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2 RUNNING HEAD: ON THE MULTIPLE USES OF FOOD-EXTRINSIC SCENTS

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4 **On the use of ambient odours to influence**

5 **the multisensory experience of dining**

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ABSTRACT

In recent years, a number of modernist chefs have started to pay more attention to the potential role of food or drink-extrinsic scents in enhancing their guest's multisensory gastronomic experiences. This narrative review highlights the wide range of uses for such ambient, and/or food-extrinsic, aromas. Oftentimes, in a gastronomic setting, ambient scents have been introduced by chefs in order to help set the context for a particular dish, and/or to assist with the storytelling that surrounds a specific element within an experiential meal. Ambient scents have also been introduced in order to induce a specific mood and/or to trigger nostalgia in the minds of diners. Food-extrinsic scents have, on occasion, even been used deliberately to modify the taste/flavour of the food or drink itself. At the same time, however, a number of sensory marketers have become increasingly interested in the idea of signature scents associated with branded food establishments and the role that they may play in inducing a desire to consume, and thus bias (or nudge) people's food purchasing behaviour. A third use of food scents is to help people control their food consumption. This narrative review highlights both the opportunities and challenges that are associated with the use of ambient and/or dish-extrinsic scent in a gastronomic setting. Ultimately, the literature reviewed here highlights the somewhat different uses to which ambient (or product-extrinsic) food smells have been put in the gastronomic, artistic/theatrical, health-related, and mainstream restaurant contexts.

KEYWORDS: SCENT; AROMA; CONSUMER BEHAVIOUR; OLFACTORY MARKETING; NOSTALGIA; MOOD; CONTEXT.

1. Introduction

The aroma of food and drink is a key part of the multisensory experience of eating and drinking. But what of the impact of other ambient odours (the latter term is used here to describe scents regardless of whether or not they happen to be food-related) on the consumption experience? In recent years, both modernist chefs (Spence & Youssef, 2018) and mainstream food marketers have become increasingly interested in the putative influence of ambient olfactory stimuli on people's mood, perception, and behaviour (e.g., Guéguen & Petr, 2006; Nassauer, 2014; Spence & Youssef, 2015; see also De Wijk & Zijlstra, 2012). There has long been interest in the role of ambient olfactory cues in the context of arts and entertainment, including in venues such as art galleries and museums (see Spence, 2020c, for a review), cinemas (see Spence, 2020b, for a review), a variety of live performance settings (see Spence, 2021b, for a review), as well as music events (see Spence, 2021a, for a review), theme park rides (see Spence, 2021c, for a review), and even as a component of architecture/interior design (see Spence, 2020d, for a review). However, what distinguishes the gastronomic setting from all of these other contexts is the central role of aroma/flavour to the experience in the former case. As such, the challenges and opportunities associated with deliberately adding a scented element to gastronomic experiences is likely to be a little different from these other cases.

Look closely at a number of the most popular gastronomic dishes provided by some of the world's top chefs and it soon becomes apparent how often they work with what might be called 'off-the-plate' scents. Prominent North American chefs working in this area include Grant Achatz (Spence 2017a), the late Homaro Cantu (Hardy, 2007; Spence, 2017b), and Jordan Kahn (Baum, 2017; Scattergood, 2017). In the UK, relevant chefs include Heston Blumenthal (Blumenthal, 2008) and Jozef Youssef (Youssef & Spence, 2021a, b). Meanwhile, there has also been interest from a number of gastronomic innovators in Spain in capturing and thereafter reintroducing ambient scent to enhance the diner's experience of the food, be it in the context of the restaurant or else online (Trebolazabala & Atxa, 2012; see also Yuan, 2014).

Although the list of modernist chefs who have deliberately chosen to introduce ambient, or food-extrinsic, scents and aromas may thus far still be relatively small, the apparent success of these chefs' innovative use of 'off-the-plate' scent nevertheless hints that its use may continue to grow in popularity in the years ahead. Of course, the sceptic here might consider that the use of off-the-plate scent is little more than a fad (Berasaluce Linares, 2018; see also Otero, 2018). While future developments are undoubtedly hard to predict, the available evidence would at least appear to suggest that the introduction of a scented element to gastronomy (i.e., beyond the intrinsic aroma of the food itself) is likely going to be rather more successful than has been the case when creative individuals have tried introducing scent into a variety of other arts and entertainment contexts. At the same time, however, as we will see below, off the plate scents have also been posited as an effective means of controlling consumer behaviour – no matter whether it is helping the consumer to eat less, or to make different food choices.

1.1. Review outline

This narrative review summarizes the various ways in which ambient, or food-extrinsic, scents have been introduced by chefs, designers, marketers, and food companies alike. I highlight the various uses to which such scents have been put, including marketing (and signature scents;

Minsky, Fahey, & Fabrigas, 2018), mood-induction (Herz, 2009; Leenders, Smidts, & El Haji, 2019), triggering nostalgia and to help with the storytelling, as well as to enhance the taste of the food and drink itself. I briefly discuss the separate line of discussion, and occasional experimental research that has emerged over the decades concerning the potential use of food aromas in helping those who want to control their consumption do so a little more effectively. This narrative review therefore highlights a number of the most important opportunities and challenges that are associated with the use of ambient and/or dish-extrinsic scent in both a gastronomic and mainstream food service setting. Ultimately, the literature reviewed here highlights the somewhat different uses to which ambient (or product-extrinsic) food smells have been put in the gastronomic, artistic/theatrical, health-related, and mainstream restaurant contexts.

2. On the use of ambient scent to help control people's food behaviour

In this section, I discuss two of the uses of food aromas: One that has been capitalized on by the sensory marketers working in a mainstream food service setting, and the other by those individuals and designers interested in helping people to try and control their weight/food consumption.

2.1. On the use of food scents in a marketing context

In 2006, Guéguen and Petr, investigated the impact of introducing a non-food aroma, namely lavender, into a small independent pizza restaurant in France. In a between-participants study of 88 diners over a period of several days, these researchers reported that those who dined in the presence of the lavender scent spent significantly more and lingered in the restaurant for longer than those exposed to a lemon scent or no scent condition instead. Guéguen and Petr hypothesized that this might be because those diners in the lavender condition were more relaxed. That said, Teller and Dennis (2012) have questioned how confident one can be that such results (i.e., from between-participants experimental designs) really reflect the impact of ambient scent versus perhaps reflecting variation in the attributes of those dining in the different conditions (which have typically been assumed but not assessed to be equivalent). Meanwhile, Amsteus, Olsson, and Paulsson (2015) investigated the consequences of introducing an (in-)congruent ambient scent in a café setting (cf. Mitchell, Kahn, & Knasko, 1995). They found that adding a congruent scent (specifically vanilla-scented candles) exerted a positive effect on the impression of the café amongst females when compared to an incongruent scent condition (fresh linen scent).

A few years ago, McDonald's France commissioned experimental research to evaluate which of three specially-developed fruity-floral scents had the most positive impact on typical consumers' impressions of the store environment (see Spence, 2020a). The idea here had been to choose a new ambient scent to help give the chain's stores a 'healthy' olfactory makeover (i.e., so that it would no longer smell of greasy burgers). Ultimately though, despite commissioning several different strands of evaluative research (including human psychophysics, neuroimaging, and consumer focus group research) to determine which of the scents 'worked' best (in terms of setting the right brand expectations in the minds of the typical customer), the selected scent was never released into the marketplace. The latter example thus

helps to illustrate the interest from the biggest food companies in figuring out how to control/manipulate the ambient scent in a food service setting in order to convey a particular impression on customers. At the same time, however, it should be noted that, at least according to Biswas and Szocs (2019), exposure to those food aromas that are associated with less unhealthy foods can sometimes lead to compensatory effects on healthy food choices/purchasing.

As well as masking, or modifying, the traditional aromas associated with cooking, there has also been a growing awareness of how some of the world's most successful food chains use scent strategically in order to help capture the attention of the consumer via the distinctive and appealing aromas of their products (and/or their preparation). For instance, in an article that appeared in *The Wall Street Journal*, Nassauer (2014) highlighted the deliberate approach to scent marketing that has been adopted by everyone from Cinnabon through to Subway and Panera Bread. According to Nassauer, these chains deliberately choose the location for their outlets where the ambient scent of food preparation is likely to be noticed by the largest number of people. They also tend to use minimally effective extractor fans in order to help ensure the brand's distinctive smell is experienced by as many consumers as possible. Meanwhile, Carbone (2004, p. 240) has written of how the Taco Bell chain introduced cooking grills into its store back in 2002 in order to accentuate the food aromas as part of the customer's experience.

Food-related scents are not only used to improve the customers' experience of food outlets; They are often used in a non-food retail context to help improve the olfactory atmosphere too. One increasingly ubiquitous example comes from the smell of coffee that is such a common feature of many bookstores, clothing retail, and even gas station forecourts (see Pape, 2009; Smiley, 2014; Spence, 2015; Spence & Carvalho, 2020). Relevant here, it is worth noting how the smell (and sight) of appealing food can make the consumer salivate in a way that simply does not occur on seeing the food if it can't also be smelled (Fine & Riera, 2019; Proctor, 2016; Spence, 2011; Yeomans, 2006).¹ Though, as noted recently by Biswas, Labrecque, and Lehmann (2021), seeing the food before smelling it may well help to deliver a more enjoyable tasting experience. The presence of an appealing ambient food aroma has also been shown to bias people's food choices, regardless of whether or not they happen to be consciously perceived (or considered) or not (e.g., Gaillet-Torrent, Sulmont-Rossé, Issanchou, Chabanet, & Chambaron, 2013, 2014; Girard, Lichters, Sarstedt, & Biswas, 2019; Ouyang, Behnke, Almanza, & Ghiselli, 2018).

The marketing potential of scent is highlighted by the growing interest in sensory marketing (Hilton, 2015; Sundar & Noseworthy, 2016), and, in particular, by the potential use of so-called signature scents (e.g., see Minsky et al., 2018). However, it is worth noting that such a strategic use of e.g., signature scent is less likely to convey any particular advantage in the context of

¹ As Gordon Proctor, Professor of Salivary Biology at King's College London, notes: *"It's almost impossible to walk past a bakery without enjoying the mix of aromas from all the savoury treats. Your mouth begins to water and your stomach starts to rumble as you desperately try to get hold of the fresh batch of cookies. But it's often left people confused as to why their mouth drools when we see and smell tasty snacks."* (Proctor, 2016). Or, writing much earlier, Haagen-Smit (1952, p. 28) notes how: *"The odor of broiled steak has an immediate effect on metabolism: it starts secretions of saliva and stomach juices even before eating begins. By setting up favourable conditions for digestion the flavour factors in food play a role in nutrition comparable to those of vitamins and hormones."* These quotes help to illustrate the sometimes marked physiological responses that can sometimes be triggered by exposure to appetizing olfactory food cues.

fine-dining/modernist cuisine, where bookings tend to be made in advance (as opposed to walk-ins), and where the typical diner may only experience a particular high-end gastronomy restaurant once, or at most, very infrequently. The key point here is that ambient scent typically plays a rather different role in the context of high-end gastronomy versus in mainstream food and beverage provision.

2.2. On the use of scent to help control consumption

While there is published evidence concerning the role of food aromas in helping to control consumption, and helping people to feel satisfied with less (Ramaekers, Luning, Ruijschop, Lakemond, Bult, Gort, & van Boekel, 2014; Ruijschop, Boelrijk, de Graaf, Westerterp-Plantenga, 2009), the majority of the scientific literature that has looked at the impact of ambient food aromas on people's behaviour has focused primarily on food choice (e.g., Anon., 1963; Biswas & Szocs, 2019; Gaillet-Torrent et al., 2013, 2014; Yamada, Sasaki, Kunieda, & Wada, 2014). Nevertheless, a separate line of commentary exists on the use of food aromas to replace, in a calorie-free manner, the pleasures of the table. This was first suggested by the Italian Futurists and, at around the same time, in the writings of Evelyn Waugh, where one finds the following: *"He lay back for a little in his bed thinking about the smells of food, of the greasy horror of fried fish and the deeply moving smell that came from it; of the intoxicating breath of bakeries and the dullness of buns... He planned dinners, of enchanting aromatic foods that should be carried under the nose, snuffed and then thrown to the dogs...endless dinners, in which one could alternate flavour with flavour from sunset to dawn without satiety, while one breathed great drafts of the bouquet of old brandy."* (Waugh, 1930; this quote also appears in Robbins, 1983). In fact, one of the culinary experiences that was proposed by the Italian Futurists involved the preparing of a delicious-smelling dish, which was then paraded around diners at the table, so that the latter could enjoy the dish's aroma, albeit briefly, before returning the food uneaten to the kitchen. The Italian Futurists were, in other words, amongst the first to be interested in the role of off-the-plate scent (Berghaus, 2001; Marinetti, 1932/2014; Novero, 2010; Spence, 2017b).²

In recent years, a number of press stories have appeared from those dieters who have attributed their weight loss to smelling the dishes they create/bake, which they then allow others to consume (Kirkova, 2013; see also Massolt, van Haard, Rehfeld, Posthuma, van der Veer, & Schweitzer, 2010). That said, it is worth keeping in mind how various of the claims around the use of specific food aromas to aid those in weight loss programs achieve their goals have had to be retracted under pressure from the courts (Deardorff & King, 2014).

Along somewhat similar lines (that is, considering the role of food-extrinsic scent in helping the consumer to engage in healthy patterns of food consumption), the development of various patent-pending drinking receptacles, from the Right Cup to scented water bottles have come onto the market in recent years (O'Hare, 2015; <https://www.facebook.com/TheRightCup/>). The scent embedded in the receptacle is supposed to enhance the taste/flavour of water, and so

² Another of the Futurist's recommendations involved spraying a carnation scent into the faces of their diners. According to the Futurists, at the tactile dinner party, for instance: *"Meals were to be eaten to the accompaniment of perfumes . . . to be sprayed over the diners, who, fork in the right hand, would stroke meanwhile with the left some suitable substance —velvet, silk, or emery paper."*

promote the healthy consumption of liquids. For example, the Right Cup includes a colourful sleeve that gives off a fruity aroma for several months after purchase. The apple-flavoured cup is bright green, the lemon yellow, and the orange, coloured orange. The idea is that the consumer can drink water from the cup and have a tasting experience that at least approximates what might be expected on drinking the appropriately-flavoured water. Unfortunately, however, too often the scents that have been impregnated into the plastic in such cases tend to smell synthetic and artificial, thus reducing the appeal/likely success of such scent-enhanced food solutions (see Spence, 2017a, b). Much the same problem has also been commented on by those who have tried Molecule-R's scented forks (Bloom, 2014; Lower, 2014; Spence-Piqueras-Fiszman, 2014). Just take the following quote from someone using a basil-scented Aromafork to augment their tomato and mozzarella salad and you will, I think, get the idea: *"This was reminiscent of a caprese salad, but like one of those caprese salads where the basil is a little weak. You know, just kind of anemic tasting ... definitely not organic."* (quoted in Lower, 2014).

In a marketing-led intervention that launched at the start of 2020, plant-based food company Strong Roots promoted Veganuary by releasing a limited edition bacon-scented sticker was released with the idea being that people could wear it on their arm and scratch whenever they found themselves tempted to break their fast (see **Figure 1**). One of the problems in this case (which was widely covered by the press; e.g., see Daily Mail Reporter, 2020; News US, 2020; Sawyer, 2020) was that the bacon scent smelled more of Frazzles (a very synthetic-bacon scented version of crisps from the 1970s), for those who remember them, than the authentic highly-desirable smell of real bacon. Indeed, the problem of getting the off-the-plate scent right is one that has affected a number of the attempts to capitalize on the use of dish-extrinsic scents. In part, this is because it tends to be much easier and/or cheaper to produce a synthetic- than an authentic-smelling imitation odour. At the same time, however, a number of other complex food aromas, such as the smell of freshly-baked bread and chocolate, have proven to be much more difficult to imitate artificially (Spence, 2017b).

INSERT FIGURE 1 ABOUT HERE

Finally, here it is worth noting that eliminating the sense of smell completely may actually provide a more effective means of helping people to reduce their weight than tantalizing their nostrils with food aromas. Intriguingly, the designers at NozNoz have developed patented rubber seals to insert discretely into one's nostrils in order to block any food aromas that might otherwise be tempting you. Developed by the Rabin Medical Centre in Israel, the results of a small-scale preliminary study suggested that that wearing these inserts could lead to a reduction in weight in those under 50 years of age (see Spence, 2021d).

2.3. Interim summary

While the examples reported in this section highlight a number of popular uses for ambient, or dish-extrinsic, scent, they are of less relevance in the case of high-end gastronomy where there tends to be less concern over the health credentials of the meal, and where walk-in bookings, and repeat custom tend to be rare. In the next section, I turn to summarizing the literature around a number of gastronomic uses of off-the-plate scent.

3. Gastronomic uses of dish-extrinsic scent

One can start here by asking the question of why a chef or restaurateur might want to use ambient, or dish-extrinsic, scent in a gastronomic setting in the first place? For one thing, note only how the dispersal of ambient scent has often been used to add a theatrical touch to proceedings. Consider here only the dry ice dispersal of the smell of oak moss in one of the dishes served at chef Heston Blumenthal's The Fat Duck restaurant in Bray (Blumenthal, 2008). A few years ago, North American scientist David Edwards and French culinary designer Marc Bretillot invented a gadget that they christened 'Le Whaf', which can transform food into a cloud of flavour (<http://labstoreparis.com/#&p=foodlab>). This food nebulizer was popular amongst those modernist chefs wanting to play with flavoured air (see Spence & Piqueras-Fiszman, 2014, for a review). However, in this case, the aroma is, in some sense at least, the dish and so these examples do not really fit with the focus here on the specific use of 'off-the-plate' scents despite their obviously being relevant to those interested in the gastronomic use of aroma.

Ambient scents are also used in a gastronomic context to help set the context (Trebolazabala & Atxa, 2012; Youssef & Spence, 2021a, b), stimulate appetite (Zoon, de Graaf, & Boesveldt, 2016), and even to modify the flavour of the food or drink itself (Chambers, 2015; Robertson, 2013). Scents have also sometimes been used in order to try and modify the diner's mood (see Spence, 2020e, for a review; see also Ouyang et al., 2018). Scent is also increasingly being used in the context of storytelling (see Spence, 2021c, for a review), and as but one element of multisensory experiential dining (cf. Pine & Gilmore, 1998, 1999).

3.1. Nostalgic scents

Proust's madeleine has long offered a famous literary example of the power of even mundane food scents to trigger intense nostalgic reflection (see Brennan, 2013). Proust's narrator involuntarily recalls an episode from his childhood after tasting a madeleine dipped in tea. Proust writes: "*No sooner had the warm liquid mixed with the crumbs touched my palate than a shudder ran through me and I stopped, intent upon the extraordinary thing that was happening to me.*" Relevant here, the laboratory research has demonstrated that odours constitute better cues of autobiographical memory than do cues presented to the other senses (Chu & Downes, 2002; see also Herz & Schooler, 2002; Larsson & Willander, 2009; Van Campen, 2014).

While the idea that positive nostalgia could be triggered in a diner's mind, be it by the use of scent (Blumenthal, 2008) or sound (Leonor, Lake, & Guerra, 2018), has proved an appealing notion to world-leading chefs such as Heston Blumenthal (of The Fat Duck fame), it is important to remember that the majority of nostalgia-inducing scents are likely to be idiosyncratic in nature. For instance, the scent of a madeleine dunked in linden tea is unlikely to trigger nostalgic thoughts in the majority of consumers nowadays – after all, why should it? Hinting at the wide range of likely nostalgia-inducing smells, one food journalist writes of how it is: "*The smell of garlic and onions sweating in a hot pan always transports me to my mother's kitchen.*" (Yuan, 2016). The typically idiosyncratic (or autobiographical) nature of nostalgia-inducing scents obviously represents something of a challenge for the chef wanting to induce

positively-valenced nostalgia in his/her guests be it through the food itself (as in the Proustian moment) or through the use of ambient, or off-the-plate scent.

The chef Heston Blumenthal has, though, managed to successfully target a couple of memories that appear to be positively-valenced for the majority of people – namely, the seaside (though the Sounds of the Sea dish, though in this case involving a sonic rather than a scented accompaniment, meant to elicit memories of happy childhood holidays; Leonor et al., 2018; cf. Willander & Larsson, 2006) and the ‘like a child in a sweet shop’ concept (cf. Vignolles & Pichon, 2014). In the latter case, the idea was for the scent to be sent out with the reminder card confirming the forthcoming booking. The next time that the guest would experience the scent was when they entered the front door of the restaurant, as the scent was supposed to be rubbed around the doorframe each and every day. Finally, assuming that the diners may still not have recognized the pleasant and familiar scent, they were sent home with a bag of sweeties directly referencing the source of that sweet smell. As always, it remains something of an open question as to how many diners will recognize the scent on first sniffing it. But, once again, note how the source for the scent was eventually revealed at the end of the meal. The scented element in this case also helping to temporally extend the diner’s multisensory engagement with the meal experience.

Top cocktail maker, Tony Conigliaro developed a cocktail in which the ambient scent is actually embedded within the drink itself (Hyslop, 2014). With ‘The Rose’ cocktail, guests were served a glass of Champagne with a rose-scented sugar cube dropped in the bottom of the glass when served. The idea in this case is that the scent of roses will soon pervade the atmosphere around the drinker and help to transport them to a summer rose garden. Hence, though the ambient scent actually originates from within the drink itself, the purpose is nevertheless not so much to modify the drink’s flavour, but rather to create a pleasant olfactory context, or atmosphere, and so, hopefully, transport the drinker somewhere else (namely, to an English rose garden in the summertime; see also Buchanan, 2015).

In his restaurant Alinea in Chicago, chef Grant Achatz has developed a number of innovative dishes that effectively emphasize the role of off-the-plate scent. See, for example, **Figure 2**, for one personally-meaningful evocation of the autumnal scent of North America that is relevant to the chef, and which he has chosen to share with his guests.³ Once again, the question of how meaningful this scent was to diners remains unclear. However, note that in this case, the explanation of the inspiration for the dish by the wait staff helps to orientate the diner with respect to the intended meaning of the scent for the chef who created it. Hence, at the very least, the idea is that the guests should be able to appreciate the sentiment behind the inclusion of ambient scent in the dish, even if it doesn’t necessarily trigger any specific autobiographical memories in the diners themselves. Achatz is also famous for the dish in which hot water is poured over a bowl of flowers when serving a dish of ‘Wild Turbot, Shellfish, Water Chestnuts, and Hyacinth Vapor’. From an olfactory design perspective, it is interesting to note how often the modernist chefs tend intuitively to stress, either explicitly or otherwise, the *natural* origins of their off-the-plate aromas (see Spence & Piqueras-Fiszman, 2014): Be it the scent that is

³ It is interesting to consider the extent to which this famous chef’s loss of his ability to taste, as a result of cancer, may have led to his innovative use of scent (see Achatz, 2009; Anonymous, 2011; Vettel & Mitchum, 2007).

released when hot water is poured over the hyacinths at Achatz's Alinea, or Homaro Cantu's former use of fresh sprigs of herbs in the curly handles of his cutlery at Moto.

INSERT FIGURE 2 ABOUT HERE

The final dish on the tasting menu at The Fat Duck restaurant, 'Counting Sheep', is served with a furry spoon that has been scented with the heliotrope scent of Johnson & Johnson's baby powder. In this case, the scent is not intended to be treated as part of the flavour of the dish, but is rather there to help set a context for a bedtime-themed dish congruent with the time of the journey that diners are taken on, from evening to morning and on to the following evening. However, one diner, writing on TripAdvisor about their experience of the dish wrote that: *'The final dish was "Going to Bed" ["Counting Sheep"] and I think was meant to be reminiscent of being a baby, but the smell of baby talc was overwhelming and that's not an aroma one necessarily wants while eating.'* (see https://www.tripadvisor.co.uk/Restaurant_Review-g528798-d1571626-Reviews-The_Fat_Duck-Bray_on_Thames_Berkshire_England.html). This highlights one of the challenges of the use of non-food related scents, and how to make sure that the diner does not integrate them into their multisensory flavour experience.

3.2. Setting the mood

At one stage, the entrance passageway to Grant Achatz's restaurant Alinea in Chicago was covered with fresh flowers. The idea in this case being that the scent of the flower-filled corridor would help to provide an olfactory reset for diners between their everyday stresses of the outside world and the calm atmosphere in the restaurant. Indeed, it is interesting to consider, given the rise of nature effect literature, the extent to which the use of nature scents – e.g., geosmin to evoke the smell of the earth after it rains (see Spence & Youssef, 2015), may play a dual role, both in helping to set the appropriate context for a given dish, but also triggering the beneficial effects of nature exposure, in this case an olfactory, or more often multisensory, nature (see Spence, 2021d, on this theme; see also Wang, 2013).

Similarly, the scent of copal that was conspicuously dispersed through the dining room when guests arrived for the Mexico dining experience organized by chef Jozef Youssef of Kitchen Theory (<https://kitchen-theory.com/>) in 2016 may also have played a dual role, both being contextually appropriate to the theme (for a Mexican-themed gastronomic meal) while also potentially helping to calm the diners at the start of the meal (see Gigliarelli, Becerra, Curini, Marcotullio, 2015; Youssef & Spence, 2021b). Remember how according to Guéguen and Petr (2006), mentioned earlier, introducing an ambient lavender aroma into a pizzeria had helped to relax diners, thus leading them to linger for longer and spend more. A final intriguing use of olfactory branding to help set the mood/ambiance has been introduced in Jordan Kahn's Vespertine restaurant in Los Angeles, California (see <http://vespertine.la/>). A distinctive scent pervades the various areas in the restaurant through which guests pass as part of their curated dining experience. What is more, diners leave the restaurant taking a small phial of the distinctive bespoke scent that has been especially created for the restaurant to compliment the experience. According to the website selling the limited edition scent, it is an exclusive fragrance created to compliment the high concept dining experience (<https://www.capsuleparfumerie.com/orrisexclusives/vespertine-i>). It also helps to unite the various parts of the experience which unfold both inside and outside the restaurant building.

3.3. *Using dish-extrinsic scent to modify flavour*

When food- or drink-extrinsic scent is introduced at the same time as a dish is served, it may be incorporated into the diner's multisensory flavour experience. This was entertainingly demonstrated by chef Jozef Youssef in one of the courses on his gastrophysics Chef's Table menu called 'A Taste of Chivas'. The ten guests were given two glasses of whisky to taste from different glasses. One part of the dish/drink involved the chef spritzing caramel or smoky bacon aroma into the air over the diners at the table, as they nosed and tasted the whisky (see Spence, 2017b). The ambient caramel/vanilla aroma introduces a sweet note to the taste of the whisky, while the scent of bacon can help to bring out the smokiness of the drink instead (cf. Chambers, 2015; Spence, 2021f). The orthonasal release of ambient aroma is integrated into the retronasal flavour experience. See Shepherd (2012) for neuroimaging data concerning olfactory/flavour perception.

In such cases, the guests' brains are presumably integrating the orthonasal and retronasal aromas, associated with the drink-extrinsic scent and the flavour of the whisky, into an integrated percept. Culinary artist Caroline Hopkinson has also demonstrated a similar interaction between personal fragrance and food perception in some of her food displays/events. For example, she uses a pepper-scented gourmand fragrance sprayed on the wrist to enhance people's enjoyment of fresh strawberries. In this case, as in several others, one might ask what exactly the advantage for presenting the scent externally. It would appear that it is for educational entertainment, or what has been called 'edutainment'.

In one multisensory experiential dinner in Tallinn, Estonia as part of the Sauce 2016 congress, the 100 or so guests were offered a choice of breads at the start of the meal by the waiting staff. Those who chose the rosemary option were asked to extend their arm, whereupon a rosemary scent was sprayed on their wrist (Spence, 2016). Note that a very similar approach to the enhancement of the taste/flavour sounds like it is being pursued commercially by those patenting scented closures to drink bottles (i.e., packaging; Morran, 2013; see also Thompson, 2006) though in the latter case the aim is to deliver enhanced flavour perception rather than to illustrate the workings of flavour. A similar outcome was achieved by Courvoisier a few years ago, when their premium customers were sent a set of six key aromas that are typically found in their cognac (Crisinel, Jacquier, Deroy, & Spence, 2013). In an innovative marketing intervention, a set of music tracks was commissioned to match each of the aroma notes, including coffee, candied orange, ginger biscuits, and iris flower. The idea was that the customers would sniff the individual fragrances while listening to the matching piece of music. Once they had learnt the association between scent and sound (with a different instrument sound associated with each aroma), they were then encouraged to drink a glass of cognac while listening to a different musical composition that incorporated all of the individual aromatic musical elements. Again, the separate drink-extrinsic aromas were being used to help enhance the multisensory drink experience.

Finally here, taking the idea of dish-extrinsic scent to the extreme, a 2013 art exhibit called Ghost Food was designed to highlight the problems of global warming for the future supply of everyday foods such as cod, chocolate, and peanut butter (Robertson, 2013). The travelling exhibit offered visitors the opportunity to eat a tasteless cube of textured food substrate, while the relevant food aroma was delivered by means of a head-mounted tube that provide the

relevant orthonasal aroma to match the food (see **Figure 3**). The experience was presumably intended to be more shocking than pleasurable.

INSERT FIGURE 3 ABOUT HERE

3.4. Scents associated with (other) diners, and the food they prepare/consume

For those who love them, there is little that is more appealing than the aroma of truffles (cf. Gottfried, 2005). This point of view is captured in the following quote: “*Presently, we were aware of an odour gradually coming towards us, something musky, fiery, savoury, mysterious,—a hot drowsy smell, that lulls the senses, and yet enflames them,—the truffles were coming.*” (William Makepeace Thackeray, 1811-1863). However, for those who do not like truffles, the intense smell can be most off-putting, as when some of those synthetically truffle-scented cheesy fries are delivered to one of the other tables in the restaurant. For those in the latter category, while the scent originates from one of the dishes that is served in the restaurant, it is just not one that the diner concerned necessarily enjoys. For such individuals, the lingering aroma of truffles takes on the status of an unpleasant ambient odour that can deleteriously affect their own dining pleasure. Unfortunately, however, I am not aware of any practical solutions to this problem of scent contamination (from other diners’ food) yet. Fortunately for the restaurateur, though, the proportion of the population having such an aversive response to the orthonasal smell of specific culinary ingredients is pretty low (Reed & Knaapila, 2010). Problems associated with the smell of other people’s food has also been documented by those attempting to prepare hot food in the work kitchen microwave, with the olfactory aroma disturbing to those who aren’t eating (Summers, 2021).⁴

The rise of the open kitchen in contemporary restaurant design (see Steel, 2008), unless suitably screened, not to mention incorporating sufficiently powerful extractor fans, will presumably have resulted in more of the odours of cooking reaching the diners’ nostrils, at least compared to the traditional design of restaurants, where the kitchens would have been hidden away out of sight (along with the chef).⁵ What this is like for the chef working in the kitchen is brought home by the following quote from Avery Gilbert (2008, p. 150): “*Bill Burford encountered a typically sedate olfactory tempo when he worked as a line chef in the kitchen of an Italian restaurant: By midmorning, when many things had been prepared, they were cooked in quick*

⁴ This very different from the appealing food aromas described by Kenneth Grahame, in *The Wind in the Willows* (1908, p. 54): “The smell of that buttered toast simply talked to Toad, and with no uncertain voice; talked of warm kitchens, of breakfasts on bright frosty mornings, of cozy parlor firesides on winter evenings.”

⁵ It is perhaps worth recognizing how the opportunity to introduce ambient scent is something that becomes much easier in the contemporary era, once all the unpleasant food and fecal aromas that were such a ubiquitous and pervasive feature of traditional indoor environments had been eliminated, facilitated in part by the invention of the flushing toilet (see Jütte, 2005; Stamp, 2014). The toilet, if there was one, in Ancient Rome homes was typically situated in the cooking space/kitchen (e.g., see Koloski-Ostrow, 2015). As such, it is often suggested that bad smells likely abounded. Potter (2015) has written extensively on the many ingenious ways in which a number of those enlightened individuals who were rich and important enough to throw feasts in Ancient Greece/Rome would go about scenting their dining spaces. For example, in the written record, one finds mention of diners and/or dining rooms being scented with fragrant showers, rose petals, and even scented doves (...). Meanwhile, according to Classen et al. (1994, pp. 20-26), the fragrance of fresh flowers, perfumed unguents, and incense would once have been considered an essential accompaniment for a successful dinner party in ancient Greece or Rome.

succession, and the smells came, one after the other, waves of smell, like sounds in music. There was the smell of meat, and the kitchen was overwhelmed by the rich, sticky smell of wintry lamb. And then, in minutes, it would be chocolate melting in a metal bowl. Then a disturbing non-sequitur like tripe (a curious disjunction, having chocolate in your nose followed quickly by stewing cow innards). Then something ripe and fishy—octopus in a hot tub—followed by overextracted pineapple. And so they came, one after the other.”

It is important to recognize that any ambient scent may influence the perception of the dining environment (see Spence, 2020d) and potentially even the wait staff – i.e., and not just the food (see Spence, 2020d, 2021e). Note here only how there is a separate literature on ambient scent and interpersonal trust/attraction (Sellaro, van Dijk, Paccani, Hommel, & Colzato, 2015; Spence, 2021e). Intuitively, however, many chefs would already appear to have addressed the problem of ensuring that the ambient scent is linked to the food by ensuring that the source of the scent is somehow visibly tied to the presentation of the dish itself. However, it is worth noting that there are famous restaurants, such as *Per Se* in New York (<http://www.thomaskeller.com/per-se>) where the serving staff are banned from wearing any fragranced products for fear that their scent might interfere with the diner’s enjoyment of the food (Damrosch, 2008, p. 22). As such, the tap labels found in one unnamed New York restaurant bathroom start to make a lot more sense (see **Figure 4**).⁶

INSERT FIGURE 4 ABOUT HERE

Evidence that Thomas Keller might be right to be concerned about the impact of staff fragrance comes from a recent study by Singh, Beekman, and Seo (2019). The latter researchers demoed that the olfactory cues associated with restaurant wait staff do indeed modulate patrons’ dining experiences and restaurant behaviour. The 213 participants in a study by Singh et al. (2019) had to select and consume one of four chicken meat menu items: baked, broiled, fried, and smoked chicken, in a mock restaurant setting, under one of the three scents conditions: congruent with the food (a smoky barbecue scent), fragrance (a perfume scent), and no scent (control) applied to fabric aprons worn by the wait staff. The results revealed that menu choice and flavour perception of the meat dishes did not differ as a function of the scent condition. The effects of wait staff scents on overall liking of chicken meat items, meal satisfaction, and tip amount for wait staff differed as a function of patron gender. Female patrons gave higher ratings of overall liking and meal satisfaction in the fragrance condition than when the wait staff were unscented, while the male participants showed no effect with respect to overall liking and were less satisfied with their dish overall. Female patrons gave larger tips to wait staff under the congruent scent condition than under the no scent condition (though whether this is because the scent affected their perception of the food or the perceived attractiveness of the wait staff is unclear; see Spence, 2021e, for a review). For whatever reason, the participants also consumed less when the wait staff smelled of BBQ (see also Girard et al., 2019; Ouyang et al., 2018).

The famous French oenologist, Emile Peynaud (1987, 2005) once suggested that perfumes and aftershaves should be avoided in the context of tasting fine wine (cf. Poupon 1957). Peynaud thought that ambient scents, such as perfume, would interfere with a wine taster’s ability to

⁶ Note here also that a diner’s own fragrance is likely to exert a greater influence over others than the self due to the fact that people rapidly habituate and adapt to those smells to which they are constantly exposed (Pellegrino, Sinding, de Wijk, & Hummel, 2017).

rate a wine thus matching the concern from the high-end of the gastronomy. Taken together, the anecdotes and results that have been reviewed in this section help to demonstrate how the scents of (or worn by) other diners, not to mention the food they order.

3.5. Challenges associated with the incorporation of ambient scent into the dining experience

As well as the various opportunities outlined herein for the use of ambient and/or dish-extrinsic scent in a gastronomic context, it is also worth noting those interested in pursuing this particular route to olfactorily-enhanced experience design should be ready to address a number of challenges that have been documented in various of the examples reviewed here. These include the challenge of sourcing and presenting a scent that smells both authentic and not synthetic. For example, Trebolazabala and Atxa (2012) document the many challenges that they faced as far as developing an authentic scent of the sea to be released with a particular dish in Restaurante Azurmendi, located in País Vasco, Spain. There is also a very real danger that ambient scent, especially if it is not food-related, may adversely affect the diner's taste/flavour experience, if it happens to be integrated into the flavour of the food, rather than being treated as a contextual dish-extrinsic scent.

For a restaurant serving an international clientele, the challenge is to settle on a scent/aroma that has a common positive association regardless of the part of the world from which the guests may have come. This can be a challenging thing to do, as a number of cross-cultural differences in the associations, and thus hedonic ratings of everyday scents and aromas have been reported in the literature (e.g., see Ayabe-Kanamura, Schicker, Laska, Hudson, Distel, Kobayakawa, & Saito, 1998; Blank & Mattes, 1990). One final point to bear in mind here is that certain odours have been shown to be preferred more at certain times of year than others (see Spence, 2021g, for a review). So, for example, the smell of cinnamon is more familiar and pleasant during Christmas season than summertime odour attributes change in relation to the time of the year (Seo, Buschhüter, & Hummel, 2009). Such findings hint at the potential importance of trying to use ambient food scents that are seasonally-appropriate (cf. Yamada et al., 2014).

3.6. Interim summary

As the results reviewed in this section have hopefully made clear, there are multiple potential uses for ambient, or dish-extrinsic, scent in a gastronomic context. Oftentimes, ambient scents have been introduced in order to help with storytelling and/or to help evoke a particular context, typically associated with nature (e.g., the smell of the sea, or the forest; Wang, 2013; Youssef & Spence, 2021a, b). At the same time, however, there have also been a number of chefs who have used ambient scents to try and trigger specific autobiographical memories (including nostalgia), prime specific associations, or moods in their guests. Finally, ambient, or food-extrinsic scent has, on occasion, been used to help draw attention to the role of orthonasal olfaction in multisensory flavour perception and the way in which food-extrinsic scents can nevertheless be integrated into the flavour experience. One final point to note here is that there is scope to use the introduction of the dish-extrinsic scent to the table as a means of adding a theatrical element to service, something that anecdotally at least, it would appear stays in the diner's mind long after the meal is over (Spence, 2017b; Youssef & Spence, 2021a). This might be something as simple as the waitress or chef spritzing scent over the diners at the table, or

else using a dry ice method to diffuse the scent as a fog that hangs over the table if they want to deliver a more theatrical restaurant serve. At the same time the olfactory chef should also be aware of the problem of fragrance sensitivity (Steinemann, 2019).

4. Conclusions

While the world of gastronomy is unlike most other forms of art and entertainment in being intrinsically aromatic, there is nevertheless something of a shared interest in the potential use of ambient or, at the very least, product-extrinsic scent to enhance the consumer's experience of a wide range of arts and entertainment experiences. Modernist chefs are increasingly using scent to help set the naturalistic context for a dish (Trebolazabala & Atxa, 2012), to induce a particular mood (and/or trigger nostalgia; see also Orth & Bourrain, 2008), and to help tell stories etc. Food marketers have also been interested in the potential role that ambient scent to help induce hunger and purchase behaviour (cf. Fine & Riera, 2019; Sanburn, 2011; White, 2011), its potential role in terms of signature scents (Minsky et al., 2018), and, on occasion, to help mask the smell of the foods themselves, or rather the smells associated with their preparation (Spence, 2020a).

No matter where we eat and drink, there is always an olfactory atmosphere (what McGee, 2020, calls the 'osmocsm'), that affects our food perception, choices, and behaviour, no matter whether we realize it or not (Firmin, Gillette, Hobbs, & Wu, 2016). While chefs operating at the higher end of gastronomy tend to draw attention to the use, and impact, of off-the-plate, or atmospheric scent, by means of a more theatrical approach to service, the mainstream food and beverage chains often pay just as much attention to the optimization of the olfactory atmosphere, though often without the consumer realizing quite what is going on.

Although, as has been suggested here, ambient scent's introduction into a gastronomic context would appear to have been more successful than has been the case for a number of other arts and entertainment formats (see Spence, 2020b, c.; 2021a, c, d), there may be a number of uses for scent that have yet to be tapped by those interested in the innovative use of olfaction in gastronomy. In her enlightening review, Sally Banes (2001) highlights a number of uses of scent in a live-performance setting that could potentially be adapted for use in a gastronomic context, such as, for example, the use of scent to inject a note of humour. Banes also highlights the use of ambient scent to provide a contrastive note and/or to deliberately inject an incongruent note into proceedings. To give one such early example of incongruity from the Surrealists were interested in delivering when, for example, they incorporated the powerful smell of roasting Brazilian coffee at the 1938 International Surrealist Exhibition held at the Galerie des Beaux Arts. At the same time, however, this smell was also semantically meaningful (Kachur, 2001). In particular, the smell may have been chosen both because of its incongruity with the interior setting of the gallery (at the time, it would have been more congruent with an outdoor café), and also the fact that it was specifically (and to some, recognizably) the smell of Brazilian coffee roasting perhaps referencing 1938 as the year in which the Brazilians joined the Surrealist movement (Verbeek, 2015, 2018; Verbeek & van Campen, 2013).

At the same time as a number of the world's top modernist chefs and molecular mixologists have been thinking increasingly creatively about how to deliver enhanced multisensory dining

and drinking experiences through the more intelligent delivery of aroma and scent (e.g., see Anonymous, 2011; Koutsovoulou, 2014; Yeap, 2015), some commentators have started to become tired of all the show, as perhaps involved in the theatrical use of off-the-plate scent. For instance, in his 2018 book *El engaño de la gastronomía española. Perversiones, mentiras y capital cultural* [The deception of Spanish gastronomy. Perversions, lies and cultural capital], the Spanish commentator José Berasaluce Linares argues for a return in gastronomy to a fundamental focus on good food. One other potentially relevant point to note here concerns the fact that chefs may perceive odours in a different way to the non-expert guests they serve. Indeed, according to the evidence, it would appear that chefs tend to describe food aromas more in terms of the relevant olfactory qualities whereas non-experts typically refer to odours primarily in terms of their source objects and their hedonic qualities instead (Sezille, Fournel, Rouby, Rinck, & Bensafi, 2014).

In light of the contemporary Covid pandemic sweeping the globe, it is intriguing to note how a few chefs have started to incorporate a scented element for diners to enjoy while consuming the high-end meal boxes that they send out to people's homes (see Spence, Youssef, & Levitan, 2021). So, for instance, with two of the themed meal box options developed by chef Jozef Youssef of Kitchen Theory fame, diners were offered a complete home multisensory experience; In February, 2021, Kitchen Theory offered Valentine's Day boxes incorporating a four-course meal, wine, a scented candle and a curated Spotify playlist (<https://kitchen-theory.com/valentinesday/>). The following month, Youssef developed a Mother's Day box with full afternoon tea, glass cake stand, rose atomiser, luxury tea selection and another Spotify playlist (<https://kitchen-theory.com/mothers-day-afternoon-tea/>).

4.1. Future outlook: Digital scent delivery of gastronomic aromas

More futuristically, there is interest in the use of digital food apps to help bring the smells of the restaurant to the consumer's phone, as debuted by Mugaritz at Madrid Fusion a few years ago (Yuan, 2014).⁷ However, in this case, it is worth highlighting the very limited range of scents that such digital olfactory devices can deliver at present, thus likely limiting the use of such apps. The day when you can send a scented message with the aroma of the meal you are currently enjoying is many years away (Spence, Ranasinghe, Velasco, & Obrist, 2017). Digital olfactory displays are now also being considered as a means of enhancing the perceived sweetness of reduced sugar products (e.g., Aisala, Rantala, Vanhatalo, Nikinmaa, Pennanen, Raisamo, & Sözer, 2020). It is to be hoped that the insights and opportunities that have been revealed by the gastronomic use of ambient, and dish-extrinsic, scents will one day help to maximize the chances of success for these scented solutions to the problem of healthy eating too.

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962 Figure 1. Wearers of the patch scratch it to get a whiff of sizzling bacon to help quell their
963 craving for meat. One example of the marketing-led use of food-extrinsic scent to help control
964 our food behaviour (see Sawyer, 2020).



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967 Figure 2. North American chef, Grant Achatz is famous for his pheasant, served with shallot,
968 and cider gel, which is accompanied by burning oak leaves. The idea here is to use scent to
969 trigger happy memories of an autumnal day from childhood.



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973 Figure 3. Ghost Truck. A mobile art exhibit designed to highlight the problem of global
974 warming for the food supply, by providing visitors with a tasteless cube of food texture and
975 delivering the orthonasal aroma of chocolate, peanut butter, or cod orthonasally via a tube.
976 [Figure reprinted from Robertson (2013).]

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980 Figure 4. One New York restaurant's solution to the problem of personal fragrance
981 deleteriously affecting the taste of the food. [Picture reprinted from Rach (2020)].



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