Spence *Flavour* (2017) 6:3
DOI 10.1186/s13411-017-0055-y

Flavour

OPINION Open Access

Hospital food

Charles Spence

Abstract

This opinion piece takes a critical look at the current state of hospital food, with a focus on the UK's National Health Service. Some of the unique challenges facing those serving food in this situation are identified. Unlike many other environments, the hospital/care home setting is one in which undernutrition is a significant issue. The suggestion is made that a number of the findings from studies of high-end gastrophysics research may have application as far as the provision of improved hospital food is concerned. A number of concrete recommendations and low-cost solutions are proposed.

Keywords: Gastrophysics, Flavour, Undernutrition, Sensory design

Introduction

Hospital: It is where we start out and, most probably, where we will spend our final days, too. Depending on the hand that we have been dealt, we may find ourselves sampling the food there on a more-or-less infrequent basis in-between. I am not even going to ask you what you think about it. For the last time you likely had a good feed there was probably when you were suckling at your mother's breast, that umami-rich, sweet and nutritious nectar.

But do you even have any idea how many hospital meals go uneaten each and every day here in the UK alone? The answer, somewhere in the region of 80,000. If you do the math, that is around 30 million meals a year wasted. What justification can there be for the dreadful statistic suggesting that 70% of the food currently served in hospitals is simply thrown away?[1] Absolutely none. So what can be done about this scandalous problem and why are we faced with it in the first place? In this opinion piece, I want to try and answer those questions. I will also illustrate how a number of the gastrophysics findings, first tested out in the upper echelons of modernist cuisine, provide recommendations that can potentially be used to help improve the food service in the hospital setting. Importantly, and that will turn out to be key, many of these suggestions could be implemented at relatively little cost.

Correspondence: charles.spence@psy.ox.ac.uk
Department of Experimental Psychology, University of Oxford, Oxford OX1 3UD, UK

'Doctor, doctor, there's something wrong with my food'

So what do people think about the food that is currently served in hospitals? Not much, is the answer. Prue Leith, head of Leith's Cookery School in London, captured the view of many when she said in 2015 that: 'most hospital food is a disgrace'.[2] Just take the following to get an idea of what people think:

'I could only describe it as slop'—Chris, patient
'Pinnacle of awfulness'—Brenda, patient
'Hospitals should go back to having chefs'—Karen, patient
'I just needed something that tasted like food'—Lynne, patient
'I would baulk at serving that as pig swill'—Janette, patient's wife
'Horrified by the slop'—Linda, NHS cook[3]

The above quotes will likely ring true with anyone who has spent time in hospital. For, at some point in our lives, most of us will have experienced terrible food there. And public or private, the story tends to be much the same.[4] At the time, I am sure we all had other, more pressing concerns than the quality of the meals we were given to eat. Hopefully, we think if we are only there for a day or two, then we can stand it. Yet, I think that the parlous state of hospital food really does matter—it is, in fact, a crying shame. And although the problem is nothing new, the situation does, if anything, seem to be getting worse. While the cost of hospital care is high, and keeps on rising, the proportion spent on nutrition declines year-on-year. Our growing awareness of just how

terrible hospital food is perhaps also the result of all those patients out there who are now taking pictures of their very own dire hospital meals and sharing them online.[5]

Is it simply a matter of getting what we expect?

In the hospital case, could it simply be that part of the problem is that no one goes in believing that the food will taste good? At least I presume they don't. As Tyler Cowen wryly notes in his best-selling book *An Economist Gets Lunch*, hospitals aren't famed for their fine cuisine. Such negative expectations may then, in part, be a self-fulfilling prophecy. If we think that what we are about to eat is going to be bad, then the chances are that it will not taste as good to us as it otherwise might. Though, that said, all those negative beliefs are presumably based on something. Perhaps our bad mood while in hospital also negatively affects our evaluation of the taste of the food too.[6]

One of the main objections raised whenever the topic of hospital meals is brought up here in the UK, though, is the cost. How could anyone justify spending money on improving the food given the financial strains that the National Health Service (NHS) is currently facing? Surely, any spare resources would be better spent on new and improved treatments or staff salaries and not on an enhanced culinary offering. The latter seems like something of a luxury, does it not? And, anyway, if the food service was better, wouldn't that just make the problem of bed-blocking at our publically funded institutions worse? Yet, one also finds others arguing that 'Food and drink should be put on a par with medicine in hospitals.'[7]

I would like to argue that there are, in fact, a number of simple fixes that any hospital food service provider could make: Everything from the elimination of the red tray regime through to the better (i.e. more aesthetically pleasing) arrangement of the elements on the plate. I will suggest later that, for those who are willing to invest in their food service offering, there may actually be a cost saving in the long run. Hence, it may be a price that *is* ultimately worth paying.

What is the problem with hospital food?

While everyone tends to focus on the growing global obesity crisis, it is worth remembering that the situation amongst those in hospital tends to be rather different.[8] For, in contrast to society at large (quite literally), the majority of older hospital patients are likely suffering from undernutrition. If not when they go in, then more than likely if (and, hopefully, when) they come out. According to one estimate, 6 out of every 10 elderly hospital patients are at serious risk of malnutrition. The results of one recent study are revealing: 1 in 5 hospitalized patients over the age of 65 years of age was found to have an average nutrient intake that was below half their daily requirements?[9]

Will TV chefs save hospital food?

'TV chef parachuted into hospital and revolutionizes food service. Patients much happier, and eat more as a result of star chef's intervention.' There is no doubt that this kind of headline makes for engaging television. The only problem here is that such fairy-tale 'happily-ever-after' solutions rarely work.[10] While many of the chefs have the right idea, and I do not doubt for a second that their hearts are in the right place, the concern is that their solutions may just not be financially viable in the long term. What is more, there is a very real danger that the chef's much-publicized presence may create more distraction than is necessarily healthy for the institution concerned. The million dollar question here, I think, is what happens once the camera crews have packed up, and gone home? Not difficult to imagine…

Just take Prue Leith's (2015) suggestion concerning what she would like to see done to revolutionize hospital food: 'What would it take to improve the meals the sick can expect? Ideally, I would eliminate over-packaged, overprocessed junk. Which of us wants the dispiriting experience of having to open a packet to find sustenance when we're not well? I'd have a smaller range of healthy, filling options: vegetable soup, fishcakes with chilli chutney, chicken and leek pie or vegetarian curry. You would be able to order a tempting salad or a scrambled egg on toast if you didn't feel up to a full meal. And I'd make sure everything was cooked fresh and on the spot, possibly even on the ward to cater for patients who cannot eat at scheduled mealtimes.' Sounds wonderful, doesn't it? And certainly, the evidence suggests that people tend to like food more if they feel like they have been given a choice about what they order/eat.[11] But, the problem is, it is just hard to see it ever happening.[12]

Back in 2000, it was Loyd Grossman then a TV chef (now more famous for his readymade pasta sauces), who was drafted in by the NHS to help revive the food served in UK hospitals. More recently, Heston Blumenthal tried his hand in a project designed to explore: 'ways to rejuvenate the dining environment in hospital and improve the flavour in the mouth.' However, if the latest press coverage concerning the parlous state of hospital food (at least here in the UK) is anything to go by, then you'd have to say that these chefs have not really been able to make much of an impression on the problem, at least not at a national level.[13]

Don't get me wrong. It's not that I think that modernist cuisine has no role to play in improving the food service offering in hospitals. It most certainly does. It's just that many of the solutions that really stand a chance of

making a difference in the long-run simply don't make for glitzy TV.[14] One successful example that I often like to point to, comes from an intriguing collaboration between those working in a hospital oncology department and the Alicia Foundation—the latter, Ferran Adrià's research centre based just outside of Barcelona. In one study, for instance, patients consumed significantly more of a nutritious protein shake when it was served as an ice cream than in its traditional format. What is more, they also rated the food as tasting better too.[15]

Ironically, one of the modernist chef's key food preparation techniques, namely *sous vide* actually started out life in the hospital. This French gastronomic term refers to the style of cooking in a vacuum, placing sealed meat or vegetables into a water bath at an exact (normally relatively low) temperature for much longer than one would normally think about cooking food. This approach first made its appearance in Switzerland back in the 1960s as a way of preserving and sterilizing hospital food. The technique was further refined in 1967 by chef Pralus in his restaurant in Roanne, France. Today, it is hard to find a modernist chef who doesn't use the technique.[16]

Of course, one of the biggest barriers to improving the quality of hospital food is that many institutions are signed up to long-term contracts, established as part of the UK's Private Finance Initiative (PFI) schemes. What this means, in practice, is that even if the chef or enlightened kitchen staff at a hospital really did want to change the food offering, they can find it surprisingly difficult to do so.[17]

More worrying still, though, is the suggestion that many hospitals may actually have a vested interest in their patients eating as few hospital-kitchen-prepared meals as possible. For, as Prue Leith's article goes on to note: 'In hospitals, the more meals are served, the more it costs. And if the patients won't order from the menu, and their relatives buy junk from the hospital shop for them instead, the hospital gains twice: once from saving on that hospital meal, once from its share of the profits from the shop. Successive governments have wasted more than £50 million of taxpayers' money on voluntary, often celebrity-led, headline-grabbing initiatives to improve hospital food since 1992. They didn't work, of course. Dishing out famous chefs' recipes to untrained kitchen staff, in hospitals geared to reheating food, was never going to work. And the Hospital Food Standards Panel's suggestions aren't going to either.'[18]

'Eye appeal really is half the meal', even in hospital

So what might the solution look like? First off, I would argue that more attention should be paid to the presentation of the food on the plate in order to increase the eye appeal of the dish. Ironically, it turns out that this may be even truer for those who find it difficult to see clearly what exactly they are eating. The latest evidence from the growing number of gastrophysics studies conducted together with top chefs demonstrates that by incorporating such essentially cost-free interventions, one's customers will rate the food more highly, they will be willing to pay significantly more, and they may also eat more as well. My belief is that many of the same, relatively simple, steps should hopefully result in fewer patients returning their food untouched to the hospital's kitchens.

There are certainly a number of aspects of the visual presentation of the food currently served in hospitals that demand urgent attention. Elements that could so easily be improved upon with even just an elementary grasp of the gastrophysics literature. So, for example, let's start by thinking about the colour of the plate and/or tray on which the food is served. Is there anything that could be done here to improve the patient's appetite and appreciation of what they have been offered?

Well, getting the colour contrast right is key when it comes to deciding which colour of plate to put particular foods on in order to make them 'look their best'. It is clearly not feasible to replicate much of what one sees at the top end of modernist cuisine in the hospital setting, e.g. with each course (e.g. on the tasting menu) coming on its own specialized plateware (and would anyone even want that?). That said, there are still likely to be plate colours that, on average, work better, or worse, for the typical colour palate of hospital food. Here, one should also be thinking about the colour contrast between the various foods. The lack of visual contrast can be especially problematic for those with poor vision. For instance, many patients with Alzheimer's disease suffer from deficient contrast sensitivity, and so can find it difficult to distinguish the plate from the food or the drink from the glass (just think of milk served in a white beaker). This, in turn, can lead to reduced consumption.[19]

The gastrophysics research now shows that enhancing the visual contrast on the plate can lead to a substantial increase in food and liquid intake in those who are suffering from advanced Alzheimer's disease. In one study conducted at a long-term care facility over in the States, for instance, switching to high contrast blue or red plates and glasses led to a 25% increase in food consumption and liquid intake going up by as much as 84%.[20] The results of another hospital study were equally dramatic: Average consumption amongst the older and more vulnerable patients, including those suffering from dementia, went up by 30% from 114 to 152 g, just by changing the plate colour. In this case, the hospital replaced their standard issue white plates with blue crockery instead. Elsewhere, older people have been shown to eat more white fish when it is served from a blue plate.[21] Better contrast between the food in the foreground and

the background colour can probably best help explain such remarkable results.

But hold on a minute, I hear some of you say. There is something that just doesn't quite make sense here. What about 'the blue plate special'? As Crumpacker put it: '… the term blue plate special became popular during the Great Depression because restaurant owners found that diners were satisfied with smaller portions of food if it was served on blue plates.'[22] So how can it be that blue plates reduced consumption back in the 1920's but significantly increase how much patients eat today? One suggestion here is that the majority of the food served in hospitals tends to be both bland in taste and in colour. Hence, it may just fail to stand out against a white plate. By contrast, serve it on a blue plate and suddenly it is much easier to see what one is eating. The visual contrast is simply more striking. Or, as one article puts it, serving steak off a white plate is fine, but porridge should never be.

You do not need to be a gastrophysicist to know intuitively that presenting hospital food from a red plate or tray just has to be wrong. There is a justification for this approach, of course. It is supposed to help the relevant healthcare professionals identify those patients needing some sort of special nutritional attention more easily. I suspect that it is a bad idea though. Why? Well, because the colour red tends to elicit avoidance motivation. What this means in practice is that people eat significantly less when served food on a red plate than when offered exactly the same food from plateware of another colour. The effects here aren't small either. In one study, people consumed almost twice as many pretzels (though admittedly under lab conditions), when they ate from a white plate than from a red plate instead. There would seem no good reason to imagine that serving food on a red tray, rather than from a tray of a different colour, say, wouldn't trigger exactly the same kind of avoidance motivation. Hence, while red plates and trays might be something to recommend for anyone who wishes to lose weight, this is simply not the situation that most hospital patients find themselves in.[23]

Now here the attentive reader will likely have noticed that coloured plates/trays (specifically red and blue) sometimes seem to increase consumption while other studies suggest that they decrease consumption instead. All published studies, though, would seem to agree that the colour of the plate matters (and hence is something worth investigating). My suspicion is that the typical colour of the food will determine, at least in part, the optimal plate colour. There are, however, also likely contrasting effects of enhancing the visibility of the food on the one hand and avoidance motivation on the other that may both result from a change in plate colour.

Just how important is the visual presentation of the food in hospital?

As has been stressed for centuries, eye appeal really is half the meal.[24] Obviously, the presentation of hospital food is never going to get anywhere close to the amazing gastroporn that many modernist chefs are creating nowadays.[25] Nevertheless, there are a number of insights from the field that have clear implications for the way in which hospital food is served. The evidence is absolutely clear on this point: Make the food look more visually attractive, and people will have better things to say about it. And that would appear to be as true of high-end gastronomy, as it is the much more basic dishes any one of us might cook at home, such as a basic garden salad, or steak and chips, say.[26]

One of the mystifying fashions in plating currently, which has definitely been on the rise recently, involves those modernist chefs who present their food on only one half of the plate (see Fig. 1a for an example). Now, one might have assumed that this sort of asymmetric presentation, or plating, was the preserve of the high-end modernist restaurant. Apparently not, though, as one occasionally finds examples of it in hospital too (see Fig. 1b). Though, in the latter case, it would appear to be more

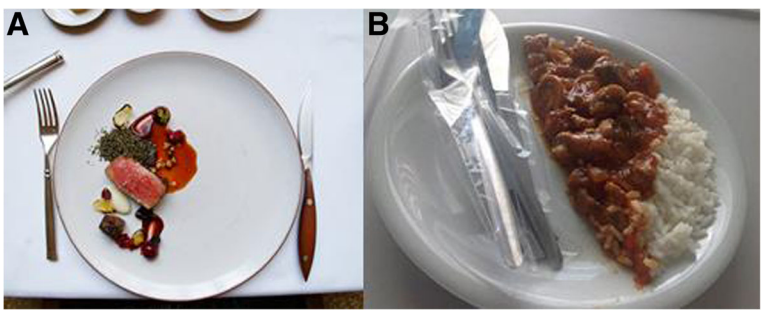

Fig. 1 a High-end asymmetrical plating from the modernist restaurant. The sort of image that you might well see on Instagram's 'The art of plating'. **b** The hospital version. The chef in the latter case presumably hasn't heard about the research sponsored by Tilda rice suggesting that the ratio between the rice and the meat should conform to the Golden Ratio. (Deroy, O., & Spence, C. (2014). Can you find the golden ratio in your plate? *Flavour*, 3:5)

convenience and space-saving that is at stake, rather than the hospital chef necessarily wanting to get their work featured on Instagram's 'The art of plating' site.[27]

But the real question here is what asymmetric plating does to the perceived value and enjoyment of a dish? One could certainly imagine that if the top chefs are doing it, then it ought to be *adding* value, right? We are still waiting for anyone to conduct the study in either modernist restaurant or hospital setting. Nevertheless, when the asymmetric plating was tested at a lunch for around 150 parents and students at Somerville College, Oxford, they didn't think much of it. A couple of years ago, the parents and their families were served a main course of ox cheek, mashed potato and seasonal vegetables, plated either in the centre or else off to one side of the plate. Intriguingly, those sitting at tables where the food was centred preferred their lunch, and what is more, they were also willing to pay significantly more for it (see Fig. 2).[28]

Can you save money by spending more on the food in hospitals?

As has been mentioned already, the suggestions concerning the visual presentation of the food served in the hospital setting that have been made thus far are essentially cost neutral. However, one might ask just what would be possible for any hospital that was interested in going further in terms of improving the quality of their food service offering. Well, in at least one case, a hospital trust has demonstrated how investing in the food could potentially result in long term financial savings. In 2012, Hinchingbrooke Hospital (in Huntingdon, UK), was taken over by an investor's circle, described as 'a John Lewis-style partnership of stakeholder workers and investors.' Unbelievably, they managed to turn a 10-million-pounds-a-year deficit into a predicted 2 million profit, and all within a year or two. In this case, the menus were inspired by a Michelin-starred chef. As one newspaper commentator described it at the time: 'In the kitchen, head-chef Lisa Normanton, 46, cooks fresh, locally-sourced food instead of standard-issue frozen supplies, and takes inspiration from the company's Michelin-starred head chef Andreas Wingert. The restaurant-standard meals not only make patients happier; As ever with Circle, there is a financial benefit, too. Though they are more expensive—£10 a day as opposed to £7—well-nourished patients tend to recover quicker and go home sooner.'[29]

Fig. 2 Two versions of the same dish. Centred plating on the *left* and asymmetric plating on the *right*. The price below the dishes indicates how much more diners would have been willing to pay for the centred version

Doesn't this just sound too good to be true? Well, unfortunately, in this case, it was. For after receiving a scathing review from the UK's Care Quality Commission (CQC), in which the privatized hospital was rated a failure, it was returned to government control late in 2014.[30] So much for this gleaming case study, then. There are, though, a couple of things to note here. On the one hand, some commentators have suggested that the privatized hospital's failure smacks of a political stitch-up. That said, I, for one, do not think that we necessarily want to throw the baby out with the bath water. For despite any political meddling that may have gone on in this particular case, it can still be argued that we try and hold on to the hospital's more enlightened approach. Namely, spending more on the food with a view to saving money in the long term.[31] One could easily imagine how it would also translate into significantly improved patient satisfaction. And happier, better-fed, patients can presumably be discharged from hospital sooner too.[32] Though one very real danger here is that if the quality of the food becomes too good, the problem of patient bed-blocking in our publically funded hospitals, might get worse.

More practitioners are starting to think ever more carefully about how to put the *hospitality* into hospital care.[33] Did you ever hear the one about the French hospital that opened a wine bar? Sounds unbelievable, no? Yet, in this case, it really did happen. Back in 2014, the Clermont-Ferrand University Hospital in central France opened a bar for its terminally ill patients in the hospital's palliative care centre. This most unusual facility was designed to cheer up the patients and improve their quality of life. Importantly, friends and relatives could also enjoy a drink at the bar too, thus helping to create a more convivial and social atmosphere.

According to Virgine Guastella, head of the centre, the bar allows those families: 'facing bereavement to create moments of conviviality despite being in a hospital environment. … It's a little detail but it can make all the difference.'[34] Perhaps unsurprisingly, this is the first hospital of its kind in France (or, I imagine, anywhere else for that matter) to take such a progressive step forward (i.e. offering genuine hospitality). However, given the overwhelmingly positive feedback that this innovative

scheme has received, it would not surprise me if other hospitals were not tempted to take a similar path in the years to come. Let's hope they will. (The wine used to support this innovative scheme was donated.) And the good news for those who don't like wine is that beer, whisky and champagne are also stocked.[35] The innovations in experience design at the Clermont-Ferrand University Hospital do not stop with the bar though. The nurses don waitress outfits rather than their normal nurse's attire at mealtimes. They also insist on using proper crockery.[36]

Background noise

Going beyond the weight of the cutlery and plateware, there is also scope to improve the context, or multisensory atmosphere, where patients eat. As anyone who has been in a public hospital ward knows only too well, they tend to be exceptionally loud.[37] And as has been shown elsewhere, loud background noise is known to adversely affects people's ability to taste food and drink.[38] It can also have a detrimental effect on their health. Noise-cancelling headphones could help here, just like they do on the airplane. In fact, anything that can be done to suppress the noise and/or to provide music, or an auditory atmosphere, that is likely to match either the food, or else the specific needs of the patient will likely have a beneficial effect on the food offering.[39] The composer Brian Eno created a healing ambient soundscape for the patients at Montefiore Hospital in Sussex in 2013.[40] The hope is that such soundscapes will enhance the patients' sense of well-being, no matter whether they be in hospital or residential care home. As AgeUK noted in 2010: 'Hospitals should introduce "protected mealtimes", so that staff cannot carry out routine tests or rounds when patients are eating their meals.' (The one danger to look out for here, that putting headphones on may well make the patients feel even more lonely and isolated.)[41]

Intriguingly, calming music and soundscapes were being used in the care setting to help calm anxious and agitated patients long before ambient soundscapes such as seagulls and waves crashing on the beach of the *Sound of the sea* seafood dish became famous.[42] Crucially, calmer diners tend to eat more at mealtimes. And getting this right is all the more important given that, as one writer notes: 'meals are often one of the last activities in which severely regressed patients can participate.'[43] One could also imagine the hospitals of the future offering those they feed some sonic seasoning. That is, music chosen to match the style of the food.[44] Here one should probably also be thinking of picking music from the right period (some Vera Lynn for all those called Vera perhaps). This would hopefully distract them for a while from their current environment. There is also an important suggestion around the delivery of comfort foods and those foods from years gone by that might provide effective nostalgia cues to trigger memories that might otherwise remain forgotten.[45] And while we are at it, why not change the colour of the lighting too to help relieve stress, enhance calmness, etc. (and who knows, eat more healthily too).[46] A dose of Baker Miller pink to calm perhaps, though probably best stay away from the blue given the results of a recent study suggesting that people (well Swedish males at least) may eat less under such lighting.[47]

Snack/fast food in the hospital setting

The hospital branch of Greggs bakery in New Cross Hospital, in Wolverhampton, is actually the second most profitable in the country. It makes far more money than all but one of their 1600 high street shops scattered across the UK. For those who don't know, the chain sells pies, pasties and sandwiches—think cheese and bacon wrap, chicken fajita slice, and beef and vegetable pasties, items delivering anywhere between 300 and 600 calories apiece. According to David Loughton, the chief executive of Royal Wolverhampton Hospitals: 'There is a cafe in site that sells all healthy food but it gets nowhere near the footfall that Greggs gets.' No wonder then that there is growing concern about the presence of so many junk food outlets in many of our hospitals.[48]

Maybe the bigger issue, though, ought to be all those readily accessible vending machines stocked full of carbonated sugary soft drinks 24/7. According to the results of one recent survey, every one of the 76 hospital trusts that replied indicated that they had vending machines in their departments selling mostly sweets, crisps and chocolate. (Only 2 offered diet versions of fizzy drinks.) How can the UK government be advocating a sugar tax on all those unhealthy soft drinks on the one hand and, at the same time, allowing so many vending machines into our hospitals? But, then again, this situation is all too reminiscent of the debate in North America concerning the long-term contracts between the big drinks manufacturers and district school boards. Impressionable children over there are exposed to such unhealthy carbonated sugary drinks throughout the school day.[49]

It would certainly seem like there is money to be made from the food served in hospitals, it's just not the meals that are being prepared by the hospital kitchens. If this really is the case, then one could see why the hospitals wouldn't be too keen on the idea of high-end takeaway and even restaurant meals being delivered direct to the patient's bedside from one of the increasingly popular gourmet delivery services.[50] And, of course, one other thing to be concerned about here is to make sure that the food that the patients ordered wasn't too aromatic/pungent, as this could impact the comfort of others.[51]

Hospital food: what do we need to know?

Japanese researchers have been looking into whether they can enhance the experience of softer foods for those older patients who may have difficulty chewing or swallowing by adding crunching sounds in time with the movement of a person's jaw. It turns out that more than 1 in 5 of those who are over 50 years of age find it difficult to chew and swallow. As a consequence, many older hospital patients need to get a lot of their nutrients and energy intake by means of such protein shakes. Therefore, anything that can be done to improve the flavour, which is normally not all that pleasant, or at least to improve the overall experience, has to be a good thing.

It can easily be imagined how giving protein shakes, etc., a modernist spin and turning them into a tasty ice-cream might well deliver widespread nutritional benefits. Why so? Well, carers and nurses often ask me why older patients, including those suffering from dementia, start to crave ice cream towards the end of life.[52] Is this a desire for comfort food, something that is associated with the pleasant memories and emotions of childhood? Or could it instead perhaps be that for those who have lost much of their ability to taste and smell, then it is the freezing-cold temperature that provides the necessary sensory stimulation that may otherwise be lacking in the foods they eat? I haven't been able to find an answer to this question yet, so definitely a case of more research needed.[53]

There are a number of challenges here in terms of enhancing the hospital food offering: For one thing, many older people end-up having to add unhealthy levels of seasoning to get the same taste experience as their younger counterparts.[54] The research shows that elderly people require two to three times more salt in their food, say in a bowl of tomato soup, to detect its presence. What is more, the decline in flavour perception can be particularly severe for those older individuals on medication, and how many of them aren't? The latter may need to put as much as 12 times more salt on their food than younger adults in order to detect its presence.[55] Just imagine the negative health consequences associated with all that salt. So what can be done?

One of the other fascinating challenges here from the gastrophysics perspective is to consider the metallic taste that puts so many patients, especially those undergoing chemotherapy, off of their food. Metallic is considered by many to be a basic taste, along with sweet, salty, sour, bitter and umami.[56] But why should it be disliked? Is this only because of the context in which it is normally first experienced (think unpleasant health-care scenario)? Many of us learn to like all those bitter foods and drinks (things that we were certainly born disliking), like coffee and beer, and even the stinkiest of French cheeses can become highly sought after. So what, exactly, is stopping *metallic* from becoming a desirable taste (or should that be flavour) sensation too? Although I don't have an answer yet, I do think that it is just the kind of challenge where the gastrophysicists and chefs could start banging their heads together productively in order to try and deliver better food experiences for patients. Surely, the chef could make metallic desirable? After all, consumers are supposed to be on the look-out for new taste sensations are they not?[57] So, could metallic be it? And if our first exposure to this taste were to be at the hands of a modernist chef in a fancy restaurant, would it no longer strike us as so unpleasant when we come to experience it in the healthcare setting? The psychologist interested in food might be able to contribute here with their knowledge of conditioning and the various factors that lead to learned taste aversions.[58]

Putting the hospitality into healthcare

I am happy to see more top chefs starting to work in this area, not necessarily those that you see on TV, but those ones who may really help to make a difference to the food that, like it or not, many of us will likely be served at the end. There must, then, be a glimmer of hope for the future of hospital food. The collaboration between a hospital oncology department in Barcelona and the Alicia Foundation—the latter, top chef, Ferran Adrià's, research centre—sets an intriguing precedent. It is just this kind of interaction between top chefs and gastrophysicists that will offer more in terms of long-lasting healthcare solutions than all those TV show that leaves nothing behind when camera crews have packed up and gone home.

The most beneficial effects on patient health, recovery and well-being are likely to result from more careful attention being paid to the multisensory design of the entire patient experience (see Fig. 3) or customer journey (to borrow Virgin Atlantic's terminology).[59] This involves everything from a consideration of the view through the window from the hospital bed through to the use of

Fig. 3 The multisensory future of health care? A multisensory 'Beach room' in a care facility in Vreugdehof, Amsterdam

petting dogs to relieve the stress that many patients feel. Those patients who find themselves in a room with a window that looks out onto nature tend to recover faster than those who do not. Meanwhile, stroking an animal has been shown to help reduce patient stress. Put all of the insights together, and combine with better food, and who knows just how much faster patients would recover.[60]

Conclusions

This review of the literature provides clear evidence concerning a number of ways in which the design of multisensory flavour experiences could be enhanced in the hospital/care home setting. While the findings of different studies have sometimes proved inconsistent, there is enough evidence to support the claim that heathcare food provision could certainly be improved at relatively little cost and that this would have a major beneficial effect on the quality of life of those affected. In terms of future research, though, one thing to note about many of the studies reported here (e.g. studies conducted in the hospital setting) is the short-term nature of the interventions reported. Given the well-known Hawthorne effect,[61] it would, I believe, be desirable to check on the longer-term benefits of the various interventions outlined here.

Endnotes

[1]Leith, P. (2015). My recipe to make our sickening hospital food edible again: Scrambled egg on toast, vegetable soup and fishcakes by Prue Leith. *Daily Mail Online*, March 3rd. Malm, S. (2015). It's enough to make you ill! A shrivelled apple, mush and chips and dishes that are simply impossible to identify among the latest NHS hospital food offerings shared by (hungry) patients. *Daily Mail Online*, July 19th. http://www.dailymail.co.uk/news/article-3167353/It-s-make-ill-dried-apple-mush-chips-mushrooms-swimming-gravy-latest-NHS-hospital-food-offerings-turn-patients-dinner.html

[2]Leith (2015); See also Girling, R. (2002). Government health warning: Hospital food can make you ill (whether you eat it or not). *The Sunday Times Magazine*, June 9th, 43–50; McKenna, K. (2016). If we're a nation of foodies, why do patients starve? *The Guardian*, July 31st. https://www.theguardian.com/commentisfree/2016/jul/31/nation-of-foodies-hospital-patients-starve; see also Goldstein, D. (2016). Remembrance of foods past. *Gastronomica*, 9:4

[3]Quotes from The Campaign for Better Hospital Food (http://www.sustainweb.org/hospitalfood/)

[4]Though, there are, of course, exceptions. See Adams, S. (2016). The secrets of Britain's poshest maternity ward: A birth that cost half a million pounds, Dom Perignon with lobster and oysters on demand and a countess gynaecologist dubbed 'too posh to push'. *Daily Mail Online*, March 27th. http://www.dailymail.co.uk/health/article-3510987/The-secrets-Britain-s-poshest-maternity-ward-birth-cost-half-million-pounds-Dom-Perignon-lobster-oysters-demand-countess-gynaecologist-dubbed-posh-push.html.

[5]The gastroporn equivalent of a horror movie, I suppose. Media outlets like *The Daily Mail* certainly love to appal their readers with this kind of stuff! Who knows whether the hospitals will not ban this habit, as the Royal Navy recently did. See Anon. (2016). Seasick! Sailors banned from sharing photos of terrible Royal Navy food. April 19th. https://www.rt.com/uk/340199-military-food-social-media/

[6]Maller, O., DuBose, C. N., & Cardello, A. V. (1980). Consumer opinions of hospital food and foodservice. *Journal of the American Dietetic Association*, 76, 236–242; Piqueras-Fiszman, B., & Spence, C. (2015). Sensory expectations based on product-extrinsic food cues: An interdisciplinary review of the empirical evidence and theoretical accounts. *Food Quality & Preference*, 40, 165–179; Cowen, T. (2012). *An economist gets lunch: New rules for everyday foodies*. New York, NY: Plume

[7]This, the title of a commentary that appeared in the *Nursing Standard* magazine. Although, the article itself focused on the treatment of malnutrition and dehydration in hospitals, the sentiment is one that we should consider seriously. See Keogh, K. (2013). 'Food and drink should be put on a par with medicine in hospitals'. *Nursing Standard,* 28(6), 11; according to this report, 40% of patients are malnourished on admission to hospital, while £45 million of hospital food is wasted every year here in England.

[8]Caballero, B. (2007). The global epidemic of obesity: An overview. *Epidemiologic Reviews*, 29, 1–5; NCD Risk Factor Collaboration (NCD-RisC). (2016). Trends in adult body-mass index in 200 countries from 1975 to 2014: A pooled analysis of 1698 population-based measurement studies with 19·2 million participants. *The Lancet*, 387, 1377–1396

[9]Figures from a 2006 study conducted by Age Concern. Note that undernutrition is a common feature amongst the older hospital population. Significant weight loss is seen in 40% of patients with Alzheimer's disease, this according to Wang, S. Y. (2002). Weight loss and metabolic changes in dementia. *Journal of Nutrition Health Aging*, 6, 201–205; Hill, G. L., Pickford, I., Young, G. A., Schorah, C. J., Blackett, R. L., Burkinshaw, L., Warren, J. V., & Morgan, D. B. (1977). Malnutrition in surgical patients: An unrecognized problem. *The Lancet*, 309, 689–692; West, G. E., Ouellet, D., & Oullette, S. (2003). Resident and staff ratings of foodservices in long-term care: Implications for autonomy and quality

of life. *Journal of Applied Gerontology*, 22, 57–75; The problem for long-term care (LTC) residents is just as bad, with somewhere between 40–85% being malnourished. See Coulston, A. M. (1995). Nutrition management in nursing homes. In J. E. Morley, Z. Glick, & L. Z Rubenstein (Eds.), *Geriatric nutrition* 2nd Ed. (pp. 295–302). New York, NY: Raven Press. For a powerful, first-person perspective, describing what happened when a cardiologist's mother was admitted to hospital; see Malhotra, A. (2014). Over-treatment is the great threat to western health. *The Observer*, July 20th, 39. https://www.theguardian.com/commentisfree/2014/jul/19/patients-hospital-care-over-intervention.

[10]See Walker, T. (2009). Heston Blumenthal serves snail porridge on the NHS. *The Daily Telegraph*, June 7th. http://www.telegraph.co.uk/news/newstopics/mandrake/5469344/Heston-Blumenthal-serves-snail-porridge-on-the-NHS.html.

[11]King, S. C., Weber, A. J., Meiselman, H. L., & Lv, N. (2004). The effect of meal situation, social interaction, physical environment and choice on food acceptability. *Food Quality & Preference*, 15, 645–653. See also Hayward, T. (2016). Menus without choice blaspheme against the doctrine of dining. *FT Weekend Magazine*, 23/24 January, 12.

[12]http://www.theguardian.com/healthcare-network/2015/oct/09/food-medicine-hospital-healthy-fresh-local-produce; http://www.bbc.co.uk/programmes/b01cbwfm; http://www.rbht.nhs.uk/about/news-events/archive/prince-charles-praises-royal-brompton-hospital/. That said, things are apparently different in some North American hospitals; see Landro, L. (2007). Hospital food that won't make you sick. *Wall Street Journal,* September 19th. https://www.wsj.com/articles/SB119016039256231811.

[13]See Malm (2015).

[14]Commentators have, after all, been recommending that hospitals and care homes add more colour, crunch and flavour to meals with fresh produce for going on half a century now; see Bonnell, M. (1966). Add colour, crunch and flavour to meals with fresh produce. 2. *Hospitals*, 40(3), 126–130.

[15]The Alicia Foundation was also where research was conducted showing that exactly the same frozen strawberry dessert would be rated as tasting 10% sweeter and 15% more flavourful if served off a round white plate than off a round black plate instead; see Piqueras-Fiszman, B., Alcaide, J., Roura, E., & Spence, C. (2012). Is it the plate or is it the food? Assessing the influence of the color (black or white) and shape of the plate on the perception of the food placed on it. *Food Quality & Preference*, 24, 205–208; Casas, F., León, C., Jovell, E., Gómez, J., Corvitto, A., Blanco, R. et al. (2012). Adapted ice cream as a nutritional supplement in cancer patients: Impact on quality of life and nutritional status. *Clinical & Translational Oncology*, 14, 66–72.

[16]See Spence, C., & Piqueras-Fiszman, B. (2014). *The perfect meal: The multisensory science of food and dining*. Oxford, UK: Wiley-Blackwell; Samadder, R. (2016). Sous vide multi cooker review – my breasts were extremely succulent. *The Guardian*, June 29th. https://www.theguardian.com/lifeandstyle/2016/jun/29/sous-vide-multi-cooker-review-gadget-rhik-samadder; and for a review, Baldwin, D. E. (2012). Sous vide cooking: A review. *International Journal of Gastronomy and Food Science*, 1, 15–30; though see Coren, G. (2014). 'Oh no! Sous-vide! They're still doing that out here in the boonies! Oh help. Oh say it isn't so. *The Times Magazine*, July 19th, 63–64. http://www.thetimes.co.uk/tto/magazine/article4147192.ece.

[17]According to Prue Leith (2015): 'The Department of Health set up a 'Hospital Food Standards Panel' in December 2013. That was some progress, but then it invited food manufacturers (including Apetito, one of the biggest suppliers of hospital food in the UK) to sit on the panel.'

[18]Leith (2015)

[19]In one Australian study, for instance, 27% of LTC residents at one facility rated meals as 'boring'; see Pearson, A., Hocking, S., Mott, S., & Riggs, A. (1993). Quality of care in nursing homes: From the resident's perspective. *Journal of Advanced Nursing*, 18, 20–24. According to one writer: 'Simultaneous color contrast suggests that foods can be arranged in combinations so that their colors are subtly enhanced, subdued, or otherwise modified. Yellow scrambled eggs on a yellow plate will look paler because of contrast. Purple grapes will look less purple on a purple plate and will look redder on a blue plate. A green salad will look less green on a green plate than on a plate that has no green in it. Red food on a blue plate will look more orange. Broccoli served with red fish will make the fish look redder, and slices of lime surrounding a grape mousse will enhance the color of both.' See Lyman, B. (1989, p. 112). *A psychology of food, more than a matter of taste*. New York, NY: Avi, van Nostrand Reinhold. See also Hutchings, J. B. (1994). *Food colour and appearance*. London, UK: Blackie Academic and Professional; Brainard, D. H., & Radonjíc, A. (2013). Color constancy. In J. S. Werner & L. M. Chalupa (Eds.), *The new visual neurosciences* (pp. 545–556). Cambridge, MA: MIT Press. The lack of contrast between the food and the plate can make it difficult, for example, to see white foods, such as mashed potato, against the background of a white plate. See Leith (2015) and Malm (2015) for a number of examples; see also Smith, J. (2014). Is this how the NHS hopes to heal the nation? Irate patient snaps pitiful meals during stay in new £430million hospital—including

roast dinner with just ONE tiny floret of broccoli. *Daily Mail Online*, August 22nd. http://www.dailymail.co.uk/news/article-2731786/Is-NHS-hopes-heal-nation-Irate-patient-snaps-pitiful-meals-stay-new-430million-hospital-including-roast-dinner-just-ONE-tiny-floret-broccoli.html; Dunn, J. (2015). Hospital is supposed to make you feel better! MailOnline readers share pictures of the WORST food served up on Britain's wards. *Daily Mail Online*, December 10th. http://www.dailymail.co.uk/news/article-3354029/Hospital-supposed-make-feel-better-MailOnline-readers-share-pictures-WORST-food-served-UK-s-wards.html. Just take the following from Lampi (1973, p. 60): 'The appetizing appearance of a well-browned roast is best brought out against colourful green and red vegetables. On a black plate, food nearly always looks more appetizing than on a white one. This is because the food reflects more light towards the viewer than the black plate.' Lampi E. (1973). Hotel and restaurant lighting. *Cornell Hotel and Restaurant Administration Quarterly*, 13, 58–64.

[20]Interestingly, the use of pale blue or red plates didn't change consumption relative to the white tableware baseline; Dunne, T. E., Neargarder, S. A., Cipolloni, P. B., & Cronin-Golomb, A. (2004). Visual contrast enhances food and liquid intake in advanced Alzheimer's disease. *Clinical Nutrition*, 23, 533–538. No wonder, then, that given such striking results, a number of start-ups have appeared in the last few years offering enhanced contrast for plateware for the home environment; e.g. https://www.indiegogo.com/projects/eatwell-tableware-for-people-with-special-needs#/. See Robbins (2015); dining set created by industrial designer Sha Yao uses bright primary colours. *Eatwell* has already raised in excess of $100,000 in crowdfunding; prices for pre-orders range from $55–$110.

[21]This study was conducted at Salisbury District Hospital (UK). See Adams, S. (2013). How to rescue NHS food? Put it on a blue plate: Simple switch has helped elderly and weak patients eat nearly a third more. *Daily-Mail Online,* December 7th. http://www.dailymail.co.uk/news/article-2520058/How-rescue-NHS-food-Put-blue-plate-Simple-switch-helped-elderly-weak-patients-eat-nearly-more.html. Meanwhile, in another recent study, yellow plateware was also found to increase dementia patient's consumption; Smyth, S. (2016). Yellow plates that help dementia patients to eat: Brightly coloured crockery said to make patients more likely to finish their food and put on weight. *Daily Mail Online*, July 6th. http://www.dailymail.co.uk/news/article-3676207/Yellow-plates-help-dementia-patients-eat.html; simply serving the same food off blue plateware proved so successful in the hospital study just mentioned that the intervention has, according to Ian Robinson, head of catering, since been rolled out across the hospital trust; just remember, though, that the benefits of a given plate colour (on food consumption) likely depend on the visual properties (i.e. the hue) of the food that is served; so before you all go out and buy yourselves a set of blue crockery, remember that this colour won't necessarily improve the taste of everything; e.g. see Van Doorn, G., Wuillemin, D., & Spence, C. (2014). Does the colour of the mug influence the taste of the coffee? *Flavour,* 3:10. The white fish study conducted at Ystad, Sweden; see Hultén, B., Broweus, N., & van Dijk, M. (2009, p. 119). *Sensory marketing*. Basingstoke, UK: Palgrave Macmillan.

[22]Crumpacker, B. (2006, p. 143). *The sex life of food: When body and soul meet to eat*. New York, NY: Thomas Dunne Books.

[23]AgeUK (2010). *Still hungry to be heard*. http://www.ageuk.org.uk/BrandPartnerGlobal/londonVPP/Documents/Still_Hungry_To_Be_Heard_Report.pdf;Bradley, L., & Rees, C. (2003). Reducing nutritional risk in hospital: The red tray. *Nursing Standard*, 17, 33–37; Mehta, R., & Zhu, R. (2009). Blue or red? Exploring the effect of color on cognitive task performances. *Science,* 323, 1226–1229; Though see also Steele, K. M. (2014). Failure to replicate the Mehta and Zhu (2009) color-priming effect on anagram solution times. *Psychonomic Bulletin & Review*, 21, 771–776; Bruno, N., Martani, M., Corsini, C., & Oleari, C. (2013). The effect of the color red on consuming food does not depend on achromatic (Michelson) contrast and extends to rubbing cream on the skin. *Appetite*, 71, 307–313; Genschow, O., Reutner, L., & Wänke, M. (2012). The color red reduces snack food and soft drink intake. *Appetite*, 58, 699–702. In the latter study, people ate nearly twice as many pretzels when served off white as opposed to red plate, despite the colour of the plate not affecting tastiness ratings. Note that the effect wasn't about how appealing the food looked on the different plates either.

[24]Apicius (1936). *Cooking and dining in Imperial Rome* (c. 1st Century; translated by J. D. Vehling). University of Chicago Press, Chicago

[25]Spence, C., Okajima, K., Cheok, A. D., Petit, O., & Michel, C. (2016). Eating with our eyes: From visual hunger to digital satiation. *Brain & Cognition*, 110, 53–63

[26]Macrae, F. (2015). If a meal looks good, we think it tastes better: Simply arranging food carefully on the plate can persuade diners to pay three times more for it. *DailyMail Online*, July 21st. http://www.dailymail.co.uk/news/article-3168913/If-meal-looks-good-think-tastes-better-Simply-arranging-food-carefully-plate-persuade-diners-pay-three-times-it.html#ixzz42WZgXxHn

[27]https://www.instagram.com/theartofplating/

[28]Michel, C., Velasco, C., Fraemohs, P., & Spence, C. (2015). Studying the impact of plating on ratings of the food served in a naturalistic dining context. *Appetite,* 90, 45–50. Since publishing this study, we have obtained similar results in a number of other online experiments where people had to choose which of two plates, presented side-by-side, they preferred. The majority of

people prefer centred to asymmetric plating; see Michel, C., Velasco, C., Woods, A., & Spence, C. (2016). On the importance of balance to aesthetic plating. *International Journal of Food Design*, 5–6, 10–16. See also Roque, J., Guastavino, C., Lafrairec, J., & Fernandeza, P. (2016). *Plating influences diners' perception of culinary creativity*. Manuscript submitted for publication.

[29]Hinchingbrooke District Hospital; see Jones, D. (2014). Is this hospital a miracle cure for the NHS? It has a Michelin chef, happy patients and is run by doctors and nurses. And shock, horror, it's operated for the state—at a profit—by a private firm. *Daily Mail Online*, May 27th. http://www.dailymail.co.uk/health/article-2641055/Is-hospital-miracle-cure-NHS-It-Michelin-chef-happy-patients-run-doctors-nurses-And-shock-horror-operated-profit-private-firm.html.

[30]Birrell, I. (2015). Blundering, bloated and biased, the NHS watchdog isn't fit for purpose writes IAN BIRRELL. *Daily Mail Online*, January 20th. http://www.dailymail.co.uk/news/article-2917600/Blundering-bloated-biased-NHS-watchdog-isn-t-fit-purpose-writes-IAN-BIRRELL.html

[31]See Landro (2008) for such an approach in some parts of the North American healthcare system

[32]Horan, D., & Coad, J. (2000). Can nurses improve patient feeding? *Nursing Times*, 96(50), 33–34

[33]Sloan Kettering Hospital has been doing some interesting things in this space already with their Brooklyn Infusion Center and treatment pods; See Anon. (2012). Memorial Sloan-Kettering Cancer Center, Brooklyn Infusion Center - Brooklyn, NY. *Healthcare Design Magazine*, June 30th. http://www.healthcaredesignmagazine.com/article/brooklyn-infusion-center; Leber, J. (2015). Reinventing cancer surgery—By designing a better hospital experience. *Fast Co.*, March 12th. http://www.fastcoexist.com/3053883/reinventing-cancer-surgery-by-designing-a-better-hospital-experience. Though see Chaffee, M. (2016). *Why giant hospital systems might be getting it wrong*. May 3rd. https://www.linkedin.com/pulse/why-giant-hospital-systems-might-getting-wrong-michelle-chaffee. In a way, one can think of multisensory design in the healthcare setting as a natural extension of Kotler's (1974) early ideas about the role of atmospherics, and Pine and Gilmore's later work on the 'experience economy'. While in his seminal article, Kotler doesn't mention hospitals, he does have a paragraph on the atmospheric design of the psychiatrist's office. See Kotler, P. (1974). Atmospherics as a marketing tool. *Journal of Retailing*, 49 (Winter), 48–64; Pine, II, B. J., & Gilmore, J. H. (1998). Welcome to the experience economy. *Harvard Business Review*, 76(4), 97–105; Pine, II, B. J., & Gilmore, J. H. (1999). *The experience economy: Work is theatre & every business is a stage*. Boston, MA: Harvard Business Review Press. See also Andrus, D. (1986). Office atmospherics and dental service satisfaction. *Journal of Professional Services Marketing*, 1 (Summer), 77–85.

[34]Newton, J. (2014). French hospital plans wine bar to cheer patients' last days. *Daily Mail Online*, August 1st. http://www.dailymail.co.uk/news/article-2713390/French-hospital-open-wine-bar-cheer-terminally-ill-patients.html. A few years ago chef Heston Blumenthal echoed much the same sentiment while addressing an audience at the Cheltenham Science Festival: 'Mealtimes should be something to be celebrated in hospital. They should be something to look forward to, and they're not…' (quoted in Walker, 2009).

[35]See also Wood, P., & Vogen, B. D. (1998). Feeding the anorectic client: Comfort foods and happy hour. *Geriatric Nursing*, 19(4), 192–194, on the notion that happy hour drinks in a social setting can be a very effective means of getting anorectic individuals to consume more calories.

[36]All of this, of course, makes perfect sense given the evidence that food typically tastes better when eaten with heavier cutlery; see Michel, C., Velasco, C., & Spence, C. (2015). Cutlery matters: Heavy cutlery enhances diners' enjoyment of the food served in a realistic dining environment. *Flavour*, 4:27. So, if your patients get plastic cutlery to eat with at mealtimes then you should know just what to expect in terms of their feedback about the quality of the food service offering. It is interesting to note that a number of companies have recently started-up offering specialized cutlery for patients, typically utilizing strong colours (to enhance colour contrast). See Robbins, R. (2015). Can high-tech plates and silverware help patients manage disease? *Stat News*, December 28th. http://www.statnews.com/2015/12/28/plates-silverware-health/.

[37]Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S., & Stansfeld, S. (2014). Auditory and non-auditory effects of noise on health. *The Lancet*, 383, 1325–1332; Burne, J. (2014). Is the noise of modern life making you ill? It can trigger heart disease, blood pressure and weight gain – even when you are asleep. *Daily-Mail Online*, June 10th. http://www.dailymail.co.uk/health/article-2653249/Is-noise-modern-life-making-ill-It-trigger-heart-disease-blood-pressure-weight-gain-youre-asleep.html; Falk, S. A., & Woods, N. F. (1973). Hospital noise: Levels and potential health hazards. *The New England Journal of Medicine,* 289, 774–781; Hilton, A. (1987). The hospital racket: How noisy is your unit. *American Journal of Nursing*, 87, 59–61; http://www.telegraph.co.uk/news/science/science-news/12207648/Critically-ill-patients-disturbed-every-six-minutes-at-night-in-noisy-hospital-wards.html; Spence, C. (2014). Noise and its impact on the perception of food and drink. *Flavour*, 3:9. See also http://www.telegraph.co.uk/science/2016/04/15/cambridge-professor-reduced-to-tears-by-noisy-hospital-before-de/.

[38]Spence, C., Michel, C., & Smith, B. (2014). Airplane noise and the taste of umami. *Flavour*, 3:2

[39]Spence (2017)

[40]Sherwin, A. (2013). From Roxy Music to the cure? Brian Eno composes soundscapes to treat hospital patients. *The Independent*, April 18th. http://www.independent.co.uk/arts-entertainment/art/news/from-roxy-music-to-the-cure-brian-eno-composes-soundscapes-to-treat-hospital-patients-8577179.html.

[41]Cf. Paquet, C., St-Arnaud-McKenzie, D., Ma, Z., Kergoat, M.-J., Ferland, G., & Dubé, L. (2008). More than just not being alone: The number, nature, and complementarity of meal-time social interactions influence food intake in hospitalized elderly patients, *The Gerontologist*, 48, 603–611

[42]Courtright et al. (1990) studied the effects of relaxing music on disruptive and violent aggressive behaviours during dinner amongst more than 100 psychiatric inpatients. The idea here was that music would buffer the general noise level that is typically found in dining rooms. The hope was that it would exert a calming influence, and thus perhaps reduce prevent disruptive behaviours. Playing the sound of sea gulls apparently led to a drastic reduction in the incidence of aggressive behaviours. See Sandman, P., Norberg, A., Adolfsson, A., Eriksson, S., & Nystrom, P. (1990). Prevalence and characteristics of persons with dependency on feeding at institutions for the elderly. *Scandinavian Journal of Caring Sciences*, 4, 121–127; Palmer, H. (1978). *Sea gulls…Music for rest and relaxation*. Freeport, NY: Education Activities, Inc. (Tape #AR504).

[43]Music can both enhance mood a have a calming effect amongst patients suffering from severe cognitive impairment; Goddaer, J., & Abraham, I. L. (1994, p. 150). Effects of relaxing music on agitation during meals among nursing home residents with severe cognitive impairment. *Archives of Psychiatric Nursing*, 8, 150–158; Courtright, P., Johnson, S., Baumgartner, M., Jordan, M., & Webster, J. (1990). Dinner music: Does it affect the behavior of psychiatric patients? *Journal of Psychosocial Nursing and Mental Health Services*, 28(3), 37–40; Davies, A., & Snaith, P. (1980). Mealtime problems in a continuing-care hospital for the elderly. *Age and Ageing*, 9, 100–105; Ragneskog, H., Bråne, G., Karlsson, I., & Kihlgren, M. (1996). Influence of dinner music on food intake and symptoms common in dementia. *Scandinavian Journal of Caring Science,* 10, 11–17

[44]Spence (2017)

[45]See Stein, K. (2008). Contemporary comfort foods: Bringing back old favorites. *Journal of the American Dietetic Association*, 108, 412–414, on the desire amongst those patients questioned for comfort foods like grilled cheese and chicken noodle soup. See also Landro (2008); Wood & Vogen (1998); Locher, J. L., Yoels, W. C., Maurer, D., & Van Ells, J. (2005). Comfort foods: An exploratory journey into the social and emotional significance of food. *Food and Foodways*, 13, 273–297; Paquet, C., Arnaud-McKenzie, D., Kergoat, M. J., Ferland, G., & Dubé, L. (2003). Direct and indirect effects of everyday emotions on food intake of elderly patients in institutions. *Journal of Gerontology A. Biological Science Medical Science*, 58, 153–158

[46]And, of course, things don't stop there. Once, the background noise levels have been sorted, one can start to think about enhancing the scent of the space. Spence, C. (2002). *The ICI report on the secret of the senses*. London, UK: The Communication Group. See also Lehrner, J., Eckersberger, C., Walla, P., Pötsch, G., & Deecke, L. (2000). Ambient odor of orange in a dental office reduces anxiety and improves mood in female patients. *Physiology & Behavior*, 71, 83–86; Robin, O., Alaoui-Ismaïli, O., Dittmar, A., & Vernet-Maury, E. (1998). Emotional responses evoked by dental odors: An evaluation from autonomic parameters. *Journal of Dental Research*, 77, 1638–1646; Toet, A., Smeets, M. A. M., van Dijk, E., Dijkstra, D., & van den Reijen, L. (2010). Effects of pleasant ambient fragrances on dental fear: Comparing apples and oranges. *Chemosensory Perception*, 3, 182–189

[47]Alter, A. (2013). *Drunk tank pink: And other unexpected forces that shape how we think, feel, and behave*. New York, NY; Penguin; Cho, S., Han, A., Taylor, M. H., Huck, A. C., Mishler, A. M., Mattal, K. L., Barker, C. A., & Seo, H.-S. (2015). Blue lighting decreases the amount of food consumed in men, but not in women. *Appetite*, 85, 111–117

[48]Williams, A. (2015). Hospital patients and visitors accused of eating all the pies as boss of medical centre claims Greggs outlet is bakery firm's second-busiest shop. *Daily Mail Online*, March 15th. http://www.dailymail.co.uk/news/article-2995944/Hospital-patients-visitors-accused-eating-pies-boss-medical-centre-claims-Greggs-outlet-bakery-firm-s-second-busiest-shop.html; Spencer, B., & White, J. (2015). Ban fast food giants from our hospitals, says NHS boss as he calls for crackdown on the amount of junk food on offer to patients. *Daily Mail Online*, September 2nd. http://www.dailymail.co.uk/health/article-3219032/Ban-fast-food-giants-hospitals-says-NHS-boss-calls-crackdown-junk-food-offer-patients.html

[49]Speir, L. (2016). How hospital vending machines are slowly killing patients and staff: Nurse describes the farce of trying to heal people who are bingeing on junk in the waiting room. *Daily Mail Online*, March 14th. http://www.dailymail.co.uk/health/article-3491347/Hospital-vending-machines-slowly-killing-patients-staff-Nurse-describes-farce-trying-heal-people-bingeing-junk-waiting-room.html. See also Anon (2016). NHS to slap 'sugar tax' on hospital cafes and snacks. *Daily Mail Online*, January 18th. http://www.dailymail.co.uk/wires/pa/article-340424

3/NHS-slap-sugar-tax-hospital-cafes-snacks.html; Campbell, D., & Johnson, P. (2016). NHS chief to introduce sugar tax in hospitals to tackle UK obesity crisis. *The Guardian*, January 17th. http://www.theguardian.com/society/2016/jan/17/nhs-sugar-tax-hospitals-tackle-uk-obesity-crisis-simon-stevens; Nestle, M. (2013). *Food politics: How the food industry influences nutrition and health*. London, UK: University of California Press.

[50]Spence, C. (2017). *Gastrophysics: The new science of eating*. London: Penguin

[51]After all, there is no guarantee that everyone else in the ward necessarily wants to smell a patient's fish and chips dinner from the take-away, say. See also Buaya, A. (2016). Virgin flight passengers VOMIT after they were served parmesan cheese sandwiches - which made the entire aircraft to smell like 'old socks'. *Daily Mail Online*, December 26th. http://www.dailymail.co.uk/news/article-4065810/Virgin-Australia-passengers-Perth-Adelaide-sick-served-smelly-parmesan-Cheese.html.

[52]http://www.foodvisionevent.com/sandra-forstner/; Endo, H., Ino, S., & Fujisaki, W. (2016). The effect of a crunchy pseudo-chewing sound on perceived texture of softened foods. *Physiology & Behavior,* 167, 324–331; Cockroft, S., Spillett, R., & Duell, M. (2016). 'Our life was full of laughter until the last 48 h when he slipped into sleep': Paul Daniels's tearful wife Debbie McGee reveals he spent his final days eating his favourite Magnum ice creams and singing Beatles songs. *Daily Mail Online*, March 17th. http://www.dailymail.co.uk/news/article-3496494/Magician-Paul-Daniels-died-home-aged-77.html. Though note that Magnums were first released in 1989 and hence would not have been something that Daniels would have grown up with. See also Doets, E. L., & Kremer, S. (2016). The silver sensory experience – A review of senior consumers' food perception, liking and intake. *Food Quality and Preference,* 48, 316–332.

[53]Though see Hyde, R. J., & Witherly, S. A. (1993). Dynamic contrast: A sensory contribution to palatability. *Appetite*, 21, 1–16, for some interesting speculations about the various ways in which ice-cream may be special, sensorially speaking.

[54]I remember the times when, as a child, I would accidentally pick-up my grandma's mug of tea. 'Yuck. Why is Grandma's tea so sweet?' I would ask anyone who'd listen. I guess I now know the answer. This is just how much sugar she probably had to add to get the same taste as I would by adding only a tiny amount.

[55]Stevens, J. C., Cain, W. S., Demarque, A., & Ruthruff, A. M. (1991). On the discrimination of missing ingredients: Aging and salt flavour. *Appetite*, 16, 129–140; Schiffman, S. S., & Graham, B. G. (2000). Taste and smell perception affect appetite and immunity in the elderly. *European Journal of Clinical Nutrition*, 54 (June Supple 3), S54-S63; Doty, R. L. (1989). Influence of age and age-related diseases on olfactory function. *Annals of the New York Academy of Sciences*, 561, 76–86.

[56]Or at least it is commonly considered as such; Lawless, H. T., Stevens, D. A., Chapman, K. W., & Kurtz, A. (2005). Metallic taste from electrical and chemical stimulation. *Chemical Senses*, 30, 185–194. Though see also Lawless, H. T., Schlake, S., Smythe, J., Lim, J., Yang, H., Chapman, K., & Bolton, B. (2004). Metallic taste and retronasal smell. *Chemical Senses*, 29, 25–33.

[57]The following quote from Fitzsimmons (2003) gives as idea: 'The snack food of the future could rely more on sensations in the mouth than flavour or texture. Food companies are experimenting with "sensates"… to make your mouth tingle, warm, cool, salivate, or tighten… the next step is to manipulate the sensates to change the length of intensity of the sensation.' Fitzsimmons, C. (2003). Snacks to be a real sensation. *The Australian,* August 20th. See also MacClancy, J. (1992). *Consuming culture: Why you eat what you eat*. New York, NY: Henry Holt.

[58]Learned taste aversion refers to the fact that just a single exposure to a food that is followed by sickness can lead to life-long aversion to that food. Bernstein, I. L. (1978). Learned taste aversion in children receiving chemotherapy. *Science*, 200, 1302–1303; Gustavson, C. R. (1977). Comparative and field aspects of learned food aversions. In L. M. Barker, M. R. Best, & M. Domjan (Eds.), *Learning mechanisms in food selection* (pp. 23–43). Waco, TX: Baylor University Press; Logue, A. W. (2004). *The psychology of eating and drinking* (3rd Ed.). Hove, East Sussex: Brunner-Routledge; Logue, A. W., Ophir, I., & Strauss, K. E. (1981). The acquisition of taste aversions in humans. *Behaviour Research and Therapy*, 19, 319–333. In fact, speaking of which, we have just started a project with the Alicià Foundation and Saint Joan de Déu hospital in Barcelona on just this kind of topic. And beyond any role that gastrophysics might play in improving patients' perception of the food service offering in the hospital, many of the same ideas around optimizing the multisensory design also apply, I think, when it comes to pharmaceuticals. For it turns out that non-compliance—that is, people failing to get to the end of treatment regime—is a major problem. Thus, anything that can be done to improve their aesthetic appeal (not to mention their expected efficacy) is key. However, taking a proper look at this fascinating area is something that we are going to have to leave for another day. Wan, X., Woods, A. T., Velasco, C., Salgado-Montejo, A., & Spence, C. (2015). Assessing the expectations associated with pharmaceutical pill colour and shape. *Food Quality & Preference*, 45, 171–182; Byron, S. P. (2014). Patient-centred, administration friendly medicines for children – An evaluation of children's preferences and how they

impact medication adherence. *International Journal of Pharmaceutics*, 469, 257–259; Cohen, T. F. (2014). The power of drug color. *The Atlantic Magazine*, October 13th. http://www.theatlantic.com/health/archive/2014/10/the-power-of-drug-color/381156/; Dohle, S., & Siegrist, M. (2014). Fluency of pharmaceutical drug names predicts perceived hazardousness, assumed sides effects and willingness to buy. *Journal of Health Psychology*, 19, 1241–1249; Worthington, J. H. (2007). Formulation - Let's talk about sense appeal. *Pharmaceutical Formulation and Quality*, 9(6), 32–38; More, A. T., & Srivastava, R. K. (2009). Aesthetic considerations for pharmaceutical OTC (over the counter) products. *Oxford Business & Economics Conference*. June 24-26th, St. Hugh's College, Oxford.

[59]See also Miller, B. J. (n.d.): What really matters at the end of life http://go.ted.com/bUcH, for why multisensory palliative care could be a good thing to think on BJ Miller: What really matters at the end of life.

[60]Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science*, 224, 420–421; Research on the beneficial effects of exposure to nature has really exploded in recent years; E.g., see Ryan, R. M., Weinstein, N., Bernstein, J., Brown, K. W., Mistretta, L., Gagné, M. (2010). Vitalizing effects of being outdoors and in nature. *Journal of Environmental Psychology*, 30, 159–168; Williams, F. (2015). This is your brain on nature. When we get closer to nature—be it untouched wilderness or a backyard tree—we do our overstressed brains a favor. *National Geographic Magazine*, December 8th. http://ngm.nationalgeographic.com/2016/01/call-to-wild-text; Lass-Hennemann, J., Peyk, P., Streb, M., Holz, E., & Michael, T. (2014). Presence of a dog reduces subjective but not physiological stress responses to an analog trauma. *Frontiers in Psychology*, 5:1010. See also http://www.philips.co.uk/healthcare/consulting/experience-solutions/ambient-experience-room-solutions; Crossman, M. K. (2016). Effects of interactions with animals on signs of human psychological distress. *Journal of Clinical Psychology*. DOI: 10.1002/jclp.22410. Though, as is always the case, some would appear to have taken things a little too far. Just see Spencer, B. (2015). Have a holiday on the NHS: Health service is buying families trips, pedalo rides and even a SUMMER HOUSE. *Daily Mail Online*, September 1st. http://www.dailymail.co.uk/news/article-3217637/NHS-blows-fortune-holidays-pedalo-ride-summer-house.html.

[61]Mayo, E. (1949). *Hawthorne and the Western Electric Company. The social problems of an industrial civilization*. London, UK: Routledge; Levitt, S. D., & List, J. A. (2011). Was there really a Hawthorne effect at the Hawthorne plant? An analysis of the original illumination experiments. *American Economic Journal: Applied Economics*, 3, 224–238. And see also Zdep, S. M., & Irvine, S. H. (1970). A reverse Hawthorne effect in educational evaluation. *Journal of Educational Psychology*, 8, 89–95; McCambridge, J., Witton, J., & Elbourne, D. R. (2014). Systematic review of the Hawthorne effect: New concepts are needed to study research participation effects. *Journal of Clinical Epidemiology*, 67, 267–277.

Abbreviations
NHS: National Health Service

Acknowledgements
None.

Funding
CS would like to acknowledge the AHRC Rethinking the Senses grant (AH/L007053/1).

Availability of data and materials
There is no data or material to make available.

Authors' contributions
CS wrote all parts of this review.

Authors' information
Charles Spence is an experimental psychologist and gastrophysicist working out of Oxford University who is fascinated by the design of multisensory dining experiences. In 2014, he published the prize-winning *The perfect meal: The multisensory science of food and dining* (Oxford, UK: Wiley-Blackwell) together with Dr. Betina Piqueras-Fiszman. In March, 2017, his new book, *Gastrophysics: The new science of eating* will be published by Penguin.

Competing interests
The author declares that he has no competing interests.

Consent for publication
Approval to publish has been given where required.

Ethics approval and consent to participate
No participants were tested in this review paper/opinion piece.

Received: 18 October 2016 Accepted: 2 February 2017
Published online: 06 March 2017