The subject of food and wine pairing in the 21st century is an animated area of discussion. Consider this comment from the University of Arkansas Hospitality Program.

‘The concepts of beverage management or wine evaluation are far from under-utilised in most hospitality programs, but other than in relatively large hospitality programs, food and wine pairing is not provided as a standalone course and is covered at a relatively cursory level in most beverage management’. (Harrington et al, 2010, p.110)

It is currently topical that a cultural change in the drinking and eating styles of the millennial and gen. z generations is bringing disruption to global food and wine. Yet things now being hailed as ‘millennial trends’ have been here before, farm to fork is not new. The famous wine routes of Europe became popular in post-war decades, pastoral roads beaded with wineries, offering wine with food from neighbouring farmers. Chèvre (local goat cheese) matched with a Sancerre wine in the Loire Valley, coq au vin matched with a Pinot Noir in Burgundy or quiche lorraine with a Sylvaner in Alsace along one of the very oldest routes (Vins Alsaces, 2020). In Italy, grilled octopus and potatoes with Falanghina in Naples or Jamon Iberico de Bellotta (Iberian Ham) with a Cava in Catalonia. But why do these pairings work so well, can we explain that and can we confidently replicate success like this in a 21st century dining room? In the following exploration of food and wine pairing, we consider thematic areas including Change, Language and Patterns. We discuss an experiential workshop platform evolved from our own work and conclude with thoughts from this perspective on some of the better-known classic food and wine pairings.

Change

In 2019, sales of high-end wine markedly declined internationally with the blame being placed firmly at the feet of the millennial consumer. This can be considered a form of disruption. Markets saw explosive growth in other wine categories however, most notably wines with lower alcohol, higher acid and a fruit driven profile like rosés, Pinot noir and other light reds and sparkling wines like Prosecco (Concours Mondial, 2019). There is also a change happening in winery tasting rooms, particularly in the US, where the search is on not just for wine but for a wine experience, again courtesy of the new consumers (Wilcox, 2019). Is this millennial revolution merely a search for a simpler, more focused food and wine experience? Emerging food and wine trends (farm to table, organic) suggest there is a craving for the table of old, sharing locally farmed wine and food with no thought of wine critic or media. Lower alcohol wines were once the norm in regions like Beaujolais just a couple of generations ago (Robinson, 2020), examples might include Muscadet in the Loire (Panaggio, 2016) or the rosés of Anjou (Rowlands, 2015, p.62). Even the field worker’s low-alcohol drink of choice in many wine regions but most familiar as ‘piquette’ in France, is also seeing a renaissance (Pickard, 2019). These moderate, less extracted wine styles were the foundations on which food and wine pairing, as we know it, was built. With wine and food pairing, we are on a sensory see-saw, juggling mellifluous strands of taste, texture, temperature, pH, all the while striving to attain an elevated experience, an ah-ha moment playfully referred to as ‘the ZiNG! thing’ (Rogers, 2014, p.8).

Dr. Paul Breslin points out that ‘we should understand the senses from the most basic perceptual phenomena of single stimuli and build from there, just as the early visual psycho-physicists, Newton and Helmholtz, did when they attempted to understand sensory experience’ adding that “…recent gustatory literature is being evaluated and it is determined whether these ‘old’ ideas are worth pursuing again” (Breslin, 2001, p.439).

Language

We should at this point clarify the difference between taste and flavour. ‘The perception of five taste qualities, namely sweet, bitter, umami (savoury), acid/sour and salty occurs through segregated pathways. Interaction of tasty compounds with specialised receptors in the taste buds of the tongue and palate is transduced into an electrical excitation of taste receptor cells. This excitation is further transmitted to the brain, where the final representation of each taste modality takes place. The result is the trigger of appetitive or aversive behavior’ (Perez et al, 2006, p.377).

Appetitive and aversive responses to different tastes are controlled by subconscous brainstem sensory-motor reflex arcs, much as the removal of a hand from a hot stove is driven subconsciously via the spinal column’ (Breslin, 2018, p.113). ‘Low levels of aversive tastes may become tolerable, like the acid in a fresh berry. As an example, vitamin C, present in many fruits and essential for humans, tastes mildly sour. Taste is therefore considered as a way to prevent eating harmful food as well as a manner to look for beneficial food fulfilling the organism’s needs’ (Sjöstrand, 2015, p.26).

We systematically recognise a need for Vitamin C and accept...
the mildly acidic berry but always the sweeter the better, because ‘...sweet taste lifts most flavours to higher acceptance’ (Breslin, 2013).

The ISO (International Organization for Standardization) defines flavour as follows: 'A complex combination of the olfactory, gustatory and trigeminal sensations perceived during tasting. The flavour may be influenced by tactile, thermal, painful and/or kinaesthetic effects.’ (ISO 5492, 2008). In all theatres, the stage must be set properly for cues to work. With taste, one prop is essential: saliva. ‘Taste is a main stimulant for formation of saliva. On the other hand, presence of saliva in the oral cavity is also essential for taste perception... because food particles need to be in solution in order to stimulate taste receptor cells in the taste buds’ (AM Pedersen, A. Bardow, S. Beier Jensen, B. Nauntofte, 2002, p.121). Breslin describes systemic links to taste and behaviour choices. The taste system is connected to the brain and metabolic organs, such as the pancreas and the liver, when foods are in the mouth, so we are able to evaluate them as either rewarding or punishing (Breslin, 2018, p.110). There's a reason for that. 'In our daily lives, taste operates as part of a set of highly integrated, specialised sensory systems we call “the chemical senses” ...to understand their importance, I think it is instructive to consider their roles in human survival and evolution’ (Breslin, 2001, p.439).

Patterns

Food and wine awareness evolved through instinctive, subconscious responses sensitive to chemical stimuli. The more rewarding combinations becoming familiar, popular and trusted. ‘Taste sensory input influences our thinking, deciding and behaviours toward sampled foods, both consciously and unconsciously, to guide ingestion’ (Breslin, 2013, [24]). That is a big deal when choosing which wine and food to have together, whether it’s a comforting glass for coddle, coq au vin or caviar. The opportunity to elevate the gustatory experience is in the choice. The five human tastes are sweet, salt, acid/sour, umami and bitter. As referenced earlier, tastes are instinctively either ‘appetitive’ or ‘aversive’. In work by Agnès Sjostrand at Université Pierre et Marie Curie, Paris ‘Each basic taste has its importance in the diet. Sweetness, produced mostly by carbohydrates, tells us about the potential energetic aspect, it generates an innate pleasure as shown by studies of facial expression of newborns stimulated by sweet solutions. Bitterness, often generated by toxins such as alkaloids, warns against potential poisons but also about potential medicine. Umami is produced by glutamate and some nucleic acids and therefore suggests high energy value (proteins) as in meat and cheese (Breslin, Spector, 2008). Salty taste is produced by alkali ions, important for terrestrial animals that lose minerals through sweating and excretion. Salty taste is therefore important in regulating the mineral balance of the body. Strong sourness is aversive, potentially revealing either unripe fruits or spoiled food whereas mild sourness is perceived as interesting, as in some beverages (Sjostrand, 2015, p.26).

Green vegetables contain substances that stimulate a bitter taste response in us, called alkaloids. Also commonly found in vegetables are salts of oxalic acid, called oxalates. In quantity, oxalates are extremely toxic to us. They bind with calcium Ca+ ions to form calcium oxalate, which we know as kidney stones. Avoiding that consequence might explain our aversive response to foods high in oxalates (Carnahan, 2018). With this consideration, we again reference Breslin and his holistic consideration of taste as ‘...part of a set of highly integrated, specialized sensory systems we call “the chemical senses” (Breslin, 2001, p.439).

Traditional culinary practices to suppress bitterness may include adding sweetness, adding salt or cooking in water. These practices mitigate our response to alkaloids and oxalates in the food and improve palatability. Another option is to add a low-acid solution to the food, a practice familiar in many cuisines e.g. squeezing lemon over steamed spinach or rapini, tossing salad greens in vinaigrette. This addition of a moderate acid can suppress the aversive bitter taste “…at medium intensity/concentration...bitterness is suppressed by sour taste” (Keast, Breslin 2002, p.19) and lead to a more pleasant food experience. We could also acidify an alkaline vegetable (Bourassa, 2019) by introducing a brightly acidic wine to the experience. In the 17th century, the Irish born writer and chemist Robert Boyle first labelled substances as acids or bases (he called them alkalies) by the following characteristics: ‘Acids taste sour, are corrosive to metals, change litmus (a dye extracted from lichens) red, and become less acidic when mixed with bases. Bases feel slippery, change litmus blue and become less basic when mixed with acids.’ (Carpri, 2003)

Balancing acid and alkali intake to maintain stability in blood and salivary pH is essential to us. Our saliva contains the digestive enzyme α-amylase. Amylase is an enzyme that initiates the digestion of carbohydrates in our mouths, releasing sugar (fuel/energy) in situ. If we were, hypothetically, in flight mode, the energy to take every possible step away from danger (the bear, the cougar) would be very helpful. We would just need carbohydrates to create fuel with. ‘With the advent of agriculture and the domestication of cereals such as barley, wheat, maize, and rice, the reliance on starches for dietary energy dramatically increased in many regions of the world’ (Mandel, Breslin, 2012, p.856).

The optimum pH for the enzymatic activity of salivary amylase ranges from 6 to 7. Above and below this range, the reaction rate reduces as enzymes get denatured. The enzyme salivary amylase is most active at pH 6.8’ (Nedungadi, Raman & McGregor, 2013). This is right at neutral, where we are systemically balanced both consciously and subconsciously.

An appetitive taste loved by almost everyone is salt. The chemical name is sodium chloride, NaCl, and humans have an anecdote laden love affair with it. Salt: A World History by Mark Kurlansky weaves a remarkable story. The author
explains how salt plays a crucial role in our health and maintenance. ‘Chloride is essential for digestion and in respiration. Without sodium, which the body cannot manufacture, the body would be unable to transport nutrients or oxygen, transmit nerve impulses, or move muscles, including the heart’ (Kurlansky, 2003, p.12). It is also vital for digestion as chloride is a crucial component in the production of the gastric acid HCl, hydrochloric acid (Caldwell, 2010). Let’s step back for a moment and reconsider the Jamon from Iberia we mentioned earlier, some of the finest ham in the world. The salt content is going to be high, probably the dominant taste element we will encounter. There are many suggestions for pairings with it including the simple freshness of Cava, a sparkling wine (Raezer, 2020). Interaction between salt and acidity is at work here. We perceive acidity in a beverage as a sour taste, and we instinctively respond to that acidity by salivating. Studies have shown that neural responses to salt (NaCl) are reduced in the presence of acidic stimuli. They further showed that these responses could be understood at the level of T4RCS (taste receptor cells) where a decrease in intracellular pH reduces Na⁺ influx through amiloride sensitive epithelial sodium channels (ENaCs). This reduction in Na⁺ influx results in a decreased neural response and ultimately in a decreased sensation to NaCl. (Lyall et al, 2002). How does wine play a part? If we are eating food that is salt dominant, couldn’t we just have a glass of water to lower the salinity in our mouths and thus make things more balanced. In ‘A Moveable Feast’ in 1920’s Paris, Ernest Hemingway set a high bar for future writers enjoying wine and food. ‘As I ate the oysters with their strong taste of the sea and their faint metallic taste that the cold white wine washed away, leaving only the sea taste and the succulent texture, and as I drank their cold liquid from each shell and washed it down with the crisp taste of the wine, I lost the empty feeling and began to be happy and make plans.’ (Hemingway, 1964, p.3). The metallic taste he describes is possibly dysgeusia, a taste distortion often corrected with the help of a sialogogue (Merriam Webster, 2020). This substance stimulates the production of saliva, as the acidic white wine did. Extra saliva can both dilute an aversive stimulant in the oral cavity and also play a defensive role if needed, protecting delicate oral epithelial tissue with mucins, as happens with tannin intrusion. (Slomianyet al, 1996)

We have attempted to illustrate the importance and authority of the human taste network. It is nonetheless extremely challenging to assign a success or failure value to an actual pairing. In workshops, we trialed different methods to record pairing results including numeric scales: 1–10, 1–5, and 1–3. We found participants were distracted from their sensory response by the difficulty of assigning a numeric value to it. We tried alpha-numeric values: ‘A’ being best, ‘B’ second, etc. This too caused similar distraction from the actual experience. After a workshop in Chicago, a group of contributing professionals were animatedly discussing how to circumvent this challenge. A designer colleague in attendance quietly came over and put down four paper napkins in front of the group. He had sketched faces on them with a marker. ‘This is what I saw’ he said. See Figure 1.

![Zing!](https://example.com/zing.png)

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**Elements Emerge**

Having collected workshop tasting data from both naïve and experienced palates over two decades, we posit there are six relevant and measurable elements in wine compromised or complemented by interactions with food. Those elements are acidity, viscosity, fruit, sugar, alcohol, and tannin.

Similarly, in foods, we posit there are eight measurable elements compromised or complemented by interaction with wine. Those elements are salt, bitter (alkaloids and oxalates), acidity, fat, umami, sugar, spice, and protein.

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We decided to trial these faces in lieu of numeric values in upcoming workshops.

We found significantly better response assessment. Participants were markedly more relaxed and interactive. Some months later at the Miami Culinary Institute, we were congratulated on our novel use of the ‘Wong Baker Scale’, see Figure 2. (Wong, D., Baker. C., 1983)

![Wong-Baker Faces Pain Rating Scale](https://example.com/wong-baker-scale.png)

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We had never heard of the scale until that day. We later learned the WB scale is an international pain measurement tool. We were intrigued by the similarities between the naïve response faces our artist friend had drawn and the images used by Wong Baker.

We know we can enhance gustatory and post-ingestive responses with food and beverage choice ‘...in humans, striatal dopamine release directly correlates with the perceived hedonic value of food stimuli’ (Small, Jones-Gotman, and Dagher, 2003).

‘It is therefore plausible to assume that the events leading to the stimulation of brain reward circuits via dopamine release are initiated within the oral cavity, upon the activation of taste receptors.’ (de Araujo, 2011) Breslin also posits ‘I believe that nearly all taste stimuli elicit both a conscious taste perception and stimulate a subconscious metabolic reflex.’ (Breslin, 2018, p.115).
Classic Combinations

Confucius said, ‘Study the past if you would define the future’. Let’s look at a couple of historic combinations and while noting these are far from everyday foods, they are truly wonderful pairings and considered classic in food and wine matching terms.

Champagne and Caviar

During the Belle Epoque, across Europe, eating caviar became a full-fledged craze among the nouveau riche, alongside oysters, champagne and other exotica. Leisure time and travel had taken hold amongst the well to do. It was no longer a novelty for a mid-western American to spend a few months in Paris. In the 1890’s, a Paris Edition of the New York Herald was started to report on the comings and goings of Americans living the good life on the continent. In 1898, The Ritz Hotel first opened its doors in Paris. Its famous bar became a favoured hangout for expatriates, Ernest Hemingway among them, and caviar with Champagne would become one of the signature items of its menu (Saffron, 2002). From a food element perspective, caviar is simple. Traditionally, the term caviar refers only to roe from wild sturgeon in the Caspian Sea and Black Sea, cured in salt. Depending on the country, caviar may also be used to describe the roe of other species of sturgeon or other fish such as salmon, steelhead, trout, lumpfish, whitefish or carp. As well as the intense salt taste, another important factor in the enjoyment of caviar is its texture. In some roe, there may even be a ‘pop’ as the egg breaks and releases the briny intenseness containing umami. (Caspian Monarque, 2020). We feel texture, temperature, and even irritants (such as capsaicin, the heat in chili peppers) through our somatosensory system. This system transmits sensory information within and on the body from protein receptors to nerve fibres and onward to the brain where a sensation is perceived. Common sensory information includes touch, pain and temperature. Prof. Richard Stevenson, in discussing flavor, writes ‘The final contributory sense is somatosensation. Not only is this instrumental in generating our sense of food texture via receptors located within the various tissues of the mouth, but it also detects sensations relating to temperature, irritation and pain.’ In the same study, he also writes ‘Drawing on recent work, the evidence suggests that concurrent gustatory and somatosensory stimulation capture attention at the expense of the olfactory channel, but it can also explain why olfaction goes largely unnoticed in our day to day experience of flavour’. He thus calls attention to the importance of texture. With caviar, not least because of the luxury attached to the experience, texture is significant. It focuses perception on taste and feel in the oral cavity at the expense of the other main flavour modality, olfaction (Stevenson, 2012). Fiona Beckett, writing in Decanter magazine on champagne and caviar says ‘…texture is key. Only Champagne (top-quality vintage Champagne at that) leaves you with the taste of each individual egg intact’ (Beckett, 2007). One way to enhance or excite pairings is to use wine with bubbles. Recent studies show our bodies are sensitive to carbon dioxide (CO2) on several levels including smell, in the brain, and in our blood to control respiration. An enzyme called carbonic anhydrase is expressed on the surface of our acid taste receptor cells, it then catalyses the conversion of CO2 to carbonic acid releasing a H+ ion (how we measure acid) right on the receptor! (Chandrashekar, 2009). In the case of sparkling wine, this H+ is in addition to the acid in the base wine. The champagne bubbles excite and sensitize receptors and acid balances salt. Now, consider the food elements onstage here which succeed famously: salt, umami (within the roe) and brittle texture. A beloved and much less expensive food that also ticks those boxes and works splendidly with sparkling wine is crispy fried fish and chips. If you’re in the US an alternative would be to match some crispy fried chicken to your favourite bubbles. This can prove to be an unexpected delight.

Cabernet Sauvignon and Steak

It’s important to set some parameters when we examine this pairing. We are considering steak with no sauce, just cooking juices. Our wine is possibly from Bordeaux, Napa or Washington State. All three produce Cabernet Sauvignon that can be grippy and muscular in style. When we use those adjectives in wine-speak, it generally means wine that are quite tannic. When we discuss steak and Cabernet Sauvignon, tannin is the primary element on the wine side. If the steak is cooked simply, the dominant food element on the plate will be protein, albeit alongside other less dominant food elements. It is worth noting that that neither tannin nor protein is a human taste. Tannins contribute to two wine-tasting characteristics: bitterness and astringency. This is as a result of tannin’s predilection to bind with protein, including salivary proteins. That causes a snowball effect. Tannin-bound proteins clump together with other tannin-bound proteins creating an aggregate, which ultimately precipitates out of our saliva. Thus, with fewer free salivary proteins, there is a decrease in salivary viscosity, leading to a decrease in mouth lubrication. (Chi Phung, 2014) This means that your mouth is dried out. However, as a result of this tendency, high-tannic red wines pair really well with high-protein foods, like steak. Wine tannins bind to the food proteins, our salivary and other oral proteins are spared, and we have no dry mouth. This produces an attractive food pairing.

Conclusion

‘Better together than apart’ may be the ultimate test of food and wine pairing success. Yesterday, our forebears felt this instinctively as they discovered the pairings we now consider traditional and continue to appreciate. The two classic pairings mentioned above are a case in point.
Millennials today, when out to eat ‘...are interested in learning more about wine. This is an opportunity that restaurants should explore. With each restaurant dining experience, the Millennial consumer gains more knowledge. It seems logical to provide information, so millennials relate their learning experience positively and associate this positivity with the restaurant’ (Hammond et al, 2013). In this paper we explored the essence of why certain foods match with certain wines and we have demonstrated that the classic pairings that have always proved so popular have a basis in our modern appreciation of how wine chemically interacts with identifiable tastes. As we learn more about food and wine interactions, we appreciate the importance of our instinctive responses and their relevance in the evolution of new pairings for new generations. These new pairings will undoubtedly influence how future generations eat. There is much work to be done to further develop this understanding, we are committed to that. We will pursue eating and drinking research avidly.

Reference list


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