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# IS THERE A LEARNING TYPE?! REVISITING LEARNING-STYLES THEORY IN VIEW OF LEARNING AND EMOTION

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**Abstract:**
Over the last twenty years the VAK learning-styles theory, which differentiates between visual, auditory, and kinesthetic learning types, has been criticized and debunked by various academic disciplines and declared by several scientists as a *neuromyth*. Regardless of its criticism, the concept has retained its popularity within the teacher-community and is regularly taught in teacher education. The aim of this article is to meet this theory-practice gap in a constructive way. After (1) a short introduction, this paper starts (2) with a differentiated assessment of the theory. The VAK learning-style theory will be deconstructed into four main hypotheses which are then (3) one at a time, evaluated (empirically as well as in view of teaching practice). After a complex evaluation of the concept and its criticism, this article continues with (4) showing, how the learning-style theory provides teachers with an approachable understanding of learning and comforts them in dealing with learning differences within a heterogenic student body. Considering the empirical evidence on the one hand and teacher's needs on the other hand, this article (5) lines out fundamental insights of learning theories, as well as (6) the relevance and capacity of emotions for perception and evaluation processes. Approaching (7) learning style-theory from the perspective of learning-theories and theories of emotion, which highlights the interdependency of learning, achievement, and emotion, finally allows concluding the paper (8) with four specific and normative principles, which allows teachers to benefit from an empirical accurate understanding of a complex process of learning and teaching.

**Keywords**: learning-styles, learning type, emotion, teaching, learning, achievement, education

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## 1. Introduction

Over the last 40 years the field of learning-styles theories has grown and diversified tremendously. A variety of theories, concepts, and models of different learning and cognitive styles have developed (for an overview see for example Cassidy, 2004). The VAK learning- styles theory, which differentiates between visual, auditory and kinesthetic learning types, has become one of the most popular and has shaped public and professional perceptions of teaching and learning (Torrijos-Muelas et al., 2021). This is indicated by several studies wherein the majority of the teacher-community approved of the theory; 96% (Tardif et al., 2015); 95%/ 96% (Dekker et al., 2012) and > 90% (Howard-Jones, 2014; Papadatou-Pastou et al., 2018) approved of learning-style theory. One major force behind the reaffirmation of learning-style theory is teacher education itself. According to a study by the *National Council on Teacher Quality* (Greenberg et al., 2016), learning-style theory is taught in 67% of teaching programs and is included in 59% of the respective course literature. Notwithstanding its popularity, scientists and experts from various related disciplines, such as education, education psychology and neuroscience, hold the concept of learning styles to be highly controversial. In opposition to proponents of the theory (e.g. Dunn & Dunn, 1978a; Sternberg et al., 2008; Tulbure, 2011), critical voices have highlighted the inaccuracy of the theory and the lack of empirical evidence for its hypothesis (e.g. Pashler et al., 2008; Willingham et al., 2015; Letharby & Harries, 2016; An & Carr, 2017). In fact, publications have noted "*a rapid decline in research on cognitive styles in mainstream psychology by the end of the 1970s*" but "*in applied fields (e.g., education, business, and management), publications on the topic continued to increase dramatically"* (Kozhevnikov et al., 2014, 4), with publications related to education peaking at 697 articles between 1999 and 2013 (Evans & Waring, 2012; Kozhevnikov et al., 2014, 9). This discrepancy between the vast approval of the general public, pedagogical practitioners, and other proponents (especially people selling programs about how to teach and learn according to the theory), and a skeptical scientific community necessitates a reconsideration of VAK learning-styles theory. This new approach must be able to incorporate recent empirical evidence and consider the questions, demands, and needs of pedagogical practice. This paper aims to serve as a meeting ground between the proponents of VAK learning-style theory and its retractors by reconceptualizing learning style theory in view of theories of learning and emotion.

Thus, we argue that, first and foremost, VAK learning-styles theory requires a more comprehensive and comprehensible understanding of *learning*. Secondly, we argue that this understanding of learning should not only be based on general fundamentals of learning theories but more specifically on a robust account of the long-overlooked interplay between emotions and learning. This approach has the potential to fruitfully contribute to the learning-style discussion within teacher education. It can serve to counteract a total rejection of learning-style theory and instead provide a more differentiated assessment of the theory as well as a crucial and intelligible understanding of learning processes.

Following a dialectical structure, this paper begins by breaking down (1) the main hypotheses underlying the VAK learning-styles theory, and (2) its criticism as well as (3) the reasons behind its popularity. This is followed by (4) an outline of fundamental conclusions rooted in learning theories, especially those emphasizing the connection between emotion and learning, in order to then (5) develop a very specific (and practical) proposal directed towards teachers and teacher education. Revisiting the VAK learning-styles theory through the lens of theories of learning and emotions will, more precisely, result in four new hypotheses that retain certain elements of learning-style theory and relativize or discard others, thus allowing for a more complete and accurate understanding of learning and teaching.

## 2. Approaching the fundamental hypotheses underlying VAK learning-styles theory and its consequences for teaching

VAK learning-styles theory can be broken down into four main hypotheses, each of them prompting concrete action within the context of teaching and learning. While all these hypotheses are interconnected within the theory and are hardly ever treated distinctly, the separation is necessary in order to allow for a differentiated approach and for a revision of the theory.

Firstly, VAK learning-style theory rests on the assumption that there is an individual who learns in different ways, according to different cognitive styles. Initially, the cognitive style was a central notion and "*referred to consistencies in an individual's manner of cognitive functioning, particularly in acquiring and processing information*" (Kozhevnikov et al., 2014, 3). According to VAK learning-styles theory, those differences lie more precisely in the *channels* through which the learning-material is received – eyes, ears, or hands/body. It is crucial to point out that the conceptual and theoretical discussions about learning-styles theory present highly variable interpretations and understandings of what style actually refers to. We, therefore, differentiate between *ability, preference, and style* in order to better understand what cognitive styles are and are not, according to VAK learning-style theory. According to Willingham et al. (2015), *ability* describes the competence of an individual to learn in a specific way (e.g., some individuals are musically more talented, while others are more competent at thinking spatially). The first hypothesis is thus that learning styles, following Willingham et al. (2015), are not abilities, because learning styles are not meant to express *that* you can do something but *how* you do it (Willingham et al., 2015, 267).

With the second hypothesis, the notion of *preference* (Willingham & Riener, 2010, 34/ Willingham et al., 2015, 266) comes into play. This is a term that is frequently invoked by proponents of the concept (e.g. Dunn & Dunn, 1993). It is important to notice that *preference,* within the context of VAK learning-styles theory, is interpreted as a trait, "*a consistent attribute of an individual*" (Willingham et al., 2015, 267), that predicts the sensual channel through which information is received. Preference, in the context of learning-styles, is therefore not understood as an individual's choice, it is not a voluntary

affectation towards a specific learning-pathway (e.g. students who hate reading but love listening to audiobooks). In the past this particular understanding of learning-styles was also described as "*perceptual attitudes*" or "*predispositions*" (Krozhevnikov et al., 2014, 5). Consequently, the second hypothesis consists of the idea that individuals differ in their learning-styles and can be divided into different learning types. According to VAK learning-styles theory, individuals can be categorized either as visual, auditory or kinesthetic learners. In other words, the second hypothesis claims that individuals *absorb*, figuratively speaking, knowledge and learning-material through different channels and that this is not due to ability but to (preconditioned) preferences.

The third hypothesis is that individual learning-styles can be determined through reliable and valid assessment-tools (e.g. Dunn and Dunn's model, cited by Coffield et al., 2014, 24). It is thus hypothesized that learning-styles can be determined via different tests. In addition to a plethora of free online self-assessment questionnaires, common tests are, for example, the *Learning Style Inventory* (Kolb, 1976), the *VARK-Questionnaire* (unknown author), and the *Verbalizer-Visualizer Questionnaire* (Richardson, 1977). These are self-assessment questionnaires, whereby learners can determine if they are visual, auditory or kinesthetical learners by answering questions such as, "*during my free time I most enjoy: a) going to museums and galleries, b) listening to music and talking to friends, c) playing sport or doing DIY"* (Chislett & Chapman, 2005).

The fourth and most crucial hypothesis is the so-called *matching/ meshing hypothesis*, which claims that learners who are allowed to learn according to their learning-style achieve better or optimal results, that the "*cognitive function should be more effective when it is consistent with a person's preferred style*" (Willingham et al., 2015, 267). Advocates of VAK learning-styles theory thus suggest teaching students (Dunn & Dunn, 1978a), elementary students (Dunn/ Dunn 1978b), secondary students (Dunn & Dunn, 1993), as well as law students (Boyle & Dunn, 1998) through individual learning styles. This means that a class of mostly *visual learners ought* to be taught with visual material (e.g. texts and textbooks) in order to allow for optimal learning outcomes.

These four hypotheses yield a series of demands regarding teaching, the development of teaching material, and didactics. At a basic level, one could argue that the tendency of individualized instruction is a central request rooted in VAK learning-styles theory. Moreover, teachers are urged to determine the respective learning-style of their students, either through self-assessment or through specific test-instruments. Hand in hand with the *matching-hypothesis* often comes the claim, popular among educational practitioners, that teachers should arrange their instruction methods and their teaching material according to the respective learning-styles of their students (Dunn & Dunn, 1992 & 1993; Boyle & Dunn, 1998). However, as Kozhevnikov et al. (2014, 11) argue, this conclusion is not shared consistently within the scientific field, and some authors even hold performance benefits from mismatching didactical material with self- identified learning-styles. Outside of the scientific field however, the matching-hypothesis has garnered far more support and imitation, especially within the teacher community.

It can be concluded that VAK learning-styles theory asks teachers and students to first determine learning-types and then to adjust their teaching and learning accordingly. For example, visual learners ought to be provided with textbooks, papers, graphics, and images, whereas their auditory learning peers ought to learn with podcasts, music, and audio books. Consequently, these assumptions and implications are accompanied by fundamental anthropological assumptions about learning, revisited in the following section.

## 3. The empirical evaluation of the VAK learning-styles theory and of its implications for teaching and education

In this section we will examine the evidence-based perspective on VAK learning-styles theory, analyzing studies grouped according to different research interests. We begin with studies, testing the existence of VAK learning-styles as well as the accuracy of the matching-hypothesis. Secondly, we direct attention to those studies that consider the testing and classification of learning types. Thirdly, this paper addresses the few studies that emphasize the consequences of the application of learning-style theories in the classroom. There is a fourth research category, containing research that addresses the roots and reasons behind the popularity of the concept and thus aims explicitly to understand thoughts, concerns, and wishes of teachers. Since this category partly shares the research interest with the present paper, the fourth chapter specifically discusses conclusions drawn within those publications.

Parshler et al. (2008) argue that the meshing-hypothesis would require a study design that is illustrated as: (1) A randomized sample with comparable learners (age, IQ, etc.) that (2) identify either as visual or auditory learners (to simplify the illustration, the kinesthetic type is ignored) and are then (3) divided into two groups according to those designations. Both groups (4) go through two learning and test periods with the same learning material (e.g. list of names), learning-conditions (time, space, etc.) and questionnaires (e.g. questionnaire asking for the names). (5) In the first session, one group learns the material visually while the other group learns in an auditory way. (6) In the second session, the learning materials are exchanged and the auditory group now learns visually and vice versa. The existence of learning-styles is proven, and the matching-hypothesis is confirmed, if the subjects perform significantly better on the test wherein they learned according to their identified learning style. Additionally, Pashler et al. (2008) highlight the necessity of a *style-by-method crossover interaction*, meaning that visual learners must perform significantly better when learning with the visual-style than their auditory peers, and significantly poorer with the auditory method, compared to the auditory group, and vice versa.

After conducting a comprehensive literature review, Pashler et al. (2008) could only identify a handful of studies meeting those criteria, none of which had significant results (e.g. Constantinidou & Baker, 2004; Massa & Mayer, 2006; Zacharis, 2011). These findings are consistent with results of previous reviews (Arter & Jenkins, 1979;

Kampwirth & Bates, 1980; Kavale & Forness, 1987; Hirshoren & Forness, 1998; Snider, 1999; Tarver & Dawson, 1978 – cited by Willingham et al., 2015, 267). It can thus be concluded that neither the existence of learning- styles (hypotheses 2 and3) as trait preferences, nor the benefits of teaching according to the identified learning-style (hypothesis 4) has been verified in valid and reliable study designs.

A second issue, empirically addressed in the context of the VAK learning-styles theory, is the validity and reliability of its classification tools (e.g. Martin, 2010). More precisely, there is an issue with the accuracy of self-reports, through which individual learning-styles are identified. Krätzig & Arbuthnott (2006) conclude in their study "*that objective test performance did not correlate with learning style preference*". Massa & Mayer (2006), Coffield et al. (2014) and Papapatou-Pastou et al. (2018) draw similar conclusions and highlight the inaccuracy of self-report instruments when it comes down to identifying learning-styles. People are generally poor at self-assessment and self-perception, and self-designating a specific learner-type is no exception. Supposing that learning-styles exist, which is highly questionable considering the empirical results presented above, the customization of the instruction according to learning-styles can thus not be based on students' self-identified beliefs.

A third point of interest is whether learning-style-research addresses the actual consequences when VAK learning-styles theory is applied in the classroom. Even though student performance, teacher satisfaction and classroom well-being are often brought up in the discussion chapter of papers on the learning-style theories as outputs, they are not as well studied as other, previously mentioned aspects. In a systematic literature-review Newton and Salvi (2020) point out, that it is even questionable to which point the teacher-belief in the theory can be actually transformed into its implementation within teaching. According to Coffield et al. (2014, 39), the few studies conducted on this topic came to very different results. Reynolds (1997) or Townsend (2002), for example, "*found nine studies which showed that learning is more effective where there is a match and nine showing it to be more effective where there is a mismatch*" (Coffield et al., 2014, 39). As Gregorc (1984) claims, teaching according to identified learning-styles could increase students' boredom and thus be counterproductive to their academic achievement (Coffield et al., 2014, 40). In general, the actual impacts of implementing VAK learning-styles theory in the classroom (identifying student's styles, teaching according to the styles etc.) are discussed rather differently, and so, from an evidence-based point of view, one cannot jump to any specific conclusions. Against the background of this uncertainty, Roberts and Newton (2001) warn, "*that it is simply premature (and perhaps unethical) to be drawing simple implications for practice, when there is so much complexity and so many gaps in knowledge*" (Coffield et al., 2014, 40). Considering the inaccuracy of self-detected learning-styles (discussed previously) Kozhevnikov et al. (2014, 12) assert that even if learning-styles exist, letting students choose their learning-style has to be considered truly problematic. A different standpoint comes from Sadler-Smith (2001, 300) who claims that VAK learning-styles theory could potentially raise students' awareness of their learning patterns. A similar idea lies behind the *Bruce Lee metaphor* (Kozhevnikov et al., 2014, 12),

which expresses the potential benefits of teaching so-called meta-styles; teaching students to learn according to every style and teaching them to accurately evaluate when to apply which style. However, this idea partly rebuts the premise of the VAK learning-styles theory while supporting the refutation made by Riener and Willingham (2010, 34), claiming that the learning-styles are tied to contents rather than to individuals.

Before concluding this chapter, it is nevertheless necessary to acknowledge that the failed efforts to empirically prove VAK learning-styles theory cannot be interpreted as a radical repudiation of each and every idea behind the concept. As Kozhevnikov et al. (2014,11) point out, the lack of evidence regarding the matching hypothesis is not enough to discard the existence of learning-styles themselves (hypothesis 2 in chapter 2). While previous authors have mentioned this, this paper explicitly emphasized the need to highlight blind spots and re-evaluate the theory in a different way. By considering problems and misconceptions of the theory, as well as by retaining possible truths behind it, this paper recognizes a chance to obtain a more differentiated and accurate understanding of how teachers and learners could approach the complex phenomenon of learning. Learning theories, and especially those highlighting the role of emotions in learning and teaching, can only enrich the fragmented and polarized discussion around learning-style theory, in particular, when not only its problems but also its popularity within the teacher-community is understood. This will be discussed in the following chapter.

## 4. Stubborn myth of learning styles within (teacher) education in spite of evidence-based backlash

In addition to empirical evaluations of the accuracy of the VAK learning-styles theory's hypotheses, the quality of assessment tools, and the advantages of the application of VAK learning-styles theory in the classroom, there is another question to address; what makes learning-style theory so popular within the teacher community?

Firstly, several authors reference psychological phenomena, especially confirmation bias or familiarity bias, in order to explain the continuing popularity and affirmation of the theory (e.g., Pasquinelli, 2012; Riener & Willingham, 2010). According to this assumption, VAK learning- styles theory constitutes a prior belief for many teachers (namely a belief of how learning works) that is, often unconsciously, preserved through filtering new information in accordance with it (Pasquinelli, 2012, 92). This is true for theoretical information, for example in publications debunking the theory, as well as for (and this seems especially relevant for the case of teachers) experiences of learning and teaching. The latter goes in hand with the so-called availability/familiarity bias, which is "*the tendency to rely more on available examples than on statistics when estimating risks and probabilities for future choices*" (Pasquinelli, 2012, 93). This seems especially dangerous within the teacher-community, since once familiar with the idea of learning styles, and once having shaped an idea of the personal learning style (or the

learning style of students in the case of teachers), situations where the subscribed learning style seems actualized are perceived whereas opposite situations go unnoticed.

Secondly, VAK learning-styles theory is likely popular within the general population because it is easily comprehensible (Dunn & Honigsfeld, 2013), self-explanatory, and plausible (Kavale et al., 1998). While concepts like the confirmation/familiarity bias have a high degree of explanatory power in terms of the popularity of the VAK learning-styles theory (e.g. in illustrating the self-fulfilling prophecy in which the theory finds continuous approval) it also appeals to teachers' required understanding and demystification of such an invisible and highly complex matter as *learning. To* this point, the concept of learning styles is thus especially appealing for teachers because it meets teachers where they are – namely in front of a complex and diverse student body. Dunn & Honigsfeld (2013, 229) have recognized this and claim that the strength of their model lies within its "*pragmatic and practitioner-orientated emphasis*". In contrast to its criticism, the theory itself, doesn't fail to "*bridge the disciplinary gap*" (Mcdonald et al., 2017, 2) between theory and science on the one hand and teacher practice on the other. This may also explain why one-third of academics in higher education still use the learning style theory, although knowing about its empirical deficiency (Newton & Miah, 2017). The concept of learning with different body parts is a popular, analogy in order to break- down the complex phenomenon of learning that is sometimes taken too literally; Pestalozzi's famous plea to learn with head, hands, and heart, here becomes learning with the eyes, ears and hands/body. But it is also an idea of typology that has been well-received as a way of understanding people and their development. Pashler et al. (2008, 107), for example, refer to Carl Gustav Jung and note that people's desire to identify with a *type* they belong to, which has become increasingly visible today.

Contexts of teaching and learning are complex and highly challenging from the perspective of those involved. It is first and foremost the combination of accessibility and intelligibility on the one hand and simplification and complexity reduction on the other hand that contribute to the popularity of the concept. However, and this is especially relevant to the following chapter, VAK learning-styles theory offers a particular understanding of learning (namely inducible via stimulating the correct channels), and its individuality (why the same teaching doesn't work for every student). It can therefore provide an explanation for learning problems encountered by teachers and laymen. In view of these aspects, the following chapter aims to revisit some of its hypotheses in conjunction with comprehensible and practical of emotional theories.

## 5. Approaching the process of learning

Learning as a life-long process enables us to expand, improve, and modify knowledge and skills, behavior, and attitudes as well as competences and capabilities (Huber, 2017). If we talk about learning in the context of education and schooling, it is hard to resist drawing on common stereotypes and personal experiences. Imagine a quiet classroom

full of pupils who follow their teacher attentively, take notes, ask questions, and solve problems. This is a scenario in which, one would think, learning happens as a process of conscious communication within teacher-student interaction. Or imagine someone sitting in front of an open textbook in a dark corner of a university library, highlighting paragraphs and scribbling notes. Here as well, one might conclude that someone is learning. However, whether learning actually takes place in either scenario can only be guessed or hypothesized.

Learning by definition is a theoretical and abstract construct that aims to explain the fact that experience influences behavior, which in turn drives changes (Schoenfeld, 1999). The process of learning cannot be directly observed. Moreover, learning is not controllable, either by the learner or by the teacher. Both can arrange optimal conditions for learning (and teaching), but the process of learning cannot be operated consciously (Helmke, 2015). Therefore, learning cannot be understood as a willful process of knowledge acquisition. Rather it has to be understood as an *automatic procedure* (gr.:αὐτόματος = *automatos* = acting on oneself) and is thus not subject to the conscious will of the learner. This notwithstanding, it makes sense to draw a clear distinction between learning as an intentional process and/or learning as an incidental occurrence. Deliberately planned classes with strategies of individualization and *good teaching* is an essential preconditions of learning and development. But the majority of learning processes happen on an incidental, implicit, non-conscious, and casual level (Reisberg & Hertel, 2004). Incidental learning, for example, makes use of inborn or inherent inquisitiveness and playful behavior, or the innate need to explore surroundings, which can be observed in all mammals from birth (Sachser, 2004). Moreover, many skills and competences we learn in our life, like perceptual and motor abilities, are procedural and have no direct connection to conscious memories or experiences (Rudy, 2006). This leads to the question of why certain contents are learned, and others are not. Why do students learn certain information better than other information and why is some of this information memorized but not all? How do specific preferences occur in the learning process and why is it sometimes easier to remember certain material? Why are some pathways allegedly more suitable for unique educational contents than others? And what are the implications for teaching and learning can be derived from this? These fundamental questions, which constitute theoretical and practical concepts of teaching and education, will be problematized in the next chapter along with the impact of emotions and emotional evaluations in learning processes.

## 6. Perception, evaluation and emotion

Considering the basic processes of perception and memory it can be assumed that every stimulus, and all patterns of perception, are always evaluated and consciously or unconsciously marked, and become part of our awareness (Kaplan-Solms & Solms, 2000). In reducing of the complexity of reality, the organism has to evaluate permanently the diversity of sensory impressions. In that sense, every stimulus leads to an emotional

evaluation, considered as a process of multilevel sequential checking (Scherer, 2001). Imagine you're at the beach, watching the sunset, maybe having a drink and enjoying dinner with your partner, wearing a summer shirt. Suddenly a mosquito sits down on your arm. What are you going to do? Most people, regardless of their origin or culture, will immediately, and without any conscious mental activity involved, slap at the spot where the insect has settled. This is remarkable, because the weight of the mosquito, monitored by skin receptors (surface sensitivity), constitutes only a fraction of the impact of the shirt. These kinds of appraisals are essential for survival because they enable the selective sensation of the large number of stimuli we are confronted with every second of our lives. And this reduction of the complexity of reality, illustrated by the simplistic mosquito example, is only possible because of assessment and appraisal caused by emotional evaluations (Scherer, 2009).

A very important scientific movement in emotion theory takes the assumption that every stimulus is apriori evaluated, and this assumption constitutes the general basis of their theoretical framework, illustrating that learning processes in particular must be understood as the attribution of meaning by evaluation. These *cognitive appraisal theories* assume that an emotion is the result of specific cognitive or mental evaluation; more precisely, proponents of its theory (e.g. Frijda, 1986; Lazarus, 1999) argue that emotion is triggered by the subjective assessment of the cognitive appraisal of an event, situation, or stimulus. Scherer (2001, 94) argues for his "*component process model of emotions*" that *emotional states* are the result of specific stimulus evaluation (appraisal) checks. This very complex theoretical model postulates that a set of criteria, the *stimulus evaluation checks,* "*are predicted to underlie the assessment of the significance of a stimulus event for an organism*". In this context, every stimulus, regardless of the sensor modality, is sequentially evaluated by four objectives that allow the organism to prepare for an appropriate reaction. These stimuli evaluation checks are in relation to their subjective relevance (how relevant is the event for me), specific implications (what are the implications and consequences of this event), coping potential (how can I cope with or adjust to these consequences) and their normative significance (with respect to the individual self-concept and the social norms and values). Scherer argues, and this is important in the context of learning and memory, that the evaluation or appraisal often happens automatically and non-consciously. Moreover, the process of appraisal is not a single action or reaction but a repetitive and transforming procedure. Therefore, the stimulus evaluation checks are interdependent and also contingent on other mental processes and habitual characteristics. The emotion itself in turn influences the evaluation process, has an impact on it, and is therefore constantly changing (Scherer, 2009, 1318-1321).

According to the cognitive-appraisal theory, one can understand that every sensory impression, regardless of whether it is visual, auditory, or kinesthetic, undergoes this fourfold evaluation process. By taking into account the processes of learning and achievement, discussed in the following section, the relevance of emotions in learning-teaching interactions will become even more clear.

## 7. Emotion, learning and achievement

Considering the relevance of cognitive appraisal theories in the context of learning, especially Reinhard Pekrun's (2006, 2018) "*control-value theory of achievement emotions*," provides an integrative framework for analyzing the importance and multi-causal effects of emotions for achievement and learning outcomes. Central to this framework is, firstly, the assumption that emotions in the context of learning and achievement can not only be categorized by their valence, as positive and negative emotions, but rather in view of the arousal perspective of emotions. This perspective elucidates that emotions have an activating or deactivating effect on learning processes. Pekrun (2018) thus categorizes emotions into four types; positive-activating (like joy, hope and pride), positive-deactivating (like relief and relaxation), negative-activating (like fear, shame, and anger), and negative-deactivating (like hopelessness and boredom) (Pekrun 2018, 216). Secondly, Pekrun's control-value theory, as well as Scherer's component-process model previously mentioned, highlight the retroactive effect of the learning process on emotions (and their development), which emphasizes the continuous interdependent interaction between achievement and emotion. This means that the effects of emotions on learning processes and achievement outcomes are manifold. For example, it was shown that negative emotions reduce the possibility of flow-experience in learning processes (Pekrun et al., 2002); positive and negative emotions can affect task-based attention (Meinhardt & Pekrun, 2003); positive emotions can enhance the intrinsic motivation of students (Zeidler, 1998); and negative-deactivating emotions can paralyze the learning motivation of students (Pekrun et al., 2010). Moreover, it has been demonstrated that memory, learning strategies, and self-regulation processes in learning go hand in hand with specific emotional evaluation (Pekrun, 2018, 227; Code, 2020). To sum up, it can be concluded that (1) every emotion is an achievement emotion, (2) every learning process and achievement goes hand in hand with different discrete emotions and (3) the result of the learning process influences the emotional experience so that learning and emotion must be understood as interdependent.

Although cognitive appraisal theories are sometimes criticized because of their complexity, which leads to massive operationalization problems (see e.g. Robinson & Clore, 2002; Barrett, 2012; Schmidt-Atzert et al., 2014), they show that emotions are a precondition of thinking, acting, and especially learning. The importance of emotion to learning processes can be discussed alongside four central perspectives. First of all, emotions are an indispensable precondition of learning processes. This means that even before academic learning in the proper sense happens, discrete emotions are activated by previous experience and idiosyncratic expectations (Hascher & Brandenberger, 2018). Every student has gone through learning experiences even before schooling starts. Those experiences have then been emotionally evaluated (appraised) and eagerness either becomes habitual or it does not, which can be seen in the fact that school absenteeism happens often already in primary school (Hagenauer, 2011). Secondly, emotions are the factors that most influence the learning process. In this sense, emotions indicate if and

how something is learned (Abel-Brem & Gedolla, 2000). Moreover, they control the direction of the learning behavior and also influence cognitive processes. Beside the valence and arousal of specific emotions, intensity is also a determining factor. Especially strong positive and activating emotions, like pride, for instance, have global effects on the learning outcome of students (Huber, 2020). Thirdly, emotions are the result of learning processes. The teaching structure, culture of learning, and experience of performance and competence are highly relevant to the development and formation of emotions. That simply means that learning itself influences the emotions of students, affecting school well-being (Lipowski, 2007). This clearly illustrates that learning and emotion are interdependent components. And finally, the fourth perspective illustrates the true potential of this indissoluble connection: emotions themself are learning processes. On the one hand, they enable the understanding of the behavior of others and oneself as well as the acquisition of related competences, which is especially apparent in the context of SEL-programs (e.g. Durlak et al., 2011). One the other hand, emotions allow the transition of knowledge in the context of problem-solving competence; during challenging situations in life, emotions and emotional evaluations allow for the transfer and reconstruction of knowledge and skills to overcome unknown situations in everyday reality of life (Huber, 2018, 106).

All four perspectives illustrate that learning and emotion are inextricably interconnected. In all stages of learning, emotions and emotional evaluation are substantial. To argue that only the type of sensation or the channel of learning is significant to the outcome and achievement of students would neglect the importance of emotion in learning in particular and for human life in general. In the context of VAK learning-styles theory, one can conclude that each experience with reading (visual), listening to audiobooks (auditory), and building bricks (kinesthetically) are emotionally appraised (first perspective). But the content consumed through those strategies and channels is emotionally evaluated as well (second perspective). Therefore, even though the former conclusion attracted attention within learning-styles theory, the latter one has been neglected. It is crucial, however, because content that accompanies strong positive activating emotions is more likely to be learned, regardless of whether it abides by the matching- hypothesis. But, much more importantly, it is the third and the fourth perspective that is overlooked when teaching in accordance with the matching-hypothesis since students probably rigidify the emotional appraisal of certain learning experiences and thus do not get the chance to develop an emotionality and a corpus of transverse competences that are crucial to handling the complexity of daily life.

Teaching according to VAK learning-styles theory is therefore not beneficial in all cases and can even hinder long-term learning-outcomes and competence development. Instead of completely rejecting the whole theory, the next chapter tries to develop a synthesis which combines an accurate understanding of learning as well as the beneficial contribution VAK theory has had on the teacher community.

## 8. Syntheses

In summary, revisiting VAK learning-styles theory through the lens of learning theory and theory of emotion leads to the following conclusions:

The premise of the individuality behind learning processes, on which VAK learning-styles theory is based (hypothesis 1 chapter 1), seems to be indisputable given the evidence that exists on the topic of learning and learning processes. Individual differences in learning mean that learning sometimes is privileged, in the sense of subjective meaningful prioritization, and sometimes is not. The decisive factor behind the question of whether learning is privileged or not does not, however, lie in each person's learning style. Linking a successful learning outcome to the question of whether the learning content was presented and absorbed through the correct learning channel is a heuristic way of thinking that underlies the matching- hypothesis of VAK learning-styles theory that neglects the complexity of learning processes, as shown in chapter 3. Breaking down the complexity of the learning process and visualizing an invisible, complex phenomenon is one of the reasons for the popularity of the VAK learning- styles theory. Considering the example of the quiet classroom full of pupils who follow their teacher attentively, take notes, and ask questions on the one hand, and considering the impact of emotions as a precondition, an influential factor, and a result of learning processes on the other hand, it can be concluded that emotions and emotional evaluations determine the learning process in the first place. This means that elements such as didactical material and learning environment cannot be seen outside of the context of emotion and emotional appraisal. With this in mind, the question comes up of how schooling and instruction can be designed in the best possible way, taking into account the quality and quantity of emotional evaluations in learning processes. Besides the basic requirements of learning and memory (repetition, attention, vigilance, and concentration) three central dimensions must be emphasized that enable the conscious design of learning-teaching interactions and take into account the impact of emotional evaluations: the subjective or individual factors of learning, the contextual factors of learning, and the relational factors of learning (Hascher, 2010; Arndt, 2012; Huber, 2017). The subjective factors can be understood as the learning needs of students and contain (a) multidimensional experience and learning spaces, (b) social interactions within the learning process, (c) intrinsic motivation, (d) reductions of requirements, (e) centering of interest, (f) strategies of individualization and (g) self-efficacy beliefs. The contextual factors of learning can be understood as the learning environment and include (a) the learning setting (spatial design, temperature, noise level, lightning, and working hours), (b) the teaching stuff (engagement, authenticity, enthusiasm, and sympathy) and (c) the teaching structure (processing of the learning material, and didactic concepts). The relation factors of learning consider the pedagogical relationship with respect to. the didactic triangle that contains (a) the relationship between students and teachers, (b) the relationship between learning topics and students and (c) the relationship between teachers, students and learning topics.

Taking into account the main premises of VAK learning-styles theory, the reasons for its popularity, as well as the indiscerptible link between emotion and learning, conceptualized through the three dimensions (individual, contextual and relational factors) of learning, this paper proposes four principles. These principles consider the complexity of learning-teaching processes derived from evidence-based learning research, without neglecting the demand for a concrete understanding and practical explanations of learning differences for teachers and practitioners. Therefore, the following principles can be understood as normative guidelines:

1) Emotional arousal allows for optimal cognitive functioning. According to Yekes-Dodson's law (1908), a certain amount of stress does not only not hinder, but is necessary for learning to succeed. In view of Pekrun's concept of *achievement emotions*, this also is true for emotions. Emotions always have an impact on thinking and acting and from an evolutionary perspective all emotions, positive and negative, are necessary and vital. Therefore, the arousal perspective of emotions is crucial for understanding the learning process of students: there is no learning without excitation potential.
2) Instead of habituation of learning styles, students should go through manifold self- efficacy experiences resp. experiences of competence using different sensory channels. In this regard, it is important that teachers foster social integration, moments of participation, and the experience of autonomy of their students (to ensure well-being).
3) The key to effective teaching is the connection between the content and the reality of the student's life. The learning content must be experienced as subjectively important and therefore teachers have to link the content of schooling to their students' reality, taking into account the intensity of the subjective emotional evaluation.
4) In general, schooling should foster positive emotions and reduce negative emotions to the greatest possible extent. But this also means that negative emotions must be understood as a part of the process and therefore teachers and students have to learn how to deal with these negative emotions: The regulation of emotions is a central aspect of learning and teaching. Therefore, the aim of designing learning spaces should be to elicit feelings of comfort, security, and trust, and as such serve as a precondition for critical engagement with knowledge and oneself. This sense of comfort and security needs appropriate continuity and structure supported by education systems and educational leaders.

Teachers do observe every day that their students end up with different learning-outcomes even though the instruction quality was indifferent. From a scientific point of view, these differences within learning processes are not imaginary but very real and have to be taken into account as educators cope with the challenges of teaching and learning. This paper highlighted that VAK learning-styles theory comes up short when it comes to explaining those differences. A look at the interplay of emotion and learning has shown that VAK-learning styles theory highlights only the type of sensory stimuli

(visual, auditory, kinesthetic) and the learning-outcome while neglecting other crucial dimensions such as the emotional appraisal of the stimuli itself (=content) or self-efficacy beliefs. It also neglects the fact that emotions are not only a result of learning but that learning strategies in turn influence the development of emotions and emotionality, including for example self-efficacy beliefs. Above all, it sketches an analogical understanding of how learning works that is underdeveloped and at a distance from scientific understandings of learning. In order to guarantee a more accurate, but nevertheless practicable account of the individual differences in learning, this paper suggests that it is necessary to provide teachers with an understanding of learning and learning processes that includes the interplay of learning and emotion. It would therefore include notions such as arousal, self-efficacy beliefs, and emotional regulation in the curriculum for teacher education in conjunction with methods allowing for the building of the connection between learning content and the reality of students' life.

**Conflict of Interest Statement**
The authors have no conflicts of interest to declare.

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