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## ABSTRACT

This article discusses the alluring topic of olfactory learning, which is often touched on in the literature but is rarely employed. I argue that olfactory learning, at its best, is achieved in contact with living nature, as in the plethora of scents that can be encountered and discussed in ecological context in a forest. An expected outcome is enhanced sensory awareness of the living environment.

**Key Words:** Multisensory learning; olfaction; plant scents; biosphere; learning atmospheres; walk-and-talk; natural scentscapes.

## ○ Life in a Scented World

Our biosphere is a thin, yet highly heterogeneous, dynamic layer consisting predominantly of mobile molecules in a liquid or gaseous state, lining the interface of lithosphere and atmosphere. Living organisms make use of these molecules, sequestering them from the air or aqueous solution to gain matter, energy, and, via the “chemical” senses of taste or smell, information. The sensual perception of a scent thus shows us to be truly embedded in, and a part of, our environment. This is what Classen et al. (1994, p. 3) refer to in saying that “odors are blending different entities into olfactory wholes.” Biehl-Missal and Saren (2012) note that “Smell works on the body, entering the body via the nose and dissolving a distinction between subject and object. It dissolves any distance and makes people part of the ambiance.” Olfactory perception of our environment is of a striking immediacy: olfactory receptor neurons are exposed to the air we inhale (Benderly, 1988), and in signal transmission the thalamus is mostly bypassed (Shepherd, 2005). Direct synapsing from the olfactory bulb to the amygdala–hippocampal complex may be the

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basis for the strong emotional connotations of scent perception (Arshamian et al., 2013).

The emotional power of scents makes for a considerable manipulative potential. Aldous Huxley’s (1932) dystopian depiction of “emotional engineering” involving “scent organs” and “scent taps” turned out to be prophetic as early as the 1950s, when technologies for olfactory stimulation were developed, some finding application in the entertainment industry (Gilbert, 2008, p. 148). The use of olfactory cues is more prevalent, however, in scent-based promotion – not only making a product appear more desirable (as in the use of “new car smell” spray), but also broadly targeting the potential customer, wrapping him in a “retail atmosphere,” forcing an olfactory input down his nose and a monetary output from his wallet. Yet sometimes it is not the buying power but the workforce that is of interest to a business. Frequently cited is the work of the Japanese company Shimizu, which produced an “environmental fragrancing” system in the 1990s that is said to reduce anxiety and improve other emotional parameters thought to make employees more productive, for example by means of a “lemony scent wafting through the air” (Griffin, 1993).

## ○ Tea Time Travel & Elusive Mnemonic Aids

For those who don’t study neuroanatomy or psycho-manipulative marketing, a more lively illustration of the emotional charge of the sense of smell and its relation to learning is provided by one’s own olfactory déjà vu – or rather *déjà senti* – experiences. The phenomenon whereby “the smell and taste of things remain poised a long time, like souls, ready to remind us, waiting and hoping for their moment, amid the ruins of all the rest; and bear unfaltering, in the tiny and almost impalpable drop of their essence, the vast structure of recollection” is commonly called the “Proust effect” after

the author of those lines, Marcel Proust (1922, p. 61). Psychological studies have confirmed not only that odors are indeed effective as reminders of life events (Chu & Downes, 2002), but also that they result in more emotional and detailed memories than other sensations (Toffolo et al., 2012).

It is a far jump from emotionally colored autobiographic memory to memorizing declensions, multiplication tables, historical dates, or foreign-language vocabulary. However, some studies have shown that the memory effect can also occur in “simple” tasks of memorization. Olfactory cues may help one recall, for example, prose passages (Pointer & Bond, 1998); and recall of words learned in the presence of an odor was found to be higher when the same odor was present during the recall phase (Morgan, 1996). Gabriel (1999) recorded the number of redirections in a class in the presence of a pleasant scent compared with an unscented condition and found that students in a scented environment required fewer redirections (Gabriel did not study the effects of the scent on the teacher, though).

As early as 1968, Barsch suggested that “Scented learning aids may prove very profitable to the learner” (Barsch, 1968, p. 200). Indeed, they have certainly been profitable to the purveyors of such products. By now there appears to be a veritable market for scented study aids, such as “memory oils” and scented glues, flashcards, and marker pens – the last item seeming to be particularly marketable (Kranowitz, 2006, p. 188ff; Dubinski, 2008; Kimmel et al., 2009; Laird, 2010; Ostrander & Schroeder, 2012, p.161; Bennett, 2013, p. 172).

## ○ Olfactory Teaching & Learning Atmospheres

A neglect of olfaction in education has been observed by many authors (Sutro & Gross, 1983; Baines, 2008, p. 89; Keogh, 2012). Although the olfactory sense is frequently discussed in texts on multisensual approaches, its coverage typically occupies the least space of all the senses. As Baines (2008, p. 95) points out, “The immediacy and intensity of the olfactory system make it a powerful instructional tool, but integrating smell and taste into a coherent instructional plan is no easy task.” An odor-based curriculum for general education is more likely to be found in a satirical magazine such as the *Onion* (see “Parents of nasal learners demand odor-based curriculum,” <http://www.theonion.com/articles/parents-of-nasal-learners-demand-odorbased-curricu,396/>) than in reality. Nevertheless, there is a small body of literature that presents mostly experimental approaches to actually using the power of scent in a teaching and learning scenario. Typically, these are attempts to artificially create olfactory environments that are thought to be generally beneficial for learning processes or to form a link to a particular subject matter.

Kranowitz (2006, p. 188ff) mentions the application of citrus or spice scents to energize children and “sugar cookie or gingerbread smells” to reduce anxiousness. Intriguingly, some publications list specific scents that are considered to lead to a very specific learning-related effect, such as “basil, cinnamon, citrus flowers” (to relax), “woody scents, cedar, cypress” (for the relief of tiredness), or “lemon, peppermint, lily of the valley, floral scents, jasmine, mint, eucalyptus” (to reduce errors and increase work rate) (Chapman et al., 2011). The

critical reader will find a suspicious specificity about which scents do what – “citrus flowers” relax, while both “other floral scents” and “lemon” increase work rate – paired with a generality about *whom* they affect in that way. In attempts at behavioral manipulation by scent, the common experience that scents can be perceived in a highly individual manner suggests that their application may also have quite individual, and potentially unplanned, results. Deploying scents in a classroom is questionable, because schools are already often a highly mixed scentscape (Jackson, 1990, p. 7). Targeted applications of an aroma artificially introduced into the learning space to manipulate emotions and behavior are reminiscent of *Brave New World* scenarios (Huxley, 1932) and of olfactory marketing. Something olfactory “mnemonics” and “emotional engineering” have in common is that the scent used is typically not content related, and is perhaps even out of context – unless the lemon-scented marker is used coincidentally on a text about the citrus family, or it happens to be a class on the psychology of aromas.

## ○ Smelly Teaching Aids & Natural Scentscapes

A review of texts on multisensory education yields a fine collection of often intriguing and sometimes amusing examples in which a specific scent is used specifically for one appropriate topic. Discussing teaching in church, Bracke and Tye (2003, p. 32) offered that “Making use of actual frankincense and myrrh when teaching the story of the wise men (Matthew 2) can be significant for olfactory learners.” Likewise, Sutro and Gross (1983) proposed using the smell of incense burning in a history class on the 1960s. In their multisensory arrangements, the same authors also used the smells of clam chowder, wool, and “two garbage cans filled with refuse common before the turn of this century! As the lesson progressed the trash cans’ contents ripened.” Sutro and Gross (1983) also described the work of “a teacher who went out in the Fall to gather plants and flowers common around Jefferson’s Monticello. These materials were brought into the classroom in some profusion. Students, blindfolded, listened to music that was played at Monticello during that era while smelling the flora.”

In some cases, the scent of a single object may offer remarkable opportunities, as illustrated by Andrews (1977), who used a pinecone as a source of olfactory stimulus. Mannschreck and von Angerer (2011) used a selection of odoriferous compounds derived from roses as a starting point for a lesson in second-year chemistry. Jackson and Dicks (2012) similarly included the “Christmas scent” of gingerol in their chemistry lesson. Inspired by “scratch and sniff pads,” Schultz (1987) constructed an original teaching aid by injecting amyl acetate, ethyl butyrate, and *trans*-cinnamaldehyde into the air cells of bubble wrap for use with younger children. Upon bursting, the air cells released a scent reminiscent of bananas, pineapples, or cinnamon, as a discussion-starter on the nature of scent. Active involvement with a scent and its perception is demonstrated by writing classes in which vivid memories and emotions become a central element. Sprinkle (1999), for example, used smell as a “writing stimulant” in writing instruction. Baart (2002) taught a poetry-writing workshop using scented products and objects provided in plastic containers with opaque lids, making the students write a “memory

poem.” As these examples show, there is a wide range of applications that aim to encourage students to not only perceive and memorize a scent, but to actively work with their own perceptions and associations.

In most of the published work on olfactory aspects of multisensory learning, scents (often of artificial) are brought to the classroom. There are surprisingly few examples of work in formal education, at any level, that involve outdoor smells “in situ.” The only outdoor areas in the activities using smell and taste described by Baines (2008, p. 97) are a “parking lot,” a “soccer field,” and an “area near a dumpster.” Not only does the “outdoor” use of smell in education appear to be rare, but it also seems focused predominantly on scents produced by human activity rather than natural biospheric odors. Leonard (1963, p. 228) discusses outdoor smells such as those emanating from a service station, restaurants, a shoe repair shop, a vegetable stand, a freshly painted building, roses in a yard, and “the earth smell from a vacant lot” – yet suggests bringing the familiar smells to the classroom, rather than bringing the class outside.

## ○ Walk in the Woods

To bring together the memory effects of scents, the elements of sensory enrichment, and “surprise” – and to foster in students an awareness of their living environment using all the senses – I integrated olfactory elements into a course in forest ecology for students aiming to become primary school teachers, at the University of Education in Freiburg, in the state of Baden-Württemberg, Germany. This course provided a general overview of forest ecology, with aspects of forest management. A particular focus was the link between morphological structure and biological function, and the development of an understanding of a forest ecosystem as a complex system of interacting living elements. Lecture/seminar class sessions were combined with field excursions to nearby forests (reached within 10–20 minutes of walking) and a nearby arboretum (reached within 30 minutes by public transport). During these excursions, individual elements of the ecosystem or species of interest were pointed out to the students, introduced in short lecture-like talks, and discussed.

As a small extra element to involve students with the scents of plants before moving on to the next site or plant of interest, a plant sample of leaves or needles was picked (and, if necessary, crushed to release scents) and passed around for the students to smell. No plants that are known to be dangerously poisonous upon contact occur in the area, yet students were asked to take great care and not to touch their faces or mouths after having crushed a leaf. Poisonous plants (such as *Taxus baccata*) were also pointed out to the learners. Protected species were pointed out as well, specifically to avoid damage to rare flora. After passing around the “smell samples,” and without describing or even giving hints about what to expect, I asked the students to work in pairs or small groups (as they form spontaneously in excursions anyway) to come up with a description that mostly involved a comparison. They were asked to exchange their thoughts and to observe the differences in their perceptions.

Following Schneider (2010), who considers that “it may be helpful to make students aware of systematic plant names that

could indicate fragrances, such as [*Rhus*] *aromatica* and *Lathyrus odoratus* (sweet pea),” I mentioned Latin names that neutrally point to the presence of an odor before the exercise. In the case of scientific or vernacular names that describe the nature of the smell – such as in the case of *Geranium robertianum* or *Hypericum hircinum* (see below) – I mentioned them only after the exercise.

At the next stop, as the students approached one-by-one or in their informal groupings, they were asked what they had come up with. Sometimes I shared my own impressions, but I gave no feedback as to “right” or “false.” I took written notes on students’ comments during the walks, without attracting attention, or simply memorized them to avoid the impression of an exam-like situation. These observations did not lend themselves to any statistical evaluation; I quote them below solely for illustration.

## ○ Observations in an Olfactory Walk-and-Talk Exercise

On field excursions, much time is needed to walk from one stop to the next. This is not “lost” time, as it is well spent in the learning environment and provides observations and a chance for discussion. In this exercise, students were asked to discuss an olfactory experience while walking on; thus, they became actively involved with a natural scent, typically from a plant.

It turned out that a majority of students were not only unfamiliar with most of the locally common species, but were surprised if their attention was called to the scents of those plants. This supports the opinion of some authors that the sense of smell has been underused in education (Sutro & Gross, 1983; Baines, 2008, p. 89; Keogh, 2012).

Conifers were found to deliver some of the most recognizable and memorable scents suitable for beginners in olfactory exploration. These included Douglas fir (*Pseudotsuga menziesii*) planted as a commercially used exotic tree in the Black Forest – specifically the “green” variety *P. menziesii* var. *menziesii*, which has the notable fruity–resinous aroma that the *glauca* form is said to lack (Packham et al., 1992, p. 124). Students likened it to a citrus aroma, a comparison that also was noted for *Abies concolor* in the arboretum. However, typically, no more specific description was delivered, such as referring to the *A. concolor* scent as orange-like – rather than, for example, grapefruit- or lemon-like. The students’ perceptions of citrus-related scents were perhaps influenced by the ubiquitous use of similar aromas in household cleaners and toiletries.

A much weaker olfactory sensation is delivered by the native spruce *Picea abies*, a common forest tree in the excursion area. Students commented on the resinous scent and referred to this spruce’s use as a Christmas tree – but soon after, they found that the native silver fir (*Abies alba*) had much more of a “Christmas aroma.” Notably, several students described the spruce aroma as “Tanne” (fir), which is often used colloquially in southern Germany as a blanket term for either of the two most common native conifers.

The incense cedar (*Calocedrus decurrens*), whose common name promises an olfactory sensation, smells similar to shoe polish (Russell, 2013, p. 39) or, according to others, turpentine (Welch, 2012, p. 76) – a scent that is also attributed to Nootka cypress (*Xanthocyparis nootkatensis*; Walters, 1984, p. 83). No similar descriptions, however, were given in this class. One

student came up with the comparison to a “cold and flu” herbal bath soak for the former, while for the latter only a general and unspecific “aromatic” was recorded.

The Lawson cypress (*Chamaecyparis lawsoniana*) is said to have a smell of parsley (Russell, 2013, p. 37), but no comparable description was put forward in the group. The fragrance of Western red cedar (*Thuja plicata*) is frequently compared to pineapple (Russell, 2013, p. 39), though to me it also has a slight note of green apple. It is strong enough that the tree can be smelled even without the foliage being crushed. One student suggested a comparison to a fruity aroma, while others noted that the scent was strong but offered no description or comparison.

Some authors (Russell, 2013, p. 21) attribute to the noble fir (*A. procera*) a “catty” odor, which is not supported by my own experience. No student drew such a feline-inspired analogy, and all their comparisons referred back to the previously smelled white fir. Unfortunately, there was no opportunity to offer, for a counter-check, a whiff of *P. canadensis*, which has a “catty” smell (Green, 1933, p. 80) and is called in some places “cat spruce” or “skunk spruce” (Williams, 2007, p. 372).

Among the nonconiferous plants encountered in this class excursion was bear leek, or broad-leaved garlic (*Allium ursinum*). This plant exudes a powerful smell, which wafts through the understory in spring and becomes overwhelming when the leaves are crushed. Sometimes the smell is a life-saving characteristic (though not for the plant), confirming to the person harvesting it that this is, indeed, the edible garlic-relative – and not the deadly poisonous lily of the valley (*Convallaria majalis*), which looks similar at first glance. The crushed leaves of so-called hedge garlic (*Alliaria petiolata*) have a pungent, garlic-like smell that is remarkable not only for being highly unusual outside of garlic and its relatives (*A. petiolata* is a member of the Brassicaceae and is thus more closely related to mustard; in English, it is sometimes called “poor man’s mustard”) but because it is said to attract the midges that pollinate the plant.

Herb-Robert (*Geranium robertianum*), known for its musky odor of caproic acid and caprylic acid (from the Latin *caper*, referring to a goat’s smell), is called “stinky Bob” in some places (Turner & Gustafson, 2006, p. 348), and the German common name, “stinkender Storchschnabel,” also refers to this trait. Similarly memorable is stinking St. John’s wort (*Hypericum hircinum*) with, as its scientific name says, a smell that some have perceived as hircine (i.e., goat-like). Although no caprine comparison was put forward by students, the smell was generally perceived as unpleasant.

An ambiguous scent is delivered by the sweetish-smelling Himalayan balsam (*Impatiens glandulifera*), which is highly invasive in the region, in particular in riparian areas, and is changing both ecosystems and scentscapes. Some students found it pleasant, others slightly sickening, yet no specific comparisons were recorded.

Similarly ambiguous is the scent of European black elderberry (*Sambucus nigra*), which not only has a markedly rank smell in its foliage, but carries flowers with a peculiar aroma that can be strangely sickening to anyone who has ever overeaten that southern German delicacy of fried elderberry-flower cakes. Several students recognized the common plant and referred to a brand of lemonade or a mixed drink that contains elderberry syrup.

With sweet-scented bedstraw, or sweet woodruff (*Galium odoratum*), some students recognized the highly characteristic aroma

from various alcoholic beverages, and some detected a similarity to artificial flavors in ice creams. Another comparison was with “grass,” which is well in accordance with the plant’s odoriferous compound, coumarin (a defense compound, as I noted in the discussion).

Ground-ivy (*Glechoma hederacea*) has a wealth of secondary compounds, evident in its aroma. For English speakers, the plant’s scent is reflected in another common name, field balm; yet another common name, alehoof, refers to its use in clarifying and preserving beer before hops came into that use. It smells slightly minty to me, but the students’ only comment was again “grass-like,” which is rather unspecific.

To encourage continuous searching for scents – after the encounter with strong-smelling plants – I called attention to species that have a more subtle, yet still characteristic, aroma. For example, the faint yet specific scent of the common dandelion (*Taraxacum officinale*) can best be perceived when the plant is picked and the white sap oozes out, but sometimes a faint whiff from larger clumps of the plant can be perceived from a small distance. One student compared the scent of dandelion to that of the freshly cut stem of lettuce (*Lactuca sativa*).

A very faint scent is also produced by the stinging nettle (*Urtica dioica*), the dwarf nettle (*U. urens*), the red deadnettle (*Lamium purpureum*), and the yellow archangel (*L. galeobdolon*), which, however, depending on the weather, can be perceived by people with sensitive noses, even when just walking by. Again, the students offered no specific comparisons or descriptions.

## ○ Results May Vary

By describing this activity that included outdoor scents “in passing” in a forest ecology class, I hope to encourage teachers to include olfactory cues in their own classes. By encouraging my students to explore plant scents and describe them, I aimed to create an enriched and memorable learning experience and, further, to use each particular plant as an illustrative example of its ecological context. Familiar and strong smells evoked the clearest responses, but often rather unsurprising comparisons. The fainter and more uncommon scents produced more of a struggle to find a comparison or description, and this led the group to some interesting responses, but often there was no specific response at all.

The nature of this activity was such that no statistically evaluable test could be given; nor was a scent-based exam possible, because the plants’ scents change over the season. However, the observations I made during the excursion encouraged me to develop more advanced learning activities on the same basis. I am working toward using the outdoors as an “expanded classroom” (Penrod et al., 2005) and making “sensory involvement a continuous process of exploring and discovering your world” (Andrews, 1977), as a contribution to enhanced awareness of our living environment, our fragrant biosphere.

## Reference

Andrews, M.F. (1977). Pine cone: sensory awareness module. *Journal of Creative Behavior*, 11, 229–232.

- Arshamian, A., Iannilli, E., Gerber, J.C., Willander, J., Persson, J., Seo, H.-S., Hummel, T. & Larsson, M. (2013). The functional neuroanatomy of odor evoked autobiographical memories cued by odors and words. *Neuropsychologia*, *51*, 123–131.
- Baart, N. (2002). Saying it “more intensely”: using sensory experience to teach poetry writing. *English Journal*, *91*, 98–103.
- Baines, L. (2008). *A Teacher's Guide to Multisensory Learning*. Alexandria, VA: Association for Supervision and Curriculum.
- Barsch, R.H. (1968). *Perceptual-Motor Curriculum, vol. 1: Achieving Perceptual-Motor Efficiency*. Seattle, WA: Special Child.
- Benderly, B.L. (1988). Aroma driven: on the trail of our most emotional sense. *Health*, *20*(12), 62–65.
- Bennett, T. (2013). *Teacher Proof: Why Research in Education Doesn't Always Mean What It Claims, and What You Can Do about It*. London, UK: Routledge.
- Biehl-Missal, B. & Saren, M. (2012). Atmospheres of seduction: a critique of aesthetic marketing practices. *Journal of Macromarketing*, *32*, 168–180.
- Bracke, J.M. & Tye, K.B. (2003). *Teaching the Bible in the Church*. St. Louis, MO: Chalice Press.
- Chapman, S., Garnett, S. & Jervis, A. (2011). *Improving Classroom Performance: Practical Applications for Effective Teaching and Learning*. Carmarthen, UK: Crown House.
- Chu, S. & Downes, J.J. (2002). Proust nose best: odors are better cues of autobiographical memory. *Memory & Cognition*, *30*, 511–518.
- Classen, C., Howes, D. & Synnott, A. (1994). *Aroma: The Cultural History of Smell*. New York, NY: Routledge.
- Dubinski, J.B. (2008). Scent activated, memory enhancing memory stick system. U.S. Patent 7597496B2.
- Gabriel, A.E. (1999). Brain-based learning: the scent of the trail. *Clearing House*, *72*, 288–290.
- Gilbert, A. (2008). *What the Nose Knows: The Science of Scent in Everyday Life*. New York, NY: Crown.
- Green, G.R. (1933). *Trees of North America (Exclusive of Mexico)*. Ann Arbor, MI: Edwards Brothers.
- Griffin, K. (1993, April 28). The smell of success: will a whiff of certain aromas make us work harder, lose weight, chill out, be happier . . . ? *Chicago Tribune*. Available online at [http://articles.chicagotribune.com/1993-04-28/entertainment/9304280317\\_1\\_smells-fragrance-inhaled](http://articles.chicagotribune.com/1993-04-28/entertainment/9304280317_1_smells-fragrance-inhaled).
- Huxley, A. (1932). *Brave New World*. London, UK: Chatto & Windus.
- Jackson, D.A. & Dicks, A.P. (2012). The five senses of Christmas chemistry. *Journal of Chemical Education*, *89*, 1267–1273.
- Jackson, P.W. (1990). *Life in Classrooms*. [Reissued.] New York, NY: Teachers College Press.
- Keogh, P. (2012). *Defining Intelligence in an Educational Context*. Bloomington, IN: Author House.
- Kimmel, P.D., Weygandt, J.J. & Kieso, D.E. (2009). *Accounting: Tools for Business Decision Making*. Hoboken, NJ: Wiley.
- Kranowitz, C.S. (2006). *The Out-of-Sync Child Has Fun: Activities for Kids with Sensory Processing Disorder*. [Revised edition.] New York, NY: Perigee.
- Laird, G. (2010, October 8). ‘Memory oils’: the latest revision fad? *Times Educational Supplement*. Available online at <https://www.tes.co.uk/article.aspx?storycode=6060248>.
- Leonard, E.M. (1963). *Foundations of Learning in Childhood Education*. Columbus, OH: C.E. Merrill.
- Mannschreck, A. & von Angerer, E. (2011). The scent of roses and beyond: molecular structures, analysis, and practical applications of odorants. *Journal of Chemical Education*, *88*, 1501–1506.
- Morgan, C.L. (1996). Odors as cues for the recall of words unrelated to odor. *Perceptual and Motor Skills*, *83*, 1227–1234.
- Ostrander, S. & Schroeder, L. (2012). *Superlearning 2000: New Triple Fast Ways You Can Learn, Earn, and Succeed in the 21st Century*. [Reissue.] New York, NY: Random House.
- Packham, J.R., Harding, D.J. & Hilton, G.M. (1992). *Functional Ecology of Woodlands and Forests*. New York, NY: Springer Science & Business Media.
- Penrod, W.M., Haley, C.D. & Matheson, L.P. (2005). A model for improving science teaching for students with visual impairments. *Re:View*, *37*(2), 53–58.
- Pointer, S.C. & Bond, N.W. (1998). Context-dependent memory: colour versus odour. *Chemical Senses*, *23*, 359–362.
- Proust, M. (1922). *Remembrance of Things Past, vol. 1: Swann's Way*. Translated by C.K. Scott-Moncrieff. London, UK: Chatto & Windus.
- Russell, T. (2013). *RSPB What's That Tree?* London, UK: Dorling Kindersley.
- Schneider, T.L. (2010). Discovering chemical aromaticity using fragrant plants. *Journal of Chemical Education*, *87*, 793–795.
- Schultz, E. (1987). Pop-and-sniff experimentation: a high sensory impact teaching device. *Journal of Chemical Education*, *64*, 797–798.
- Shepherd, G.M. (2005). Perception without a thalamus: how does olfaction do it? *Neuron*, *46*, 166–168.
- Sprinkle, R. (1999). The power of aroma and the olfactory experience in the classroom. *Teaching English in the Two-Year College*, *27*, 188–193.
- Sutro, E. & Gross, R.E. (1983). The five senses – prime keys to the art and craft of teaching. *Social Studies*, *74*, 118–124.
- Toffolo, M.B.J., Smeets, M.A.M. & van den Hout, M.A. (2012). Proust revisited: odours as triggers of aversive memories. *Cognition & Emotion*, *26*, 83–92.
- Turner, M. & Gustafson, P. (2006). *Wildflowers of the Pacific Northwest*. Portland, OR: Timber Press.
- Walters, S.M. (1984). *European Garden Flora: A Manual for the Identification of Plants Cultivated in Europe, Both Out-of-Doors and Under Glass*. Cambridge, UK: Cambridge University Press.
- Welch, H.J. (2012). *The Conifer Manual, vol. 1*. New York, NY: Springer Science & Business Media.
- Williams, M.D. (2007). *Identifying Trees: An All-Season Guide to Eastern North America*. Mechanicsburg, PA: Stackpole.

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