual learner' may avoid or disengage with music, podcasts, or webinars, while the 'auditory learner' may avoid information presented graphically. Similarly, learners may also develop a false sense of confidence in their ability to master subjects which they perceive to match their preferred learning style (Khan et al., 2018). Interestingly, a study by Breckler et al. (2009) found that, after completing the VARK questionnaire, only 15 percent of respondents were able to accurately predict their preferred modality. This suggests that how a learner thinks they learn best does not typically match with how their VARK results predict they should learn. Contrary to the metacognitive hypothesis, these perceptions are all "detrimental to motivating learners to feel empowered in taking control of their own learning" (Yan & Fralick, 2022, p. 63).

MULTIMODAL ALTERNATIVES TO VARK

Although learners may naturally prefer one modality over another, it seems there is currently no reliable evidence to support the use of VARK as a tool to improve educational outcomes. Rather, a pedagogical shift towards integrating multimodal learning experiences is more likely to support and enhance learning (Khan et al., 2018). Multimodality reflects the many ways in which we process information, communicate, and express ourselves, and is a powerful means to customise learning. It requires learners to engage with new information in a sense-making process, creating deeper learning opportunities (Bezemer & Kress, 2016), and extends the available options so that learning can be constructed via one modality, while also interweaving the use of others (Nouri, 2019; Phuong et al., 2017; Sankey et al., 2010).

According to Clark and Mayer (2023), in simple, laboratory-based contexts, presenting information in more than one modality results in a strong positive learning effect through better encoding and retrieval of memory. Similar benefits are also seen to occur in "naturalistic contexts" such as learning people's names, where faces and

written names tags provide visual support for auditory stimuli (Murray & Shams, 2023). As supporting evidence, Calvert and colleagues (2000) have shown the existence of "cross-modal" integration areas in the brain that receive information from both auditory and visual processing systems. Not only do these areas light up in brain scans when auditory and visual information are concurrently delivered, they compare, contrast, and check for congruency of auditory and visual stimuli. Aslaksen et al. (2020) reason that from this integration, transfer, and exchange of information between sensory modalities, the brain emerges as a highly plastic, interconnected, and dynamic network during learning. It follows that it is therefore incorrect to rely on only one sensory modality for learning. In a study by Sankey et al. (2010), learners reported favourably on the inclusion of multimodal learning elements, perceiving that these assisted with comprehension and retention of content, and indicating that learning materials were more engaging and easier to use. Although the study was unable to prove a positive learning effect as a direct result of the inclusion of multimodal representations, Sankey et al. (2010) conclude that careful consideration should be given to their incorporation as a means of improving learner engagement, progression, and retention. Given the evidence, the increased opportunity for communication in multiple modes, and the contemporary educational landscape, a strong case appears to exist for designing and delivering multimodal, rather than unimodal, learning experiences (Bezemer & Kress, 2016; Bouchey et al., 2021).

DUAL CODING AND THE COGNITIVE THEORY OF MULTIMEDIA LEARNING

Dual coding theory is a theory of cognition suggesting that the brain processes information along verbal and non-verbal channels. It predicts that better learning will occur if visual information is overlaid with auditory information, and that working memory capacity will be increased when information is received through both the eyes and the ears. This is because it is processed separately by visual and auditory processing centres, each of which is presumed to have a separate working memory compartment (Hodes, 1998; Paivio, 1990). Cuevas and Dawson (2018), whose research found no support for a unimodal approach to instruction, present evidence instead for dual coding as an instructional tool. Participants in their study were verbally presented with the same 20 statements and instructed to remember these by either creating a corresponding mental image, or by focusing on the sounds of the words. It was found that better learning occurred for those learners able to combine both visual and auditory information. Cuevas and Dawson (2018) reason that this provides strong evidence for dual coding theory as an instructional approach. A study by Constantinidou and Baker (2002) also found that presenting visual images with an accompanying verbal list helped all learners with recall, regardless of their preferred modality. They claim this is an example of the "picture superiority effect," and that it is therefore better not to rely on learning through unimodal auditory presentations such as lectures and discussions.

Mayer and Moreno's (1998) Cognitive Theory of Multimedia Learning (CTML) is an extension of dual coding theory. It is based on three assumptions about how information is processed in the brain: the dual-channel assumption, the limited-capacity assumption, and the active-processing assumption. The dual-channel assumption, as dictated by dual coding theory, suggests that visual and auditory information are processed via separate channels. The visual-pictorial channel processes images seen through the eyes, and the auditory-verbal channel processes spoken words. The limited-capacity assumption suggests that there is a limit to the amount of information that can be processed at any one time and the active-processing assumption suggests that learning takes place via active cognitive processes whereby information is identified, selected, organised, and integrated with prior knowledge. In short, the cognitive theory of multimedia learning assumes that the human mind is a dual-channel, limited-capacity, active-processing system, and that learning is more effective when experienced via multimedia messages (Mayer & Moreno, 2010). Criticisms of dual coding and CTML as multimodal approaches include their failure to consider that cognition can be affected by elements other than words and images. Astleitner and Wiesner (2004) point out that CTML does not consider motivational elements in relation to the amount of information that can be processed. Despite these shortcomings, there does appear to be validity in the suggestion that presenting information in multiple modalities helps learners process and integrate information more effectively (Clark & Mayer, 2023). It should be noted, however, that research in more

complex, realistic, educational environments is needed to establish the positive effect of multimodal learning approaches on learner achievement. This is particularly necessary in the context of higher education, and in the application and use of technology to promote and support multimodal instruction (Bouchey et al., 2021).

UNIVERSAL DESIGN FOR LEARNING

Bouchey et al. (2021) point to growing research interest in the use of technology as a powerful means to customise the learning experience. This extends to the ways in which technology supports multimodal representation via the principles of Universal Design for Learning (UDL). UDL is based on the premise that all learners have varied abilities, experiences, and preferences, and that these are dynamic depending on the context and an individual's stage of development (Meyer et al., 2014). Rather than matching instruction and learning environments to individual learner preferences, UDL aims to meet the needs of all learners without the need for extensive accommodations and modifications (Nelson, 2013). Its principles espouse a more flexible approach to the design of learning experiences, driven pragmatically by the nature of the content. The UDL framework is presented through three guidelines: Representation (the what of learning), Action and Expression (the how of learning), and Engagement (the why of learning). It suggests that learning experiences should be designed and delivered in multiple modalities; that flexibility be provided in the ways in which learners express themselves, and that learning should be based on learners' interests, values, and learning pathways (CAST, 2018). There is a tendency in formal education to present information unimodally via language and, specifically, printed text. This can represent a persistent barrier for some learners. The Representation guideline suggests that learning becomes more difficult when information is presented in formats that require extra effort or assistance. Research suggests that to reduce these barriers, it should instead be represented via a variety of modalities (Bodemer et al., 2005). The Action and Expression guideline also recommends that alternative modalities are provided to allow learners to express their knowledge, ideas, and understanding of concepts (CAST, 2018). UDL therefore provides a promising and well-intentioned learning approach to multimodal learning design. Boysen (2021), however, cautions that strong claims made for UDL warrant critical analysis, particularly where UDL exhibits similar features to learning styles with a lack of empirical research and overreliance on simplified neuroscience. Further research is required into the application of UDL as a multimodal learning design framework to establish a positive learning effect.

THE END … ?

VARK and the concept of learning styles frameworks can be viewed with a critical eye and considered to be 'of their time.' For the reasons presented above, if an educator chooses to use a learning styles framework such as VARK in their practice, it should not form the basis for the design and delivery of learning experiences. Furthermore, if we allow learning styles to remain in our institutions as a way of encouraging self-reflection and the acquisition of metacognitive skills, we need to validate them for that purpose. Concerns need to be addressed around learners and educators adopting fixed ideas about their learning preferences and conflating this with their ability to succeed. Importantly, we need to move beyond the neuromyth of learning styles toward multimodal approaches informed by evidence, and applied according to the content we are teaching and the context within which we are teaching it.

Our recommendations for adopting a multimodal approach to learning design and delivery are:

1. Follow the content and consider the context. It is important that all content is taught in its ideal modality and in one that is fit for purpose. For example, a mathematical model needs to be visualised; the stress on a syllable or the rhythm of a form of poetry needs to be heard, and the pressure required to shape a piece of pottery or to administer an intravenous injection needs to be felt.
2. Move between different modalities to keep your learners engaged.

3. Use multimodal approaches such as dual coding, multimedia learning and UDL, to deepen learning and support understanding of new knowledge.
4. If encouraging students to recognise their learning preferences and broaden their learning strategies, combine this with an introduction to metacognitive strategies supported by an appropriate framework.
5. Instead of differentiating content and delivery according to learning styles, explore diversity through the design of learning activities and assessments based on a learner's interests, prior knowledge, and cultural preferences.

We now have a broader, deeper understanding of how learning occurs through multiple modalities and senses. Educational practice should allow for flexibility and adopt a strengths-based approach to minimising barriers and designing learning for all learners. Replacing our use of the term "learning styles" with "modalities" in our common learning and teaching lexicon, and planning instruction that recognises the dynamic nature of learner diversity, helps us move from a fixed mindset to one that helps learners recognise their own strengths and challenges, and supports their growth and development.

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