

RUNNING HEAD: THE COFFEE DRINKING EXPERIENCE

The coffee drinking experience:

Product extrinsic (atmospheric) influences on taste and choice

Charles Spence¹ & Fabiana M. Carvalho²

1. Crossmodal Research Laboratory, University of Oxford

2. Department of Food and Nutrition, School of Food Engineering, University of
Campinas, Brazil

RESUBMITTED TO: *FOOD QUALITY & PREFERENCE*

WORD COUNT: 10,150 WORDS

DATE: AUGUST, 2019

CORRESPONDENCE TO: Prof. Charles Spence, Department of Experimental Psychology,
Anna Watts Building, University of Oxford, Oxford, OX2 6GG, UK. E-mail:
charles.spence@psy.ox.ac.uk

ABSTRACT

Coffee is one of the world's most popular beverages, with an estimated four hundred billion cups being consumed each and every year. In this review, we investigate just what effect the multisensory atmosphere/context has on people's perception of, not to mention their choices concerning, coffee. We demonstrate how many different aspects of the environment influence people's choice of what beverage to drink as well as what they think about the experience. Specifically, the visual, auditory, olfactory, and tactile aspects of the environment have all been shown to impact the experience of tasting and drinking coffee. This extensive body of empirical research complements the emerging findings demonstrating the influence of the receptacle in which coffee is consumed. Looking to the future, and acknowledging the profound influence of multisensory atmospherics on the experience of beverages, it would seem likely that there will be growing interest in optimizing and/or personalizing the environment for the kind of multisensory tasting experience that the coffee consumer wishes to have.

KEYWORDS: COFFEE; PRODUCT-EXTRINSIC; ATMOSPHERIC; EXPERIENCE; MULTISENSORY.

Introduction

Coffee has had a profound effect on our culture (see Kleidas & Jolliffe, 2010; Luttinger & Dicum, 2006; Pendergast, 2001; Robinson, 1893; Schultz & Yang, 1997; Weinberg & Bealer, 2001). As evidence of this claim, one need only consider the explosion of coffee shops on our high streets in recent years, with greater than 3.5% increase in branded coffee shops on the high street year-on-year reported in the last couple of years (Brown, 2018). The global community of coffee aficionados is also thriving globally (e.g., Tucker, 2011). And, according to Illy, (2002), somewhere in the region of four hundred billion cups of coffee were being consumed every year, around the turn of the century. Meanwhile, according to Luttinger and Dicum (2006, p. ix): “*The world drinks about 1.5 billion cups per day*” (exact figures are obviously hard to come by). The production of coffee is a significant contributor to global trade, with 97 million 60 kg bags of coffee beans being shipped across the globe in the year 2010 (this according to a report from the International Trade Centre, 2011). The trade in coffee has grown rapidly during the 20th century with gross imports quadrupling from 33 million bags in 1949 to 132 million bags in 2010. By 2015–2016, around 151.3 million 60-kg bags of coffee were consumed worldwide, according to the International Coffee Organization (ICO, 2018).

Each and every cup of coffee is consumed in a particular environment, with a certain level of background noise, ambient lighting, perhaps even a background smell (which the coffee drinker may, or may not, be aware of). But just what effect does the background atmosphere have on people’s perception of, as well as their choices concerning, the world’s fourth most popular beverage? In this review, we summarize the evidence documenting the impact of the environment on the coffee-drinking experience. We demonstrate how many different aspects of the environment influence people’s choice of what coffee to order/buy as well as what they think about the tasting experience. Such findings, note, are entirely consistent with Kotler’s (1974) suggestion from nearly half a century ago that: “one of the most significant features of the total product is the *place* where it is bought or consumed. In some cases . . . the *atmosphere* of the place is more influential than the product itself.”

Product-intrinsic coffee variables

The majority of the research on coffee, one of the world's more complex drinks,¹ containing somewhere in the region of 900-1200 volatile compounds (Clarke, 2013; Grosch, 1998; Yeretizian, 2017; though see also Caporaso, Whitworth, Cuic, & Fisk, 2018) has focused on the growing, roasting, storage of the coffee beans themselves, not to mention the quality of the water and any milk used. The extraction process clearly also has a noticeable influence (Glöss, Schönbächler, Klopprogge, et al., 2013, for a comparison of extraction technique). While the visual appearance of the coffee beverage itself likely plays some role in setting consumer expectations, here it is worth noting how little variation there actually is in terms of colour (or other visual appearance properties) of black coffee itself, at least not traditionally (see Little, Chichester, & Mackinney, 1959; though see Best, 2017, on the recent introduction of clear coffee, and Ueda, Masuda, & Okajima, 2014, on emerging augmented reality coffee applications), at least when compared to other popular drinks such as tea (e.g., see Wan, Zhou, Mu, Du, Velasco, Michel, & Spence, 2014) or wine (see Spence, 2010, for a review). However, the specialty coffee shop scene currently sees a new trend of artisanal roasting, with several types of roasting profile being developed (i.e., espresso roasting, filter roasting, Scandinavian roasting, Italian roasting; Schenker & Rothgeb, 2017). The degree of roasting of the beans used to brew the coffee is then reflected in the colour of the beverage, going from caramel to black, which is associated to rather distinct flavour profiles (Bhumiratana, Adhikari, & Chambers IV, 2011; Dmowski & Dąbrowska, 2014) and preference niches (Bhumiratana, Adhikari, & Chambers IV, 2014; Kanjanakorn & Lee, 2017). In addition, great emphasis is also placed on the appearance of the crema (see Illy & Navarini, 2011; Labbe, Sudre, Dugas, & Folmer, 2016) when companies advertise their espresso coffees (e.g., see Kuehlwein, 2017; Spence & Carvalho, 2019). It is noticeable here also how Nespresso's recent Vertuo coffee machines highlight on the website how 'a generous coffee crema' is a signature feature of the range (see <https://www.nespresso.com/de/en/nespresso-vertuo-kapselmaschinen-system-entdecken>).

Elsewhere, latte art has also been documented to influence a drinker's expectations and thereafter their hedonic rating of (or Willingness-to-Pay for) their coffee beverage (see Van Doorn, Colonna-Dashwood, Hudd-Baillie, & Spence, 2015).

In recent years, descriptive sensory analysis has played a very important role in helping to discriminate the range of flavour and aroma characteristics that may be present in specialty coffee (see Chambers, Sanchez, Phan, Miller, Civile, & Di Donfrancesco, 2016), such as

¹ See Illy (2002) on the complexity of coffee, and Spence and Wang (2018) and Palczak, Blumenthal, Rogeaux, and Delarue (2019) on the somewhat complex notion of complexity as far as the chemical senses are concerned.

‘nutty’, ‘brown spice’, ‘almond’, ‘floral’, and ‘jasmine’ (see, for example, the coffee lexicon developed by World Coffee Research: <https://worldcoffeeresearch.org/work/sensory-lexicon/>).

Product-extrinsic coffee variables

A growing body of scientific research now demonstrates that many other product-extrinsic factors also influence people’s perception of coffee, and that includes everything from branding (Martin, 1990; Sakai, 2014) through to any information concerning a coffee’s sustainability and organic credentials (Sörqvist, Hedblom, Holmgren, Haga, Langeborg, Nöstl, et al., 2013; Van Loo, Caputo, Nayga Jr., Seo, Zhang, & Verbeke, 2015; see also Baccellieri, 2006), as well as any other descriptive information that may be provided (Fenko, de Vries, & van Rompay, 2018). There has also been a recent growth of interest in the influence of coffee packaging (e.g., see Favre & November, 1979, for early work; and Henry, 2009; Kobayashi & De Toledo Benassi, 2015; Velasco & Spence, 2019, for more recent observations/findings). In terms of the product-extrinsic sensory cues influencing the tasting experience, these include everything from the colour (Carvalho & Spence, 2018; Guéguen & Jacob, 2012; Van Doorn, Willemin, & Spence, 2014) and shape of the cup/mug (Carvalho & Spence, 2019; Van Doorn, Woods, Levitan, Wan, Velasco, Bernal-Torres, & Spence, 2017) through to its texture/feel (Carvalho, Moksunova, & Spence, submitted; see also Wang & Spence, 2018), and presumably also its weight in the hand (Kampfer, Leischnig, Ivens, & Spence, 2017; see Spence & Carvalho, 2019, for a review). However, moving one stage further out from the product itself, the environment in which coffee beverages are drunk, along with the more social aspects of coffee consumption (Sommer & Steele, 1997), likely also exert an impact on the experience (see Spence, 2017a, 2019). Here, one can think of everything from the lighting and background music/noise, through the feel of the place (and that includes everything from the hardness of the chairs to the ambient temperature) and any smell that might be present. Indeed, unwanted smells (i.e., those associated with the preparation of other food products) have, on occasion, been reported to interfere with the coffee-drinking experience (see Rahner, 2006).² These are cues that, no matter whether they are consciously considered or not, may nevertheless still influence the

² The following quote on this topic appears in Nassauer (2014) “Starbucks stores stopped selling breakfast sandwiches for six months in 2008 because Chief Executive Howard Schultz hated how the smell of cooking (and often burning) cheese engulfed the coffee aroma, the exec wrote in his 2011 book *Onward: How Starbucks Fought for its life Without Losing Its Soul*.”

choices that are made by consumers about what and where to drink, as well as impacting what they think concerning the coffee beverage once they taste/drink it.

Individual differences in coffee perception/behaviour

There are, of course, a number of individual differences (e.g., PROP taster status; Masi, Dinnella, Monteleone, & Prescott, 2015) to bear in mind as well as some profound cultural differences in terms of the way in which coffee is consumed (see Cristovam, Russell, Patterson, & Reid, 2000; though see also Spence 2019c). Striking differences also exist in terms of preferred drink temperature too (Borchgrevink, Susskind, & Tarras, 1999). The motivation for drinking, hedonic or utilitarian, has also been reported to differ markedly between consumers (Labbe, Ferrage, Rytz, Pace, & Martin, 2015). And, of course, the consumer's level of involvement with coffee culture also varies quite considerably from one individual to the next (Kim, Lee, & Kim, 2016; see also Higdon & Frei, 2006). Separately, and as one might expect, there has been a lot of work on the sensory descriptive analysis of coffee (e.g., Buffo & Cardelli-Freire, 2004; Calviño, Zamora, & Sarchi, 1996; Fisk, Kettle, Hofmeister, Virdie, & Silanes Kenny, 2012; Grosch, 1998, 2001; Kerler & Poisson, 2011; Navarini, Cappuccio, Suggi-Liverani, & Illy, 2004; Seo, Lee, & Hwang, 2009; see also Geel, Kinnear, & De Kock, 2005). However, in this review, the focus is squarely on atmospheric cues and their impact on the coffee experience.

Store atmospherics

The fact that coffee outlets have, in recent years, started to appear in all manner of locations, from train stations to bookstores (think only of Starbucks link with in-store coffee shops in Barnes & Noble bookstores; Luttinger & Dicum, 2006, p. 164), and even clothing stores such as Uniqlo and Club Monaco (see Cheng, 2014; Oldenburg, 1989, p. 39) has helped bring into focus some of the issues around atmospheric control and contamination (see Spence, Puccinelli, Grewal, & Roggeveen, 2014, for a review of store atmospherics). Control here referring to how delivery and dispersal of aroma is managed, while contamination refers to the situation in which one ambient scent starts to interfere with their experience of another product/situation (as happened in the Starbucks case, mentioned above; see Nassauer, 2014).

Here, for instance, it is worth noting that laboratory research has shown how the smell of coffee influences people's viewing behaviour and draws attention (overtly and covertly) to any coffee-related stimuli in the scene. What is more, it has also been suggested that pleasant smells lead to an increase in approach behaviours (cf. Knasko, 1995; coffee note often comes out as one of the most pleasant smells; see Ayabe-Kanamura, Schicker, Laska, Hudson, Distel, Kobayakawa, & Saito, 1998). It is also important to mention that, in addition to define the concept of atmosphere based on the sensory perception (Kotler, 1974), authors have also divided atmospheric stimuli into categories or dimensions (Bitner, 1992; Berman & Evans, 2010). For instance, the store atmosphere could be approached in three categories, namely, the variables of the external environment (e.g., building architecture, surrounding area), the variables of the interior of the store (e.g., general interior design, scents, sounds), and human variables (e.g., human interaction with employees or other customers) (Renko, 2014). The present review will focus only on the investigations concerning the so-called interior variables, or what might better be considered 'atmospherics' (to distinguish it from any architectural considerations) (see **Table 1** for a summary).

INSERT TABLE 1 ABOUT HERE

Atmospheric visual contributions to the coffee-drinking experience

In one unpublished laboratory study, Gal, Wheeler, and Shiv (2007) reported that those who liked strong coffee tended to drink more under those conditions where the ambient lighting was bright (two 500-watt halogen lamps), while those who self-reported preferring weaker coffee drank more under dim conditions instead (one 60-watt incandescent bulb). The 135 undergraduate participants who took part in this unpublished between-participants study were brought into the lab under the pretext of completing a survey. Before starting, the participants were provided with a 16 oz. Styrofoam cup containing 5 oz. of freshly-brewed coffee. At the end of the study (i.e., once the survey had been completed), the coffee cups were weighed in order to determine how much coffee had been consumed. Those participants who reported liking stronger coffee showed a borderline-significant tendency to drink more under brighter

lighting. By contrast, those participants who reported liking weaker coffee drank significantly more under dim lighting instead.³

Beyond the lighting level, one might think about the colour of the environment and any impact that might have (see Spence, 2017a). It has been indicated that third wave coffee shops in the U.S. tend to use neutral colours as their dominant background colour which, according to Qian (2014), could explain these shops' nature of being accessible and having a homely feel. Another study conducted in Canada has investigated the effect of physical characteristics of two virtual coffee shops on hedonic and consumer behaviour measures (Ly, 2011). Two of the assessed physical elements were wall colours and ambient lighting which were measured in terms of "too light" versus "too heavy", and "too dim" versus "too bright", respectively. The results revealed a significant positive correlation between lighting and purchase likelihood. The variable 'wall colour' also showed a positive correlation with purchase likelihood as well as with store image, sophistication, environment quality, and brand experience. Despite the fact that none of the studies had assessed the actual coffee consumption experience, it is well-known that the cognitive representations and affective responses modulated by ambient colour and lighting may impact flavour perception (Kim et al., 2016; Stroebele & De Castro, 2004).

The visual texture of the environment might also be relevant here: Think only of all the rough textures (e.g., stressed wood finishes that seem so popular these days). Given the emerging literature on felt textures, it would not seem unreasonable to suggest that seen texture might have a similar effect (see Biggs, Juravle, & Spence, 2016; Van Rompay & Groothedde, 2019, on this theme). So, for instance, Biggs et al. demonstrated that feeling/seeing rough-textured plateware influenced people's ratings of biscuits (see also Pramudya & Seo, 2019). Meanwhile, Van Rompay, van Hoof, Rorink, and Folsche's (2019) recent findings that vertical lines in advertising in a Dutch coffee shop influenced not only the perceived luxury of coffee, but also the intensity and liking, may also be relevant here.

Atmospheric auditory contributions to the coffee-drinking experience

One of the problems for many consumers these days is the high level of background noise that one finds in so many bars, cafes, and restaurants (see Spence, 2014, for a review). This problem

³ Elsewhere, researchers have demonstrated that people order spicier chicken wings under brighter lighting too (see Xu & LaBroo, 2014).

is likely exacerbated in the context of the coffee shop, given all the hard furnishings (i.e., a preponderance of reflective surfaces that fail to absorb the ambient noise) together with the sound of the operation of the coffee machines themselves filling the air. Intriguingly, sensory science/psychophysics research has demonstrated that loud background noise can interfere with people's ability to taste sweet and salt in foods (Woods, Poliakoff, Lloyd, Kuenzel, Hodson, Gonda, Batchelor, Dijksterhuis, & Thomas, 2011; Yan & Dando, 2015).

That said, while the sound of the coffee machine may undoubtedly add to the noise levels in the context of the coffee shop, it is worth noting that such informative sounds can also play an important role in setting people's product-related expectations (see Piqueras-Fiszman & Spence, 2015, for a review of the influence of people's flavour expectations on their subsequent flavour experiences). For instance, Knöferle (2012) conducted a study in which he was able to systematically influence what people said about a cup of Nespresso coffee simply by filtering the sounds made by the coffee machine as it turned those colourful pods into cups of espresso. When the harsher, higher-pitched sounds of the machine's operation were accentuated, participants said that the coffee didn't taste so good (i.e., they rated the coffee as tasting harsher and/or bitter). When the high-frequency components were cut, taste ratings suddenly went up. Specifically, the spectral contents of the sound associated with the operation of the coffee machine were either boosted or cut by 20 dB between the frequencies of 2.5 and 6.5 kHz. Given such results, it should come as little surprise to find that a number of manufacturers are now trying to engineer the 'right' noises into their machines.

Separate from the sound of the coffee machine, there has also been work on the impact of background music, and specifically different musical styles, on people's perception of, and choices concerning, coffee (e.g., Gater, 2010). Given that the different regions have rather different taste/flavour profiles (just think of acidic vs. sweet in the case of Brazilian vs. African coffee, respectively), there are obvious semantic associations with different styles of music (cf. Feinstein, Hinskton, & Erdem, 2002). It would, for instance, certainly be interesting to repeat North and Hargreaves' classic study showing that the music playing in the background (quintessentially French vs. German) exerted a profound effect on relative sales of French vs. German wine (North, Hargreaves, & McKendrick, 1997, 1999).

Intriguingly, here, North and Croeser (2006) have reported on exploratory work studying the impact on patrons of music in the setting of a South African coffee shop. Perhaps unsurprisingly, the results of the questionnaire, which was completed by 120 patrons, revealed

that they preferred to listen to live over prerecorded music in a coffee shop. And while no differences were reported in the musical preferences of males and females, there was some suggestion that music in which the sound of a clarinet could be heard was annoying to the respondents. Information concerning people's preferred coffee consumption contexts has also been established by means of open-ended questionnaires administered by Spinelli, Dinnella, Masi, Zoboli, Prescott, and Monteleone (2017).

One could also think here about the distinctive sound like Abercrombie & Fitch (though see Elliott, 2014). In some of our own research in this space, we actually worked with Starbucks some years ago here in the UK on the design of a downloadable audio track that consumers could listen to at home while drinking the then-new Starbucks Via coffee drink (see Spence, 2017b). The track was designed to contain low notes consistent with the bitter taste of coffee. Unfortunately, however, in this marketing-led intervention, there was no opportunity to determine whether listening to this specially-composed track while tasting coffee had an influence on people's ratings.

In another intriguing (unpublished) study, Gater (2010) investigated the impact of different musical genres on people's perception of the sensory properties of a commercially-available coffee over a 10-minute period. A Qualitative Descriptive Analysis (QDA) methodology was used in which participants were exposed to four experimental conditions (no music, jazz, classical and rock music genres), with equivalent tempi (≥ 90 BPM) and volume (70 dB). The seven participants who took part in this study rated the same standardised coffee product on four characteristics (aroma, flavour, bitterness, and astringency) at intervals of one minute. Despite the small sample size, Gater nevertheless observed trends suggesting that exposure to background music increased the time needed to detect a significant change in coffee aroma ($p < 0.0001$). Gater's results also suggested that association between jazz music and a café atmosphere resulted in participants rating the coffee flavour, bitterness, and astringency as less intense than in the other conditions.

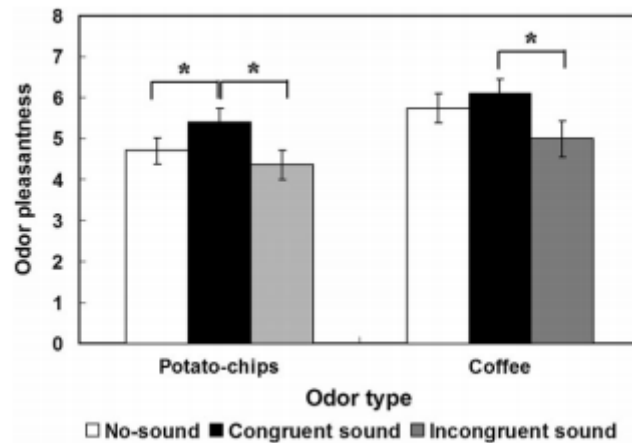


Figure 1. Mean ratings of odour pleasantness in relation to three different auditory cues: neutral (i.e., white noise), congruent, and incongruent sound in Seo and Hummel's (2011; Experiment 1). The pleasantness ratings of either potato chip odour or coffee odour were significantly higher when presented with congruent sound than when presented with incongruent sound. (Asterisk indicates significant difference at $P < 0.05$. The error bars represent the standard errors of the means.)

The sound of coffee consumption has itself also been shown to influence perception. In their 2009 study, for example, Seo and Hummel demonstrated that the hedonic valence associated with auditory stimuli can transfer to the odours. In particular, they presented 22 participants with the sound of someone else eating crisps, the sound of someone else drinking coffee or white noise. After listening to one of these sounds for 5 seconds, they presented the smell of potato chips or the smell of coffee and had their participants rate the intensity of the odour and its pleasantness. The results showed a significant effect of congruency of sound on ratings of odour pleasantness (see **Figure 1**). The effects of sound condition on odour intensity ratings were less clear. In some of our recent work, we demonstrated that people who made slurping sounds when drinking soup enjoyed it more (see Youssef, Youssef, Juravle, & Spence, 2017). Note that slurping is designed to aerate a liquid and is also common practice in coffee cupping (see Luttinger & Dicum, 2006, p. 67; Schoenholt, 1995). However, better watch out for any misophones who might be able to hear such noises. Misophonic individuals often become irritated by the sound of someone else eating or drinking (Kumar, Tansley-Hancock, Sedley, Winston, Callaghan, Allen, et al., 2017). Meanwhile, it is interesting to note how at the high-

end of multisensory coffee experience design, top baristas such as Rasmus Helgebostad and Matt Winton made a sonically enhanced coffee drink as part of their barista championships routines (see **Figure 2**).

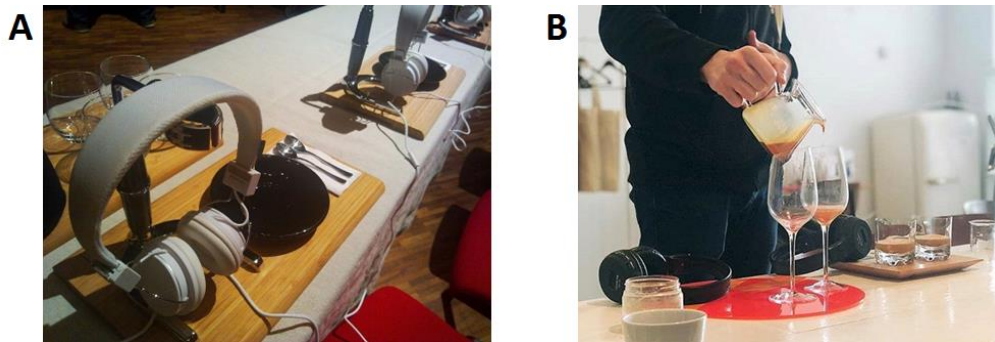


Figure 2. Multisensory experience designs during barista championships. (A) Rasmus Helgebostad's sonically-enhanced coffee drink served as part of his entry in the 2011 Norwegian barista championships; (B) Matt Winton's multisensory experience of the same signature coffee drink being served in two different setups (including distinct soundtracks) in the 2018 World Barista Championship.

Atmospheric tactile contributions to the coffee-drinking experience

The hard seats found in so many coffee shops, and familiar to most people, are presumably used to help try and reduce the likelihood that people will linger for too long (see Spence, 2017), turning the coffee shop into the 'coffice' as it is now called (Anon., 2014).⁴ The exception here, of course, being the comfortable seating to be found in Starbucks, but in this case, the consumer is paying for the experience (see Pine & Gilmore, 1998, 1999). The continued importance of the customer experience element of the coffee drinking experience was highlighted by Vanharanta, Kantola, and Seikola's (2015) discussion and analysis of customers at a Starbucks branch in Poznan, Poland (see also Wu, 2017, for research from Starbucks in Taiwan; and Richelieu & Korai, 2014, for an experiential analysis of another

⁴ McDonald's has been doing this for years; as one commentator put it: 'The rule written into the design of the seats [in McDonald's] is that 10 minutes is the appropriate length of one's stay before they become uncomfortable.' (Shelton, 1993, p. 553; see also Robson, 1999).

coffee chain, namely Tim Horton's). An emerging body of empirical research has recently started to demonstrate the impact of even modest changes in the ambient temperature on the food and beverage choices that we make, not to mention our satisfaction in the consumption experience (e.g., Andersen, Kraus, Ritz, & Bredie, 2019; Motoki, Saito, Nouchi, Kawashima, & Sugiura, 2018; Petit & Sieffermann, 2007).

For instance, Petit and Sieffermann demonstrated that liking and consumption of a milk-based and water based coffee drinks amongst French consumers were affected by the environment in which the drink was consumed/evaluated. These researchers tested in restaurant, home, lab test, and then kitted out the lab to look like one of situational environments. Here it is worth noting that the ambient temperature also varied between environments (between 22 and 28°C). The researchers also tried to evoke a warm consumption scenario by displaying pictures of the desert. Although the results are a little complicated to summarize, broadly-speaking the participants' liking and consumption ratings were both found to be dependent on the testing situation. Meanwhile, in order to try and get a handle on the tactile factors influencing consumer perceptions of the coffee shop experience in the U.S., de Luca and Pegan (2014) analysed posts of relevant online communities created by American consumers. Interestingly, together with background music, two tactile aspects of the environment were strong determinants of ambience preference, namely, comfortable chairs and couches (instead of innovative design pieces) as well as ceramic (instead of paper) cups.

Thinking also about the the impact of ambient temperature, it would presumably come as little surprise if it were to be the case that people were to drink more hot coffee in the colder winter months, while ordering more iced and chilled coffee beverages in the warmer months instead (see Petit & Sieffermann, 2007). It is, though, presently unclear whether any of the seasonal changes in odour preference that have been reported (e.g., Seo, Buschhüter, & Hummel, 2009; Wada, Inada, Yang, Kunieda, Masuda, Kimura, Kanazawa, & Yamaguchi, 2012) may be relevant to the coffee drinking experience.

Atmospheric olfactory contributions to the coffee-drinking experience

Surprising though it might seem, the Starbucks chain changed the formula of its toasted cheese paninis a few years ago when they realized that the smell of all that melting cheese in their stores was starting to interfere with their customer's ability to enjoy the smell of their coffee

(Nassauer, 2014).⁵ After all, as we saw earlier, the smell of coffee is considered one of the world's most desirable smells (Ayabe-Kanamura et al., 1998).⁶ Just as well, or perhaps precisely because this is so, it provides an increasingly-common olfactory backdrop in many shops/train stations. Those companies selling scent-projection technologies have claimed that releasing the scent of coffee on (e.g., the gas station forecourt) can result in as much as a 300% increase in sales of coffee beverage, at least according to their internal reports (Pape, 2009). That said, peer-reviewed academic literature on the impact of ambient scent on consumer behaviour tends typically to demonstrate much more modest effects (c. 10-15% change in behaviour; see Spence, 2015, for a review). It would certainly be interesting to know what it did to sales in those other retail spaces where it is commonly encountered (e.g., as noted earlier). Heller (1999) discusses the appetite appeal of advertisers in Times Square, New York, who experimented with squirting out “*engage the eye and the senses*” coffee aroma. As we will see below, though, some marketers have gone one stage further in terms of combining the scent of coffee with sound.

There is a separate literature on the impact of coffee aroma on people's alertness (Kole, Snel, & Lorist, 1998; see also Seo, Hirano, Shibato, Rakwal, Hwang, & Masuo, 2008)⁷ and pro-social behaviour (Baron, 1997).⁸ One thing to be aware of here relates to the fact that people likely do not need to be aware of the smell of coffee in order for it to influence their perception, choices, and behaviour. Indeed, there has even been some suggestion that subliminal scents may have a more pronounced impact on us than those scents that we happen to be aware of (e.g., Li, Moallem, Paller, & Gottfried, 2007; see also Köster & Degel, 2000). That people might sometimes be unaware of the scent of coffee was brought home by a recent study in which our participants were shown to be functionally anosmic to the smell of coffee if their exposure to it occurred under conditions where they were concentrating on something else (i.e.,

⁵ Nassauer (2014) reports on the following terse communication from the company on the theme of smell: “*The company continued “Aroma is one of the many things Starbucks continues to take into consideration in order to offer the best possible customer experience in each of our stores.” The company said in an email.*”

⁶ If not necessarily one of the most recognisable (see Classen, Howes, & Synnott, 1994, p. 203). That said, one of the interesting things about the aroma of coffee is how much more appealing people often find it (i.e., experienced orthonasally) when compared to the retronasal experience (see Ge, 2012; Rozin, 1982).

⁷ Intriguingly, though, the research shows that just the smell, or even the mere thought of coffee can give rise to an increase in alertness/performance, thus suggesting a placebo effect, or else some form of predictive coding account (Chan & Maglio, 2019; Madzharov, Ye, Morrin, & Block, 2014). Intriguingly, even decaffeinated coffee has been shown to facilitate people's performance (Fukuda & Aoyama, 2017).

⁸ The latter presumably mediated by the fact that coffee is one of the world's most pleasant smells (see Ayabe-Kanabe et al., 2007).

a demanding visual task; see Forster & Spence, 2018). When other participants were brought into the room, the smell of the coffee was instantly apparent. However, while it is undoubtedly the case that subliminal scents/aromas can affect us, it is difficult for marketers to deliberately use this knowledge in a commercial setting as there is likely to be only a very narrow window of opportunity in which the scent is present in sufficient concentration to be effective while still being subliminal. Note also that olfactory detection thresholds tend to vary quite dramatically between individuals (see Reed & Knaapila, 2010).

Virtual reality, emotions, and the multisensory marketing of coffee experiences

Bawa, Landwehr, and Krishna (1989) assessed the impact of marketers' retailing interventions on the sale of coffee. In particular, they reported that the almost 600 consumers exposed to different retail environments over a two-year period in two different venues, varying in terms of factors such as the width of the available product assortment and promotional activity, exhibited significant differences in their brand loyalty, promotion sensitivity, price sensitivity, and response to new coffee brands. However, it is important to note that while it may be true that there has been a tendency for experiential marketing to focus more on the visual aspects of design (Spence et al., 2014), it is likely that this is but one element of a successful multisensory strategy. According to press reports, the Marlow vending machine releases the smell of coffee and specific sounds of the coffee shop for customers ordering a coffee (Houghton, 2014). Furthermore, as we saw a little earlier Petit and Sieffermann (2007) demonstrated that liking and consumption of coffee beverages were affected by the environment (restaurant, home, lab test, or, relevant here, a laboratory simulation of one of those environments). Such contextual effects on people's perception of food and drink are obviously not restricted to coffee (see Spence, in press, for a review). In another study, Kanjanakorn and Lee (2017), assessed the emotions experienced by 332 coffee shop customers in six different venues in Philadelphia. Using a couple of different measurement tools (namely EsSense Profile®; King & Meiselman, 2010; and the 'Coffee Drinking Experience'; Bhumiratana et al., 2014), the latter researchers were able to detect a change in the customer's emotion as a result of drinking the coffee (e.g., comparing before and after, though little analysis of the different venues was reported).

Given the impact that the multisensory atmosphere exerts over the coffee drinking experience, it should come as little surprise to find that there is growing interest in the use of various virtual reality applications in order to try and assess, and presumably also to optimise, the visual and/or auditory attributes of the environment and by so doing bring out the best in the coffee-drinking experience. Certainly, this kind of virtual environment approach is one that is becoming increasingly popular across a range of product-testing scenarios (e.g., see Bangcujo, Smith, Zumach, Pierce, Guttman, and Simons, 2015; Delarue, Brassat, Jarrot, & Abiven, 2019; Petit & Sieffermann, 2007; Stelick, Penano, Riak, & Dando, 2018). In one intriguing study along just such lines, Bangcujo et al. investigated people's ratings of coffee in two different conditions, a virtual coffee shop, and a regular sensory testing facility (see **Figure 3**). Intriguingly, the results showed that the hedonic data collected in a virtual coffeehouse (i.e., liking ratings) were more discriminating and turned out to be a predictor of future coffee liking (when the exact same study was repeated a month later) than the data collected when participants were tested in traditional sensory booths. However, while these results look impressive, it is worth noting that the cups in which the coffee was served were also quite different between the two environments. In particular, foam insulated cups were used in the sensory testing laboratory whereas real ceramic mugs were used in the virtual coffee shop. Hence, given the profound impact that the coffee cup has recently been shown to exert on the perception of coffee (De Luca & Pegan, 2014; see Spence & Carvalho, 2019, for a review), it is hard, *a posteriori*, to rule this out as an uncontrolled source of variance in Bangcujo et al.'s intriguing study. (What is also noteworthy is that of the five different coffees tested in this study, the one brand that actually performed better in the virtual coffee shop environment than in the laboratory setting was actually Starbucks!)



Figure 3. The two testing environments that were compared in Bangcujo et al.'s (2015) study. (A) Traditional sensory testing booth with counter top, spit sink and 5 coffee samples presented to a panelist in foam insulated cups under red light. (B) Virtual coffeehouse in which contextual information was reintroduced into the

testing environment. Audiovisual presentation of sights and sounds recorded from One Line Coffee in Columbus, OH were displayed on high-definition monitors and a subtle cinnamon roll aroma was dispersed into the space. Coffee samples were served in ceramic coffee mugs to panelists sitting on a barstool at a high-top coffee table.

Multisensory experiential marketing is becoming more important in the world of wine and there is every reason to believe that the same kind of approach could also work in the world of coffee too (see Spence, 2019b). One need only think of the Nespresso Experience Stores. Another example of innovative multisensory marketing comes from Seoul, South Korea, where Dunkin' Donuts installed "smart" scent dispensers on to buses (see Garber, 2012). The latter recognized when the Dunkin' Donuts jingle was played on the buses' radio and responded by releasing an appealing scent of coffee. Dunkin Donuts, for its part, installed a scent spray on public buses that diffused the aroma of Dunkin' Donuts coffee into the atmosphere for riders to inhale when the chain's jingle played on the radio. The idea here was that after stepping off the bus, the riders would then see an advertising for a Dunkin Donuts store in proximity. This multisensory marketing strategy, going by the name *Dunkin' Donuts 'Flavor Radio'*, apparently worked well, with Dunkin' Donuts reporting a 16% spike in visitors at stores located near to bus stops, as well as a 29% increase in coffee sales; see Anon., 2012). Note also that this campaign picked up a prize at the prestigious Cannes Lions festival in 2012.

Optimizing the coffee drinking experience

As a growing number of baristas and coffee shop owners come to realize the profound influence that atmospheric cues have on the coffee-drinking experience, it would seem likely that in the future, there will be increased interest in trying to optimize, as well as personalize the customer's experience/journey (Walton, 2012). The scientific approach to the optimization of the environment then builds on earlier research applying scientific approach to make the perfect cup of coffee (Illy & Illy, 2015), as well as the growing body of scientific research that has been studying the impact of the coffee cup (Spence & Carvalho, 2019). Ultimately, though, one might wonder whether it is the memory of the coffee consumption episode that practitioners should really be working toward optimizing, rather than necessarily the customer's experience at the time. Work on the business school notion of 'sticktion' becomes relevant here (Carbone & Haeckel, 2004). And given the tricks that our memory plays on us,

it should come as little surprise to find that many of those working in food and hospitality sectors are increasingly trying to optimize the multisensory experience.

Conclusions and directions for future research

In conclusion, it is clear that the coffee-drinking experience, both what we choose to drink and what we think about the experience, are influenced by a host of product-extrinsic factors. These include everything from any information that is provided about the coffee beverage itself (Martin, 1990; Sorquist et al., 2014) through to the sensory properties of the receptacle in which it happens to be served (see Spence & Carvalho, 2019, for a recent review), not to mention the packaging (Harith, Ting, & Zakaria, 2014; Velasco & Spence, 2019). However, beyond that, the focus of this review has been on the multisensory atmosphere/environment in which coffee is purchased (Samoggia & Riedel, 2018) and consumed. This undoubtedly also exerts a much larger influence than any of us probably realise (see Spence, in press, for a review). We have seen how everything from the lighting levels and background noise/music through the feel of the atmosphere and any ambient odours can influence, in either a positive or negative way (e.g., Gal et al., 2007; Nassauer, 2014), both what we think about the coffee itself, and what the smell of coffee makes us think/feel about whatever else we happen to be looking at while we are smelling it (cf. Knasko, 1995).

Looking to the future, it will be important to connect the product intrinsic influences that have been extensively studied elsewhere with the product extrinsic factors reviewed here. It is, though, worth recognizing that this likely represents quite some undertaking, given the plethora of possible interactions that one might observe between the coffee beverage itself, the drinking vessel in which that beverage is consumed (see Carvalho & Spence, 2019, for congruent vs. incongruent pairing of coffee flavour profile and cup colour), and the environment (or atmosphere) in which this happens. In addition, it is also crucial to examine cross-cultural differences in consumers' choices of coffee shops. Understanding how coffee cultural values would play with product-extrinsic factors to affect preferences can shed light on hedonic and utilitarian motivations for coffee consumption in different cultures (e.g., Maguire & Hu, 2013).

REFERENCES

- Andersen, I. N. S. K., Kraus, A. A., Ritz, C., & Bredie, W. L. P. (2019). Desires for beverages and liking of skin care product odors in imaginative and immersive virtual reality beach contexts. *Food Research International*, **117**, 10-18. <https://doi.org/10.1016/j.foodres.2018.01.027>.
- Anon. (2012). Dunkin' Donuts Flavor Radio: Chain releases coffee scent when ads play in South Korea. *Huffington Post*, **July 31st**. https://www.huffpost.com/entry/dunkin-donuts-flavor-radio_n_1724869.
- Anon. (2014). The coffice: The future of work? *The Guardian*, **January 5th**. <https://www.theguardian.com/money/shortcuts/2014/jan/05/coffice-future-of-work>.
- Anonymous (2015a). Psychology: The science of sensory marketing. *Harvard Business Review*, **March**, 28-29.
- Ayabe-Kanamura, S., Schicker, I., Laska, M., Hudson, R., Distel, H., Kobayakawa, T., & Saito, S. (1998). Differences in perception of everyday odors: A Japanese-German cross-cultural study. *Chemical Senses*, **23**, 31-38.
- Baccellieri, M. (2006). Let's talk about estate coffees and the fourth wave! *Tea & Coffee Trade Journal*, **178(12)**, 28-31.
- Bangcuyo, R. G., Smith, K. J., Zumach, J. L., Pierce, A. M., Guttman, G. A., & Simons, C. T. (2015). The use of immersive technologies to improve consumer testing: The role of ecological validity, context and engagement in evaluating coffee. *Food Quality and Preference*, **41**, 84-95.
- Baron, R. A. (1997). Of cookies, coffee, and kindness: Pleasant odors and the tendency to help strangers in a shopping mall. *Aroma-Chology Review*, **6**, 3-11.
- Bawa, K., Landwehr, J. T., & Krishna, A. (1989). Consumer response to retailers' marketing environments: An analysis of coffee purchase data. *Journal of Retailing*, **65**, 471-495.
- Berman, B. R., & Evans, J. R. (2010). *Retail management: A strategic approach* (11th Ed.). Boston, MA: Prentice Hall.
- Best, S. (2017). Caffeine addicts rejoice! World's first COLOURLESS coffee contains the equivalent of two espresso shots. *DailyMail Online*, **May 23rd**. <https://www.dailymail.co.uk/sciencetech/article-4533100/World-s-COLOURLESS-coffee.html>.
- Bhumiratana, N., Adhikari, K., & Chambers IV, E. (2011). Evolution of sensory aroma attributes from coffee beans to brewed coffee. *LWT-Food Science and Technology*, **44(10)**, 2185-2192.
- Bhumiratana, N., Adhikari, K., & Chambers IV, E. (2014). The development of an emotion lexicon for the coffee drinking experience. *Food Research International*, **61**, 83-92.
- Biggs, L., Juravle, G., & Spence, C. (2016). Haptic exploration of plateware alters the perceived texture and taste of food. *Food Quality & Preference*, **50**, 129-134.
- Bitner, M. J. (1992). Servicescapes: The impact of physical surroundings on customers and employees. *Journal of Marketing*, **56(2)**, 57-71.
- Borchgrevink, C. P., Susskind, A. M., & Tarras, J. M. (1999). Consumer hot beverage temperatures. *Food Quality & Preference*, **10**, 117-121.

- Brown, N. (2018). Allegra predicts specialty segment growth in 2019 US Coffee Shop Report. *Daily Coffee News*, **October 31st**. <https://dailycoffeenews.com/2018/10/31/allegra-predicts-specialty-segment-growth-in-2019-us-coffee-shop-report/#targetText=The%203.8%20percent%20growth%20in,market%20value%20of%202445.4%20billion.>
- Buffo, R. A., & Cardelli-Freire, C. (2004). Coffee flavour: An overview. *Flavour and Fragrance Journal*, **19**, 99-104.
- Calviño, A. M., Zamora, M. C., & Sarchi, M. I. (1996). Principal components and cluster analysis for descriptive sensory assessment of instant coffee. *Journal of Sensory Studies*, **11**, 191-210.
- Caporaso, N., Whitworth, M. B., Cuic, C., & Fisk, I. D. (2018). Variability of single bean coffee volatile compounds of Arabica and Robusta roasted coffees analysed by SPME-GC-MS. *Food Research International*, **108**, 628-640.
- Carbone, L. P., & Haeckel, S. H. (1994). Engineering customer experiences. *Marketing Management*, **3(3)**, 8-19.
- Carvalho, F. M., Moksunova, V., & Spence, C. (submitted). *Cup texture influences taste and tactile judgments in specialty coffee evaluation*. Manuscript submitted for publication.
- Carvalho, F., & Spence, C. (2018). The shape of the cup influences aroma, taste, and hedonic judgements of specialty coffee. *Food Quality & Preference*, **68**, 315-321.
- Carvalho, F., & Spence, C. (2019). Cup colour influences consumers' expectations and experience on tasting specialty coffee. *Food Quality & Preference*, **75**, 157-169.
- Chambers IV, E., Sanchez, K., Phan, U. X. T., Miller, R., Civille, G. V., & Di Donfrancesco, B. (2016). Development of a "living" lexicon for descriptive sensory analysis of brewed coffee. *Journal of Sensory Studies*, **31**, 465-480.
- Chan, E. Y., & Maglio, S. J. (2019). Coffee cues elevate arousal and reduce level of construal. *Consciousness & Cognition*, **70**, 57-69.
- Cheng, A. (2014). Uniqlo's new partnerships with Starbucks, MoMa are signs of a new retail trend. *Market Watch*, **March 28th**. <http://blogs.marketwatch.com/behindthestorefront/2014/03/28/uniqlos-new-partnershipswith-starbucks-moma-are-signs-of-a-new-retail-trend/>.
- Clarke, R. J. (2013). *Coffee: Volume 1. Chemistry*. New York, NY: Springer.
- Cristovam, E., Russell, C., Patterson, A., & Reid, E. (2000). Gender preference in hedonic ratings for espresso and espresso-milk coffees. *Food Quality & Preference*, **11**, 437-444.
- de Luca, P., & Pegan, G. (2014). The coffee shop and customer experience: A study of the US market. In F. Musso & E. Druica (Eds.), *Handbook of research on retailer-consumer relationship development* (pp. 173-196). Hershey PA: IGI Global.
- Delarue, J., Brasset, A.-C., Jarrot, F., & Abiven, F. (2019). Taking control of product testing context thanks to a multi-sensory immersive room. A case study on alcohol-free beer. *Food Quality and Preference*, **75**, 78-86.
- Dmowski, P., & Dąbrowska, J. (2014). Comparative study of sensory properties and color in different coffee samples depending on the degree of roasting. *Zeszyty Naukowe Akademii Morskiej W Gdyni*, **84**, 28-36.

- Elliott, A. F. (2014). Lights up, sound down, clothes on: Abercrombie & Fitch tones down its nightclub-themed stores in a bid to win back disinterested teens. *Daily Mail Online*, **May 23rd**. <https://www.dailymail.co.uk/femail/article-2637492/Lights-sound-clothes-Abercrombie-Fitch-tones-nightclub-themed-stores-bid-win-disinterested-teens.html>.
- Favre, J.-P., & November, A. (1979). *Colour and communication*. Zurich: ABC-Verlag.
- Feinstein, A., Hinslton, T., & Erdem, M. (2002). Exploring the effects of music atmospherics on menu item selection. *Journal of Foodservice Business Research*, **5(4)**, 3-25.
- Fenko, A., de Vries, R., & van Rompay, T. (2018). How strong is your coffee? The influence of visual metaphors and textual claims on consumers' flavor perception and product evaluation. *Frontiers in Psychology*, **9**:53. <https://doi.org/10.3389/fpsyg.2018.00053>
- Ferré, S. (2010). Role of the central ascending neurotransmitter systems in the psychostimulant effects of caffeine. *Journal of Alzheimer's Disease*, **20(s1)**, S35-S49.
- Fisk, I. D., Kettle, A., Hofmeister, S., Virdie, A., & Silanes Kenny, J. (2012). Discrimination of roast and ground coffee aroma. *Flavour*, **1**:14.
- Forster, S., & Spence, C. (2018). "What smell?" Temporarily loading visual attention induces a prolonged loss of olfactory awareness. *Psychological Science*, **29(10)**, 1642-1652.
- Fukuda, M., & Aoyama, K. (2017). Decaffeinated coffee induces a faster conditioned reaction time even when participants know that the drink does not contain caffeine. *Learning and Motivation*, **59**, 11-18.
- Gal, D., Wheeler, S. C., & Shiv, B. (2007, unpublished manuscript). *Cross-modal influences on gustatory perception*. Available at SSRN: <http://ssrn.com/abstract=1030197>
- Garber, M. (2012). The future of advertising (will be squirted into your nostrils as you sit on a bus). *The Atlantic*, **July 26th**. <https://www.theatlantic.com/technology/archive/2012/07/the-future-of-advertising-will-be-squirted-into-your-nostrils-as-you-sit-on-a-bus/260283/>.
- Gater, J. (2010). *The influence of musical genre on the sensory perception of coffee*. Unpublished manuscript.
- Ge, L. (2012). Why coffee can be bittersweet. *FT Weekend Magazine*, **October 13/14th**, 50.
- Geel, L., Kinnear, M., & De Kock, H. L. (2005). Relating consumer preferences to sensory attributes of instant coffee. *Food Quality & Preference*, **16**, 237-244.
- Glöss, A. N., Schönbächler, B., Klopprogge, B., et al. (2013). Comparison of nine common coffee extraction methods: Instrumental and sensory analysis. *European Food Research and Technology*, **236(4)**, 607-627. DOI:10.1007/s00217-013-1917-x.
- Grosch, W. (1998). Flavour of coffee: A review. *Nahrung*, **42**, 344-350.
- Grosch, W. (2001). Coffee: Recent developments. In R. J. Clarke & O. Z. Vitzhum (Eds.), *Chemistry III: Volatile compounds* (pp. 68-89). Oxford, UK: Blackwell Scientific.
- Guéguen, N., & Jacob, C. (2012). Coffee cup color and evaluation of a beverage's "warmth quality". *Color Research and Application*, **39**, 79-81. DOI:10.1002/col.21757
- Harith, Z. T., Ting, C. H., & Zakaria, N. N. A. (2014). Coffee packaging: Consumer perception on appearance, branding and pricing. *International Food Research Journal*, **21(3)**, 849-853.
- Heller, S. (1999). Appetite appeal. *Social Research*, **66**, 213-224.
- Henry, P. (2009). Getting a handle, seeing red: Folgers asserts brand equity with provocative packaging. *Package Design*, **November 24th**.

- Higdon, J. V., & Frei, B. (2006). Coffee and health: A review of recent human research. *CRC Critical Reviews in Food Science & Nutrition*, **46**, 101-123.
- Houghton, L. (2014). Costa Express launches 'Marlow' self-serve coffee. <http://www.bighospitality.co.uk/content/view/print/910569>.
- Illy, E. (2002). The complexity of coffee. *Scientific American*, **286**(6), 86-91.
- Illy, E., & Illy, A. (2015). The science of a perfect cup of coffee. *Scientific American*, **June**, 10-15.
- Illy, E., & Navarini, L. (2011). Neglected food bubbles: The espresso coffee foam. *Food Biophysics*, **6**(3), 335-348.
- International Trade Centre (2011). *The coffee exporter's guide: Export impact for good* (3rd Ed.). Geneva, Switzerland: International Trade Centre.
- International Coffee Organization (ICO) (2018). *Coffee market report*. March 2018. (London, UK).
- Kampfer, K., Leischnig, A., Ivens, B. S., & Spence, C. (2017). Touch-taste-transference: Assessing the effect of the weight of product packaging on flavor perception and taste evaluation. *PLoS ONE*, **12**(10).
- Kanjanakorn, A., & Lee, J. (2017). Examining emotions and comparing the EsSense Profile® and the coffee drinking experience in coffee drinkers in the natural environment. *Food Quality and Preference*, **56**, 69-79.
- Kerler, J., & Poisson, L. (2011). In-depth understanding of coffee aroma enables translation of consumer liking via sensory profiles into molecular targets for new product development. *New Food Magazine*, **14**(6), 39-43.
- Kim, S. E., Lee, S. M., & Kim, K. O. (2016). Consumer acceptability of coffee as affected by situational conditions and involvement. *Food Quality and Preference*, **52**, 124-132.
- King, S. C., & Meiselman, H. L. (2010). Development of a method to measure consumer emotions associated with foods. *Food Quality and Preference*, **21**, 168-177.
- Kleidas, M., & Jolliffe, L. (2010). Coffee attraction experiences: A narrative study. *Tourism*, **58**(1), 61-73.
- Knasko, S. C. (1995). Pleasant odors and congruency: Effects on approach behavior. *Chemical Senses*, **20**, 479-487.
- Knöferle, K. M. (2012). Using customer insights to improve product sound design. *Marketing Review St. Gallen*, **29**(2), 47-53.
- Knowles, J. B. (1963). Conditioning and the placebo effect: The effects of decaffeinated coffee on simple reaction time in habitual coffee drinkers. *Behaviour Research and Therapy*, **1**(2-4), 151-157.
- Kobayashi, M. L., & De Toledo Benassi, M. (2015). Impact of packaging characteristics on consumer purchase intention: Instant coffee in refill packs and glass jars. *Journal of Sensory Studies*, **20**, 169-180.
- Kole, A., Snel, J., & Lorist, M. M. (1998). Caffeine, morning-evening type and coffee odour: Attention, memory search and visual event related potentials. In J. Snel & M. M. Lorist (Eds.), *Nicotine, caffeine and social drinking: Behaviour and brain function* (pp. 201-214). Amsterdam, NL: Harwood Academic.

- Köster, E. P., & Degel, J. (2000). Are weak odors stronger than strong odors? The influence of odor on human performance. *Aromachology Review*, **2**:9.
- Kotler, P. (1974). Atmospherics as a marketing tool. *Journal of Retailing*, **49** (Winter), 48-64.
- Kuehlwein, J. P. (2017). Nespresso - the 'Crema' de la Crème. *Ueber Brands*, **October 30th**. <https://medium.com/ueberbrands/nespresso-the-crema-de-la-cr%C3%A8me-6bdc1f58a22e>.
- Kumar, S., Tansley-Hancock, O., Sedley, W., Winston, J. S., Callaghan, M. F., Allen, M., et al. (2017). The brain basis for misophonia. *Current Biology*, **27**, 1-7.
- Labbe, D., Ferrage, A., Rytz, A., Pace, J., & Martin, N. (2015). Pleasantness, emotions and perceptions induced by coffee beverage experience depend on the consumption motivation (hedonic or utilitarian). *Food Quality and Preference*, **44**, 56-61. doi: <http://dx.doi.org/10.1016/j.foodqual.2015.03.017>.
- Labbe, D., Sudre, J., Dugas, V., & Folmer, B. (2016). Impact of crema on expected and actual espresso coffee experience. *Food Research International*, **82**, 53-58.
- Li, W., Moallem, I., Paller, K. A., & Gottfried, J. A. (2007). Subliminal smells can guide social preferences. *Psychological Science*, **18**, 1044-1049.
- Little, A. C., Chichester, C. O., & Mackinney, G. (1959). On the color of coffee. III. Effect of roasting conditions on flavor development for a given color. Role of initial moisture level on roasting characteristics of green coffee beans. *Food Technology*, **13**, 684-688.
- Luttinger, N., & Dicum, G. (2006). *The coffee book: Anatomy of an industry from crop to the last drop*. New York, NY: The New Press.
- Ly, L. S. (2011) A multi-method exploration on coffee shop atmospherics. *Master's thesis*, Concordia University, Canada.
- Madzharov, A., Ye, N., Morrin, M., & Block, L. (2014). The impact of coffee-like scent on expectations and performance. *Journal of Environmental Psychology*, **57**, 83-86.
- Maguire, J. S., & Hu, D. (2013). Not a simple coffee shop: Local, global and glocal dimensions of the consumption of Starbucks in China. *Social Identities*, **19**(5), 670-684.
- Martin, D. (1990). The impact of branding and marketing on perception of sensory qualities. *Food Science & Technology Today: Proceedings*, **4**(1), 44-49.
- Masi, C., Dinnella, C., Monteleone, E., & Prescott, J. (2015). The impact of individual variations in taste sensitivity on coffee perceptions and preferences. *Physiology & Behavior*, **138**, 219-226.
- Motoki, K., Saito, T., Nouchi, R., Kawashima, R., & Sugiura, M. (2018). The paradox of warmth: Ambient warm temperature decreases preference for savory foods. *Food Quality and Preference*, **69**, 1-9.
- Nassauer, S. (2014). Using scent as a marketing tool, stores hope it--and shoppers--will linger: How Cinnabon, Lush Cosmetics, Panera Bread regulate smells in stores to get you to spend more. *The Wall Street Journal*, **May 20th**. <http://www.wsj.com/articles/SB10001424052702303468704579573953132979382>.
- Navarini, L., Cappuccio, R., Suggi-Liverani, F., & Illy, A. (2004). Espresso coffee beverage: Classification of texture terms. *Journal of Texture Studies*, **35**, 525-541.
- North, A. C., Hargreaves, D. J., & McKendrick, J. (1997). In-store music affects product choice. *Nature*, **390**, 132.

- North, A. C., Hargreaves, D. J., & McKendrick, J. (1999). The influence of in-store music on wine selections. *Journal of Applied Psychology*, **84**, 271-276.
- North, E., & Croeser, V. (2006). *The influence of background music on patrons in a South African coffee shop setting: An exploratory study*. [online]. [http://repository.up.ac.za/dspace/bitstream/2263/6030/1/North_Influence\(2006\).pdf](http://repository.up.ac.za/dspace/bitstream/2263/6030/1/North_Influence(2006).pdf)
- Oldenburg, R. (1989). *The great good place: Cafes, coffee shops, bookstores, bars, hair salons, and other hangouts at the heart of a community*. New York, NY: Marlowe & Co
- Palczak, J., Blumenthal, D., Rogeaux, M., & Delarue, J. (2019). Sensory complexity and its influence on hedonic responses: A systematic review of applications in food and beverages. *Food Quality and Preference*, **71**, 66-75.
- Pape, P. (2009). It makes scents: Olfactory marketing brings pleasant aromas to customers pumping fuel. *NACS Magazine*, **August**, 8-9. <http://www.scentandrea.com/MakesScents.pdf>.
- Pendergast, M. (2001). *Uncommon grounds: The history of coffee and how it transformed our world*. London, UK: Texere.
- Petit, C., & Sieffermann, J. M. (2007). Testing consumer preferences for iced-coffee: Does the drinking environment have any influence? *Food Quality and Preference*, **18**, 161-172.
- 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.
- 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.
- Pramudya, R. C., & Seo, H.-S. (2019). Hand-feel touch cues and their influences on consumer perception and behavior with respect to food products: A review. *Foods*, **2019**:8, doi: 10.3390/foods8070259
- Reed, D. R., & Knaapila, A. (2010). Genetics of taste and smell: Poisons and pleasures. *Progress in Molecular Biology Translational Science*, **94**, 213-240.
- Qian, M. (2014). Coffee shop, environmental behavior, and design. *Master's thesis*, University of Illinois at Urbana-Champaign.
- Rahner, M. (2006). The savvy, sultry Starbucks sound. *The Seattle Times*, **April 17th**. http://seattletimes.com/html/entertainment/2002931029_kitchell17.html.
- Renko, S. (2014). Atmosphere as a store communication tool. In F. Musso & E. Druica (Eds.), *Handbook of research on retailer-consumer relationship development* (pp. 239-257). Hershey PA: IGI Global.
- Richelieu, A., & Korai, B. (2014). The consumption experience of Tim Hortons' coffee fans. *Qualitative Market Research: An International Journal*, **17(3)**, 192-208. <https://doi.org/10.1108/QMR-06-2012-0032>.
- Robinson, E. F. (1893). *The early history of coffeehouses in England*. London, UK: Kegan Paul, Trench, Trüber & Co.
- Robson, S. K. A. (1999). Turning the tables. *Cornell Hotel and Restaurant Administration Quarterly*, **39**, 32-39.

- Rozin, P. (1982). "Taste-smell confusions" and the duality of the olfactory sense. *Perception & Psychophysics*, **31**, 397-401.
- Sakai, N. (2014). The psychology of eating from the point of view of experimental, social and applied psychology. *Psychology in Russia: State of the Art*, **7**, 16-22.
- Samoggia, A., & Riedel, B. (2018). Coffee consumption and purchasing behavior review: Insights for further research. *Appetite*, **129**, 70-81.
- Schenker, S., & Rothgeb, T. (2017). The roast—Creating the beans' signature. In B. Folmer (Ed.), *The craft and science of coffee* (pp. 245-271). London, UK: Academic Press.
- Schoenholt, D. (1995). Slurping and spitting in the twentieth-century; Coffee drinking; Coffee cupping report. *Tea & Coffee Trade Journal*, **February**.
- Schultz, H., & Yang, D. J. (1997). *Pour your heart into it: How Starbucks built a company one cup at a time*. New York, NY: Hyperion.
- Seigneuric, A., Durand, K., Jiang, T., Baudouin, J.-Y., & Schaal, B. (2010). The nose tells it to the eyes: Crossmodal associations between olfaction and vision. *Perception*, **39**, 1541-1554.
- Seo, H.-S., Buschhüter, D., & Hummel, T. (2009). Odor attributes change in relation to the time of the year. Cinnamon odor is more familiar and pleasant during Christmas season than summertime. *Appetite*, **53**(2), 222-225. <http://doi.org/10.1016/j.appet.2009.06.011>.
- Seo, H.-S., Hirano, M., Shibato, J., Rakwal, R., Hwang, I., K., & Masuo, Y. (2008). Effects of coffee bean aroma on the rat brain stressed by sleep deprivation: A selected transcript- and 2D gel-based proteome analysis. *Journal of Agricultural and Food Chemistry*, **56**, 4665-4673.
- Seo, H.-S., & Hummel, T. (2011). Auditory–olfactory integration: Congruent or pleasant sounds amplify odor pleasantness. *Chemical Senses*, **36**, 301-309.
- Seo, H.-S., Lee, S.-Y., & Hwang, I. (2009). Development of sensory attribute pool of brewed coffee. *Journal of Sensory Studies*, **24**, 111-132.
- Shelton, A. (1990). A theatre for eating, looking and thinking: The restaurant as symbolic space. *Sociological Spectrum*, **10**, 507-526.
- Smith, A. P., Clark, R., & Gallagher, J. (1999). Breakfast cereal and caffeinated coffee: Effects on working memory, attention, mood, and cardiovascular function. *Physiology & Behavior*, **67**(1), 9-17.
- Sommer, R., & Steele J. (1997). Social effects on duration in restaurants. *Appetite*, **29**, 25-30.
- Sörqvist, P., Hedblom, D., Holmgren, M., Haga, A., Langeborg, L., Nörtl, A., et al. (2013). Who needs cream and sugar when there is eco-labeling? Taste and willingness to pay for "eco-friendly" coffee. *PLoS One*, **8**(12):1-9.
- Spence, C. (2010). The color of wine – Part 2. *The World of Fine Wine*, **29**, 112-119.
- Spence, C. (2014). Noise and its impact on the perception of food and drink. *Flavour*, **3**:9.
- Spence, C. (2015). Leading the consumer by the nose: On the commercialization of olfactory-design for the food and beverage sector. *Flavour*, **4**:31.
- Spence, C. (2017a). *Gastrophysics: The new science of eating*. London, UK: Viking Penguin.
- Spence, C. (2017b). Sonic seasoning. In L. Minsky & C. Fahey (Eds.), *Audio branding: Using sound to build your brand* (pp. 52-58). London, UK: Kogan Page.

- Spence, C. (2019a). Designing for the forgotten sense. *25 Magazine*, **8**, 26-30. <http://thecoffeehotspot.com/2019/03/07/designing-for-the-forgotten-sense-25-magazine-issue-8/>.
- Spence, C. (2019b). Multisensory experiential wine marketing. *Food Quality & Preference*, **71**, 106-116. <https://doi.org/10.1016/j.foodqual.2018.06.010>.
- Spence, C. (2019c). Do men and women really live in different taste worlds? *Food Quality & Preference*, **73**, 38-45.
- Spence, C. (in press). Atmospheric effects on eating and drinking: A review. In H. Meiselman (Ed.), *Handbook of eating and drinking*. Cham, Switzerland: Springer. doi:10.1007/978-3-319-75388-1_119-1
- Spence, C., & Carvahlo, F. (2019). Designing functional coffee cups. *Food Quality & Preference*, **75**, 239-248.
- Spence, C., Puccinelli, N., Grewal, D., & Roggeveen, A. L. (2014). Store atmospherics: A multisensory perspective. *Psychology & Marketing*, **31**, 472-488.
- Spence, C., & Wang, Q. J. (2018). On the meaning(s) of complexity in the chemical senses. *Chemical Senses*, **43**, 451-461.
- Spinelli, S., Dinnella, C., Masi, C., Zoboli, G. P., Prescott, J., & Monteleone, E. (2017). Investigating preferred coffee consumption contexts using open-ended questions. *Food Quality and Preference*, **61**, 63-73. <https://doi.org/10.1016/j.foodqual.2017.05.003>.
- Stelick, A., Penano, A. G., Riak, A. C., & Dando, R. (2018). Dynamic context sensory testing—A proof of concept study bringing virtual reality to the sensory booth. *Journal of Food Science*, **83**, 2047-2051.
- Stroebele, N., & De Castro, J. M. (2004). Effect of ambience on food intake and food choice. *Nutrition*, **20(9)**, 821-838.
- Tucker, C. M. (2011). *Coffee culture: Local experiences, global connections*. New York, NY: Routledge.
- Ueda, J. Masuda, M., & Okajima, K. (2014). Effects of vision and sound information of AR-modified drinks on taste and texture. *Proceedings of the ITE Annual Convention*, pp. 22.4.1-22.4.2. Yokohama National University, Japan [in Japanese].
- Van Doorn, G., Colonna-Dashwood, M., Hudd-Baillie, R., & Spence, C. (2015). Latté art influences both the expected and rated value of milk-based coffee drinks. *Journal of Sensory Studies*, **30**, 305-315.
- Van Doorn, G., Woods, A., Levitan, C. A., Wan, X., Velasco, C., Bernal-Torres, C., & Spence, C. (2017). Does the shape of a cup influence coffee taste expectations? A cross-cultural, online study. *Food Quality and Preference*, **56**, 201-211.
- Van Doorn, G., Willemin, D., & Spence, C. (2014). Does the colour of the mug influence the taste of the coffee? *Flavour*, **3**:10.
- Van Loo, E. J., Caputo, V., Nayga Jr., R. M., Seo, H. S., Zhang, B., & Verbeke, W. (2015). Sustainability labels on coffee: Consumer preferences, willingness-to-pay and visual attention to attributes. *Ecological Economics*, **118**, 215-225.
- Van Rompay, T. J. L., & Groothedde, S. (2019). The taste of touch: Enhancing saltiness impressions through surface texture. *Food Quality & Preference*, **73**, 248-254.

- Van Rompay, T. J. L., van Hoof, J. J., Rorink, J., & Folsche, M. (2019). Served straight up: Effects of verticality cues on taste evaluations and luxury perceptions. *Appetite*, **135**, 72-78. <https://doi.org/10.1016/j.appet.2019.01.002>
- Vanharanta, H., Kantola, J., & Seikola, S. (2015). Customers' conscious experience in a coffee shop. *Procedia Manufacturing*, **3**, 618-625.
- Velasco, C., & Spence, C. (Eds.). (2019). *Multisensory packaging: Designing new product experiences*. Cham, Switzerland: Palgrave MacMillan. <https://www.palgrave.com/gp/book/9783319949765>.
- Wada, Y., Inada, Y., Yang, J., Kunieda, S., Masuda, T., Kimura, A., Kanazawa, S., & Yamaguchi, M. K. (2012). Infant visual preference for fruit enhanced by congruent in-season odor. *Appetite*, **58**, 1070-1075.
- Walton, A. G. (2012). Starbucks' power over us is bigger than coffee: It's personal. *Forbes*, May 29th. <https://www.forbes.com/sites/alicegwalton/2012/05/29/starbucks-hold-on-us-is-bigger-than-coffee-its-psychology/#159961b34aed>.
- Wan, X., Zhou, X., Mu, B., Du, D., Velasco, C., Michel, C., & Spence, C. (2014). Crossmodal expectations of tea colour based on its flavour. *Journal of Sensory Studies*, **29**, 285-293.
- Wang, Q. J., & Spence, C. (2018). A smooth wine? Haptic influences on wine evaluation. *International Journal of Gastronomy & Food Science*, **14**, 9-13.
- Weinberg, B. A., & Bealer, B. K. (2001). *The world of caffeine: The science and culture of the world's most popular drug*. London, UK: Psychology Press.
- Woods, A. T., Poliakoff, E., Lloyd, D. M., Kuenzel, J., Hodson, R., Gonda, H., Batchelor, J., Dijksterhuis, G. B., & Thomas, A. (2011). Effect of background noise on food perception. *Food Quality & Preference*, **22**, 42-47.
- Wu, H. (2017). What drives experiential loyalty? A case study of Starbucks coffee chain in Taiwan. *British Food Journal*, **119**, 468-496. <https://doi.org/10.1108/BFJ-08-2016-0349>.
- Xu, A. J., & Labroo, A. A. (2014). Incandescent affect: Turning on the hot emotional system with bright light. *Journal of Consumer Psychology*, **24**, 207-216.
- Yan, K. S., & Dando, R. (2015). A crossmodal role for audition in taste perception. *Journal of Experimental Psychology: Human Perception & Performance*, **41**, 590-596.
- Yeretzian, C. (2017). Coffee. In A. Buettner (Ed.), *Springer handbook of odor* (pp. 107-128). Cham, Switzerland: Springer International Publishing.
- Youssef, J., Youssef, L., Juravle, G., & Spence, C. (2017). Plateware and slurping influence regular consumers' sensory discriminative and hedonic responses to a hot soup. *International Journal of Gastronomy & Food Science*, **9**, 100-104.