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How changes in environmental colour hue affect taste expectations, perceptions, and product preferences at different levels of attention towards atmospheric cues: A mixed experimental design

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Abstract

How does changes in environmental colour hue affect taste expectations, perceptions, and product preferences at different levels of attention toward atmospheric cues? Previous research has showed that environmental colour hue can influence taste experiences, however, the mechanisms behind this are not fully understood. In the present study, we aimed to study the effects of environmental colour hue hue on people's taste expectations, perceptions, and product experiences. In addition, we evaluated attention as a potential mechanism for such crossmodal effects. In Experiment 1, we studied coffee perceptions by using virtual reality, considering that this is an increasingly attractive technology for marketers interested in immersive experiences. In Experiment 2, we studied coffee expectations by using another increasingly used visualization mode, namely 360-degree environments. In both studies, we followed a 2 (higher attention vs. lower attention) x 3 (red vs. green. vs. white) mixed between-within experimental design for both experiments, with the first factor being between participants and the second within participants. We evaluated how these factors would influence the sensory, hedonic, and market related aspects of the coffee tasting experience.

The results of Experiment 1 suggested that environmental colour hue made the coffee seem more flavourful in the white atmosphere compared to the red atmosphere. There was also evidence of higher attention leading to higher flavourful and sweetness scores, as well as a greater immersion experience. Higher attention also made the coffee seem more balanced in the green atmosphere relative to the white and red atmospheres. The group that was instructed to pay attention to the atmospheres enjoyed the taste and liked the drink experience more in the green atmosphere compared to the red atmosphere. While the group that got no such instructions liked the drink experience more in the white atmosphere compared to the green atmosphere. In Experiment 2, the results showed that environmental colour hue affected how warm the coffee was expected to be and the expected drink experience likeability. The white 360-degree environment generated higher drink experience likeability and expected temperature of the coffee. The findings contribute to the managerial understanding of the role of environmental colour hue in the customer experience journey and also to the multisensory experience literature.

Keywords: Coffee, colour, crossmodality, expectation, perception, flavour, light, multisensory, taste, virtual reality, virtual environment, attention, experience, experiment

1. Introduction

Previous research has demonstrated that colour can influence several meaningful factors within sale and service settings. The appropriate use of colour can stimulate purchases (Price, 2010), influence purchase rate, time spent in store, contribute to pleasant feelings (Bellizzi & Hite, 1992; Cheng, Wu, & Yen, 2009), arousal (Crowley, 1993), store- and merchandise image, and attract consumers toward a retail display (Bellizzi, Crowley, & Hasty, 1983). Atmospheric colours, in particular, can influence consumers' perception and behaviour (e.g., Harrar, Piqueras-Fiszman, & Spence, 2011; Oberfeld, Hecht, Allendorf, & Wickelmaier, 2009; Van Doorn, Wuillemin, & Spence, 2014) while for example being in a bar (Sester et al., 2013), or in a luxury store (Cho & Lee, 2017). The process in which information in one sense affects the perception of information in another sense (Vrečko, Leonardis, & Skočaj, 2012) is called crossmodal effects and several researchers have found significant crossmodal effects between, for instance, music and colour, or testant and colour on taste perception (e.g., Saluja & Stevenson, 2018; Spence, Velasco, & Knoeferle, 2014).

While research has documented that, for instance, red lighting can enhance sweetness perception and green lighting can enhance sourness perception, the mechanisms associated with these observations are not altogether clear (Spence & Wang, 2015; Velasco et al., 2016). In addition, though some people have studied the effects of colour in digital environments (e.g., Cheng, Wu, & Yen, 2009; Ettis, 2017; Pelet & Papadopoulou, 2012), to our knowledge, this have not been studied in a Virtual Reality (VR) setting. In 1960 the first Head Mounted Display (HMD) was invented, which was the beginning of VR as we now know it today (Virtual Reality Society, 2017). From that time, the development within VR has been tremendous. In 2018 it was predicted that VR devices would be mainstream within five years (Loureiro, Guerreiro, Eloy, Langaro, & Panchapakesan, 2019). In other words, it has been, and will probably still be, a huge market increase during the next decades.

For these reasons, the aim of this paper was twofold: First, to extend the research on environmental colour hue and taste perception and evaluate attention as a possible mechanism that explained crossmodal effects. Second, to evaluate the effect of environmental colour hue in VR and 360-degree environments on taste expectations, perceptions, and experiences. The goal was to identify if there was a sense of immersion, where the participants blended physically into the non-physical environment by manipulating the participants attention.

2. Literature review

2.1 How colour affect flavour perception

Over the last three decades there has been done a huge amount of work in terms of connecting colour and taste. From the seminal observations of Moir in the 1930s to research on colour of especially food or beverages that can change its perceived taste or flavour (Spence, 2013). For instance, O'Mahony (1983) got students to pick one colour (out of 12) to match with one taste (out of four). His results showed that sweet was associated with red, yellow with sour, white with salty, and green/black with bitter. Later research of Saluja and Stevenson (2018) found supporting evidence of red/pink colour being perceived as sweet, white/blue as salty, green/yellow as sour, and black/green as bitter.

Flavour is a multisensory construct involving, at least, taste/gustation and olfaction (Velasco, Obrist, Petit, & Spence, 2018). There are two types of olfaction, namely, retronasal olfaction which is referred to as "mouth smell" and orthonasal olfaction which means "sniffing" or "smelling" through the nose (Spence, 2013). Spence (2013, p.1) states that "80% of what we commonly think of as flavour comes from the information transduced by the olfactory receptors in the nose". Further, there is an important distinction between flavour and taste. Although the words are mixed in daily speech, Spence (2013, p.1) describes taste as something that "refers to those sensations that are elicited by the stimulation of the gustatory receptors on the tongue – sweet, sour, bitter, salty, and umami" (see also Duffy, Hayes, Bartoshuk, & Snyder, 2009). Flavour, however, is being described by Spence (2015a, p.1) as "more complex" and can be described with words like "meaty", "fruity", "burnt" etc". The confusion between taste and

flavour can be explained by the phenomenon called “oral referral”. This phenomenon can be described as mislocalization of food- and drink-related olfactory stimuli to the oral cavity rather than to the nose (Lim & Johnson, 2011, 2012; Spence, 2013). Important results within this field are found, among others, in the study of Lim, Fujimaru, and Linscott (2014). Participants were orally presented with the aroma of either bitter or sweet coffee, or citric aroma. At the same time, they were presented with a tastant presented in a solution in the participants mouth. The results of this crossmodal experience between the olfactory and gustatory stimuli showed that taste-odour congruence was a critical component for retronasal oral referral, and that the degree of congruence modulated the degree of odour referral to the mouth. This study also showed that attentional capture by gustatory stimuli was key to understand oral referral, which will be discussed in further details later.

Flavour perception is thus more than just what happens in the mouth. When two or more elements are paired in the context of flavour perception it sometimes results in fusion, however if one is not careful, the result can equally well be confusion instead (Spence, 2020). Odour affects taste because it is hard to taste anything other than, for example, sweet, bitter, sour, and salty when there is no odour. The two senses are joined during perception when the sensory information converge, which leads to a coherent experience. Odour has at least two functions. First, odour can guide behaviour. For example, if something smells bad you are less likely to eat it than if the odour is tempting. Second, odour affect consumer preference (Ramsøy, 2015). In an experiment, Ramsøy (2015) and his colleagues tested the relationship between odour and likability. Their findings showed a nonlinear effect for pleasant odours; Up to a certain point the relationship was positive, but past this point the effect was reversed and stronger concentrations was related to lower preference ratings. These findings suggest that there was a crucial optimal concentration for an odour and how it was preferred by consumers. Odours thus help explain the liking of specific flavours.

An increasing amount of studies have showed that the experience of taste and flavour is determined to a large extent by the expectations that we generate prior to tasting (e.g., Deliza & MacFie, 1996; Hutchings, 2003; Piqueras-Fiszman & Spence, 2015; Woods, Poliakoff, Lloyd, Dijksterhuis, & Thomas, 2010). These

expectations can result from branding, labelling, packaging, and other contextual effects (e.g., Roullet & Droulers, 2005; Spence, 2018; Wan, Woods, Saldago-Montejo, Velasco, & Spence, 2015), and also from a variety of product-intrinsic cues (e.g., Cardello, 2019; Veale & Quester, 2009; Veale, Quester, & Karunaratna, 2006; Piqueras-Fizman & Spence, 2015). The aroma of food and drink have showed to be an important product-intrinsic cue for consumer behaviour, preference, and taste experience (Spence, 2015a). Hence, the expected likeability of the coffee in this experiment can therefore not only be explained by taste but can also be influenced by the functions of smell.

Visual cues such as shape, colour, and texture are critical when it comes to setting our flavour expectations and hence modifying our flavour experiences (e.g., Delwiche, 2004; de Sousa, Carvalho, & Pereira, 2020; Piqueras-Fizman & Spence, 2015; Spence, Okajima, Cheok, Petit, & Michel, 2016). Previous research has showed that the ability to identify an odour or taste is highly dependent on the visual sense, which combined, create the subjective experience (e.g., Spence et al., 2014; Velasco, Woods, Marks, Cheok, & Spence, 2016; Velasco, Woods, Deroy, & Spence, 2015; Wang, Carvalho, Persoone, & Spence, 2017; Österbauer et al., 2005). Hence, it is easier to identify an object based on its odour when other senses provide supporting cues (e.g., Desor & Bauchamp, 1974; Porada, Regenbogen, Seubert, Freiherr, & Lundström, 2019). An example of a visual cue that have a strong impact on the identification of odour is colour (Österbauer et al., 2005). According to the Oxford Dictionaries, colour can be described as "the property possessed by an object of producing different sensations on the eye as a result of the way it reflects or emits light" ("Colour", n. d) and consists of brightness, saturation and hue. Hue refers to the broad colour category, for instance, red, yellow, and black. Brightness relates to the amount of black and white added to the hue. Saturation is described as the intensity of the hue (Spence & Velasco, 2018). Colour cues can bias odour judgements (e.g., Engen, 1972; Spence, Levitan, Shankar, & Zampini, 2010 for review; Zellner, Bartoli, & Ecker, 1991; Zellner & Kautz, 1990; Zellner, Greene, Jimenez, Calderon, Diaz, & Sheraton, 2018) which affect the performance and is determined by the appropriateness of colour-odour pairing (e.g., Davis, 1981; Zampini, Sanabria, Phillips, & Spence, 2007; Zellner et al., 1991). Whereas appropriate colours increase identification, inappropriate colours reduce the accuracy of odour

identification (Gilbert, Martin, & Kemp, 1996). Furthermore, colour does not only affect identification of odours but also the judgements of odour intensity and pleasantness (Österbauer et al., 2005). Research of Zellner et al. (1991) showed that the perceived intensity and pleasantness of an appropriately coloured solution (e.g. red – strawberry) was higher than for an inappropriately coloured one (e.g. green – strawberry) or a colourless solution, even though the aroma remained the same. Furthermore, Morrot, Brochet, and Dubourdieu (2001) discovered that tasteless red colouring added to a white wine caused an illusion which led the participants to describe the wine with olfactory terms typical for red wines. Additionally, Stevenson and Oaten (2008) found that odour discrimination may be affected by stimulus colour and that this effect was mediated by odour identification. Hence, visual cues such as shape, colour, and texture are critical when it comes to setting our flavour expectations and thereby modifying our flavour experiences (e.g., Carvalho & Spence, 2019; de. Sousa et al., 2020; Piqueras-Fizman & Spence, 2015; Spence et al., 2016).

As a result, colour can be used in many categories to deliver information to the consumer about a product's sensory properties such as taste or flavour, or to prime other more abstract brand attributes such as healthy, natural, or premium (Spence & Velasco, 2018). As previously discussed, it is known that colours can influence the perception of flavour intensity (Calvo, Salvador, & Fiszman, 2001) as well as flavour identification (Zampini et al., 2007). Babin, Hardesty and Suter (2003) found that purchase intention was higher in a store with blue interior compared to a store with orange interior. However, they also found that this effect was modified by a lighting condition. By combining the orange interior with soft lights the purchase intention increased, while a reverse trend was showed for a softly lit blue store. More recent research has showed that a red (vs. blue) background elicits higher bid jumps and decrease price offers in negotiations. This could be explained by red which induces aggression through arousal (Bagchi & Cheema, 2013).

So far, we have deliberated upon and explained colour in the eyes of solution, packaging, music, food, and beverages. However, other atmospheric cues such as background noise or music, ambient light, smell, temperature, texture of furniture etc. also plays an important role in sensory research (e.g., Ettis, 2017; Gater,

2010; Knöferle, 2012; Petit & Sieffermann, 2007; Spence, 2014; Spence & Carvalho, 2020). Although the colour of the coffee is mostly black, research has showed that colours in the environment can influence the perception of the taste and likeability of the beverage more than the actual colour of the beverage (e.g., Gal, Wheeler, & Shiv, 2007; Spence et al., 2014). It is usual to divide atmospheric stimuli into categories and subdimensions (e.g., Berman & Evans, 1995; Bitner, 1992), however this research will focus only on interior variables which involves different environmental colour hues. A study done by Oberfeld et al. (2009) found that wine was perceived to be spicier and fruitier when presented in blue or green light rather than in red or white light. They also found the Riesling to be perceived as tasting better in a blue or red room compared to a green or white room. In addition, the white wine was perceived as tasting bitter in blue light while at the same time giving higher liking scores. Overall, the willingness to pay increased significantly in red light compared to white light. Supporting this, results from Ly (2011) showed a positive correlation between appropriate lighting and purchase likelihood. Therefore, environmental colour hue may influence the likeability and hence taste of coffee. Furthermore, environmental colour hue can affect perception, likability, and willingness to pay (e.g., Bellizzi & Hite, 1992; Petite & Siefferman, 2007; Turley & Milliman, 2000 for review). In the next section we discuss possible mechanisms as well as the role of environmental colour hue on taste perception.

2.2 Mechanisms underlying crossmodal effects

Previous research states that "visual attention describes a set of mechanisms that limit the processing to a subset of incoming stimuli" (Evans et al., 2011, p. 503; Mormann et al., 2020) and has four functions; data reduction/stimulus selection, stimulus enhancement, feature binding, and recognition (Evans et. al., 2011). Further, the more complex and challenging the stimulus are, the stronger the effect of attention become (e.g., Lavie, 1995, 2005). Since coffee is considered a complex product, this product needs a higher sense of attention in order for a person to better recognize the different stimuli of the coffee. Coffee aroma is the most important component of coffee flavour (Sunarharum, Williams, & Smyth, 2014) and is primarily responsible for flavour diversity for such complex products (e.g., Lawless and Heymann, 2010; Murphy, Cain, & Bartoshuk, 1977). Moreover, it has been suggested by laboratory research that people are unable to

extract more than two or three aromas from complex odour mixtures (Spence & Wang, 2015). Hence, attention is important when detecting the aroma of the coffee and thus the flavour of the coffee. A newly published research by Carvalho and Spence (2019) showed that the colour of the coffee cup significantly impacted sensory and hedonic judgement of speciality coffee, and that the contrast between expected and actual experience could result in a negative hedonic response and enhancement of the unexpected sensory attributes. The explanation of these results is based on crossmodal effects, which can be described as when information in one sense affects the perception of information in another sense (Vrečko, Leonardis, & Skočaj, 2012).

According to Spence and Wang (2015, p. 2) crossmodal correspondences (also called crossmodal effects) are "the surprising associations that we all share between features, attributes and, sensory dimensions in one sensory modality, and the seemingly unrelated features, attributes, and sensory dimensions of experience in another modality, such as between roundness and sweetness or brightness and pitch" (see also Parise, 2016; Spence, 2011, for reviews). Since research has suggested that crossmodal corresponding stimuli may influence perception, we hypothesised that environmental colour hue might make the participants pay more attention to specific characteristics of the coffee. In other words, crossmodal correspondence may guide people's attention towards a subset of the whole sensory experience at the expense of the other characteristics, which can affect the perception of specific sensory characteristics of food or beverage (e.g., sweetness and acidity), but also likability and willingness to pay for the coffee. In a study by Spence et al. (2014) two multisensory tasting experiments was conducted to measure the effect colour and music had on participants preferences for a specific wine. In the first experiment the participants rated the wine while being exposed to white lighting, red lighting, green lighting with music designed to enhance sourness, and finally under red lighting paired with music associated with sweetness. In the second experiment the same wine was rated under the same environments, but in different orders than in experiment one. In the first experiment, the wine was perceived as fresher and less intense under green lighting and sour music, as compared to any of the other three environments. On average, the participants liked the wine most under red lighting while listening to sweet music. A similar pattern of results was reported in the second experiment.

Several researchers have studied crossmodal effects in the context of food and beverage perception (e.g., Spence, 2020). For example, Sester et al. (2013) found that changes in elements of the ambience significantly affected different drink choices. A similar study conducted by Oberfeld et al. (2009) showed that ambient colour modified the taste, but not the odour of the wine. Another example is Koch and Koch (2003) who found significant crossmodal effects between red/orange and sweet, green/yellow and sour, white and salty, and black and bitter. This was also the case for Wan et. al. (2014) who found similar results when doing an online study with crossmodal effects between five basic tastes and eleven colours.

When it comes to setting people's expectations regarding the likely taste and flavour of food and drink, colour is the single most important product-intrinsic sensory cue (Biswas, Szocs, Chacko, & Wansink, 2017). Hence, by changing the hue or intensity/saturation of the colour of food and beverage, items can exert a dramatic impact in the expectations, which can affect the subsequent experiences of consumers. However, if the colour does not match the taste, this can lead to a negatively valanced disconfirmation of expectation (Spence, 2015a). An unpublished study by Gal et al. (2007) reported that those who liked strong coffee tended to drink more under bright light conditions, while those who liked weaker coffee tended to drink more under dim light conditions. In addition, as mentioned earlier, the study of Ly (2011) found that there was positive correlation between lighting and purchase likelihood when assessing physical elements such as wall colour and ambient light. Further, some evidence suggest that those who are highly involved in the product are little affected by either situational factors (that is: evocation or non-evocation inside a booth or simulation), while low involvement groups are highly affected by the environment factor which involves only booth or simulation manipulation (Kim, Lee, & Kim, 2016).

Based on these previous findings we hypothesised that for Experiment 1*, the red environmental colour hue in the VR will make the coffee taste sweeter, while the green environmental colour hue in the VR will make the coffee taste more acidic, relative to the other conditions*. Due to cancellation of Experiment 1 as a result of the coronavirus pandemic, we conducted Experiment 2 in which we tested the hypothesis of the present research at the expectation level in an online study using 360-degree environments on YouTube. In particular, for this concept,

we developed a similar hypothesis which stated that, *red environmental colour hue in the 360-degree environment will increase the expectation that the coffee tastes sweeter, while the green environmental colour hue in the 360-degree environment will increase the expectation that the coffee taste more acidic, relative to the other conditions.*

2.3 Virtual reality and sense of immersion

Multisensory technologies can be described as technologies that are designed to stimulate the human senses (Velasco et al., 2018). Virtual environments comprise computer generated or 360-degree video recordings, generally three-dimensional representations of a real, physical setting, or scene (Cheng, 2002). Today, only a few studies have been conducted with the use of virtual reality (VR) in the context of crossmodal effects. However, the use of multisensory technologies in research is growing. VR has existed since the 1960s (Virtual Reality Society, 2017), whereas the specific expression "Virtual Reality" was introduced by Jaron Lanier in the 80s (Fuchs, Moreau, & Guitton, 2011). At that time, few people had heard about the expression and the market for VR was not of a meaningful size. From that time, however, the development within VR has been tremendous. The total market size for virtual environment (both augmented and VR) is expected to increase from $27 billion in 2018 to $209.2 billion in 2022 (Loureiro et al., 2019). As technology is a fast-moving industry, new editions and smarter solutions to the different VR-devices are launched rapidly. Upcoming devices of standalone VR HMD are making this technology more available, and together with the declining prices, there is a good chance that future use of these devices will tremendously increase (Canalys, 2017). In research it is better to conduct a study in a natural and real-life setting in order to increase the test validity and engagement, however, it can be both tricky and costly (e.g., Boutrolle & Delarue, 2009; King, Weber, Meiselman, & Lv, 2004; Meiselman, Johnson, Reeve, & Crouch, 2000). Though, having these standardized environments compared to a natural setting makes the time and money worth it (Higgins & Scholer, 2009).

VR is a complex term. One can note that previous literature has a tendency to mix the purpose of VR, its functions and applications, and the techniques on which it is based on. Fuchs et al. (2011, p.7) proposed a taxonomy based on

"theoretical functions". The resulted definition was "Virtual reality will help you to come out of the physical reality to virtually change time, place and (or) the type of interaction with an environment stimulating the reality of interaction with an imaginary or symbolic world". A more technical definition of the VR term indicates that "Virtual reality is a scientific and technical domain that uses computer science and behavioural interfaces to stimulate in a virtual world the behaviour of 3D entities, which interact in real time with each other and with one or more users in pseudo-natural immersion via sensorimotor channels" (Fuchs et al., 2011, p.8).

It is important to note that immersion, interaction, and imagination are three important concepts in VR. Immersion is the perception of being physically present in a non-physical world (Flavián, Ibáñez-Sánchez, & Orús, 2019), and interaction can be explained as the natural interaction between the user and the virtual scene, and can take place in various types depending on its visual sense, auditory, or tactile perceptions. Imagination "refers to the use of multi-dimensional perception information provided by VR scenes to acquire the same feelings as the real world while acquiring the feelings that are not available in the real world" (Yang, Huang, Feng, Hong-An, & Guo-Zhong, 2019, p.4). Immersive VR refers to the construction of a virtual world where users feel immersed as if they were part of the virtual environment. According to Loureiro et al. (2019, p.516), "Immersion is Virtual Environment (VE) systems ability to deliver an inclusive, extensive, surrounding and vivid illusion of reality to the sense of the human participant".

Greater immersion is related to a stronger sense of presence, and vice versa. Moreover, the difference between the two is that immersion relates to what the system delivers from a technical perspective, while presence relates to the human experience of the given environment (Loureiro et al., 2019). The goal of immersive VE is to let the user experience a recorded world as if it were real, producing a sense of presence in the user's mind. While immersion is objective and measurable (since one system can have a higher level of immersion than another), presence refers to a user's subjective psychological response to a VR system related to "being there" (Bowman & McMahan, 2007). For immersion to be effective, a user must be able to explore what appears to be a life-sized VE and be able to change perspectives seamlessly (Strickland, 2007). By now, research

has showed that the quality of the participant's experience depends, mostly, on the quality of the interaction supported by the environment (Cheng, 2002). By asking the participants to pay more or less attention to the VE, this may influence their sense of immersion as higher attention potentially could lead to higher sense of presence and therefore makes the immersive VE appropriate. For Experiment 1 we therefore hypothesised that*; the effect that environmental colour hue has on the perceived coffee taste (sweet vs. acidic) will be enhanced for the participants that are instructed to pay attention (vs. no instructions) and conversely feel more immersed*. In Experiment 2 our hypothesis was similar; *the effect the environmental colour hue has on the expected coffee taste (sweet vs. acidic) will be enhanced for the participants that are instructed to pay attention (vs. no instructions) and conversely feel more immersed.*

The immersive virtual reality (IVR) technology provides the feeling of a virtual world in a one to one scale which can give the participant a feeling of "being there". Although the graphics provided by the virtual environment world seem far from completely natural, two benefits of IVR are specially highlighted. First, users are surrounded by the VE and gets the impression of being in the virtual world. Second, users can interact in real time. These two characteristics determine the sense of credibility of a virtual scenario, that is, the sensation that the simulated world is perceptually convincing and that it can produce events that directly relate to participant's sensorimotor contingencies (Ruotolo et al., 2013). In our experiment the virtual world is presented as a restaurant. However, there is a low-interaction environment where the participants stay passive. As this type of technology is advanced and costly, we needed to conduct the experiment based on our resources.

There are few researchers who combine an immersive approach with food/drinks (e.g., Pennanen, Näräinen, Vanhatalo, Raisamo, & Sozer, 2020; Sinesio et al., 2019; Spence & Carvalho, 2020; Stelick, Penano, Riak, & Dando, 2018). Yet, Sester et al. (2013) used this approach where they created different bar environments with different furniture. Their research showed that drink choices changed with different ambience, however, they state that it was a possibility that the consumers did not feel fully immersed. Another study using VR is the study by Chen, Huang, Faber, Makransky and Perez-Cueto (2020). The participants

tasted the same beverage in three different VR environments while they mainly evaluated the environment and beverage liking, but also perceived flavour intensity, congruency, comfort, and environment vividness. They found a positive correlation between environmental liking and beverage liking which they explained by the 3D VR experience and not a usual 2D image. Further, the results showed that visual-taste congruence had a significant influence on the perceived intensity of sweetness but did not have any influence on product liking. They explained the insignificant results by the level of comfort.

Other studies such as the one of Huang, Huang, and Wan (2019) showed that visual cues from the virtual world and gustatory cues from the real world may be integrated to influence the perception of an actual drink when the colour were generated based on one's own crossmodal correspondence. In addition, results from Torrico et al. (2020) showed that context affected the perception of the wine's floral aroma and that emotional responses were different based on the light of the VR environment. VR can thus be used to understand contextual effects on consumer expectations, perceptions, and likability. To further contribute to the literature within this existing field of VR-experiments and multisensory research, we used the VR experience as a mean to investigate this relationship in Experiment 1, and in Experiment 2 we investigated the expectations of taste within the same environments as in Experiment 1 by using 360-degree environments on YouTube.

3. Aims

In summary, Experiment 1 focused on 1) Evaluating the role of environmental colour hue on taste perception and product preferences in VR, 2) Evaluating the role of attention as a likely mechanism that may explain such crossmodal effects. Whereas, Experiment 2 focused on 1) Evaluating the role of environmental colour hue on taste expectations and expected product preferences generated from a 360-degree environment, 2) Evaluating the role of attention as a likely mechanism that may explain such crossmodal effects. The aim of these experiments was to answer our research question: *How does changes in environmental colour hue affect taste expectations, perceptions, and product preferences at different levels of attention toward atmospheric cues?*

4. Experiment 1

4.1 Method and design

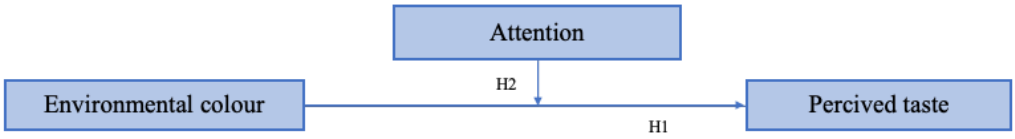
4.1.1 Quantitative research and approaches

The present study followed a quantitative approach. This approach involved several steps and went as followed; First, we decided on what we wanted to study. In this case we used the article of Spence et al. (2014) as inspiration and decided to investigate how attention moderated the effect of different environmental colour hues (red, green, and white) on perceived taste (sweet or acidic) and product experience in VR. Secondly, we came up with hypotheses which was measured by using the different variables to facilitate the finding of answers. Our hypotheses were:

H1: The red environmental colour hue in the VR will make the coffee taste sweeter, while the green environmental colour hue in the VR will make the coffee taste more acidic, relative to the other conditions.
H2: The effect that environmental colour hue has on the perceived coffee taste (sweet vs. acidic) will be enhanced for the participants that are instructed to pay attention (vs. no instructions) and conversely feel more immersed.

Model 1

Model for Experiment 1



These measures were then analysed to capture information that could help answer our hypotheses, and finally interpreted (Creswell, 2014). This can also be referred to as a deductive approach where one seeks theoretical evidence to prove or disprove a hypothesis (Greener, 2008). Further, this study used an exploratory design where the aim was to "gain new insights from which new hypotheses might be developed" (Jaeger & Halliday, 1998, p.64). As we used Spence et al.

(2014) as inspiration, we hoped for new evidence which could further contribute to the research of sensory marketing, and hopefully inspire others.

4.1.2 Participants

The experiment was conducted at BI Norwegian Business School's laboratory with a random sample of 53 participants (18 men, 34 women and 1 who preferred not to answer) at the age of 18 to 33 years old (M = 23.11, SD = 2.39), recruited through BI's internal database of participants and BI's common areas. The participants signed a consent form at the beginning of the study and were compensated with 50 NOK for taking part in the experiment. Before the experiment was conducted the participants were informed that they were participating in a coffee tasting experiment. To make the experiment as generalizable as possible the participants were randomly assigned to the between participant groups. The experiment lasted for 10 minutes and was conducted throughout three days.

The initial plan was to collect data from at least 120 participants throughout five days. However, considering that the peak of the coronavirus pandemic reached Norway during the data collection, the experiment had to stop. Yet, we agreed with our supervisor and school that we would present the preliminary findings of this experiment and also conduct a second study online to complement the preliminary findings of this study.

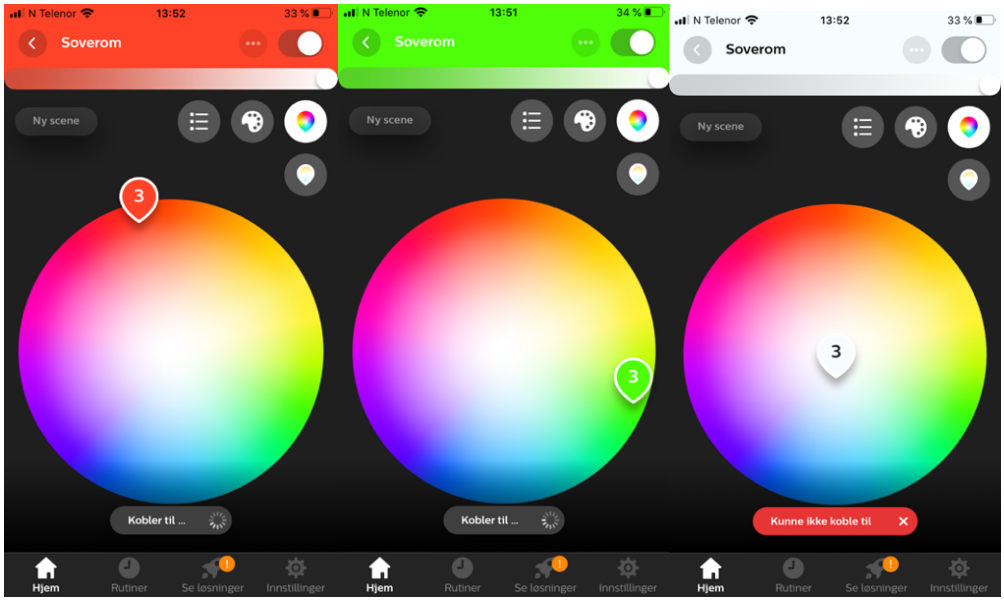
4.1.3 Apparatus and materials

During the experiment the participants used the VR headset "HD Oculus Go" (https://www.oculus.com/go/), which took them into a restaurant environment in the virtual world to make the experience as immersive as possible. The environment was recorded at Palmen at Grand Hotel (Oslo, Norway), by using a 360-degree camera (https://store.insta360.com/product/one_x?insrc=INRQH05). We used Philip Hue White and Coloured Ambiance set (https://www2.meethue.com/en-hk/p/hue-white-and-color-ambiance-starter-kit-e27/8718696725429) to capture the environmental colour hues; red, green, and white. We used the same hue and intensity, following Philips Hue app interface (see Figure 1, Panel A). The coffee contained approximately 2 ml of a nicely blended coffee from El Huabo, Peru. According to the flavour profile, the coffee

had flavour notes of mango, stone fruit, florals, jasmine, and citrus. It was also described as having great complexity and elegant finish. To ensure quality and consistency, Nordic Approach (NA) stored the coffee carefully, used good milling practices, and shipped the coffee quickly. In addition, they cupped the coffee at origin both before it was shipped and again when it arrived. To learn more about the coffee you can visit: https://hub.cropster.com/store/listings/7797.

Figure 1

Lighting conditions and the virtual environment



Note. Panel A: The lighting conditions made via the Hue app

Note. Panel B: The virtual environment recorded at the restaurant "Palmen" at Grand Hotel (Oslo, Norway) with the different light conditions in 360-degree photos.

4.1.4 Measures and scales

Given that we expected the participants to be mainly non-experts on coffee we decided to keep the questionnaire as simple and intuitive as possible. Since the experiment was conducted in collaboration with NA, not only questions about taste, but other questions about the experience of the coffee were included for exploratory purposes and to provide insight to NA. In that sense, the present research aimed to balance between furthering theory and providing practical insights to the coffee industry. We choose to use a 7-point Likert scale as done by Spence, Velasco, and Knoeferle (2014) (see Appendix 1.1). Specifically, eleven questions were included in the study. Four questions regarding the taste of the coffee; one for sweetness anchored with "not sweet at all" to "really sweet", one

for acidity anchored with “not acidic at all” to “really acidic”, one for flavour anchored with “not flavourful at all” to “really flavourful”, and one for balance anchored with “not balanced at all” to “very much balanced”. In addition, two questions regarding the experience was included; one for the enjoyment of the taste anchored with “not at all” to “very much” and one for the drink experience likeability anchored with “not at all” to “very much”. To detect any differences in temperature and to see if the temperature could be influenced by environmental colour hue, a question regarding the warmth of the coffee was included which was anchored with “very cold” to “very warm”. In addition, a question about the participants coffee experience was included which was anchored with “not experienced” to “very experienced”. All these questions were asked after being presented with each of the environmental colour hues.

Further, the following questions is common to include for measures of general purchase intention (e.g., White, MacDonnel, & Ellard, 2012) and are included for marketing purposes; one for likelihood of purchase anchored with “not likely” to “very likely”, one for first choice anchored with “not likely” to “very likely”, and one for effort of purchase anchored with “not likely” to “very likely”. The participants were also asked to write down their willingness to pay more for the cup of the coffee in NOK compared to their usual cup of coffee after being introduced to each environmental colour hue.

To measure the sense of immersion five questions were included after each environmental colour hue with the following options “strongly disagree”, “somewhat disagree”, “neither agree nor disagree”, “somewhat agree”, and “strongly agree” (e.g., Hassell, Goyal, Limayem, & Boughzala, 2009; Schubert, Friedmann, & Regenbrecht, 2001). Specifically, these questions included: the reality of the VE, the sense of acting in the VE, the experience of the VE, the sense of “being there”, and captivation.

Further, control questions were included. First, one that asked about how frequently they drink coffee in order to control for how experienced the participants was, hence to confirm that the majority were non-experts, with the different options; “I don’t drink coffee”, “a few times a week”, “few times a month”, “every day”, and “several cups a day”. In addition, we controlled for any

preferred added ingredients in the coffee since this could affect taste preferences, with the options; “milk”, cream”, “sugar”, “cinnamon”, “salt”, “alcohol”, “other”, and “I do not add anything”. Finally, the questionnaire included two questions regarding the participants age and gender.

4.1.5 Mixed experimental design

The experiment followed a 2 (higher attention vs. lower attention) x3 (red vs. green vs. white) mixed between-within experimental design, with the first factor being between participants and the second within participants. Findings found by Oberfeld et al. (2009, p.806), indicated that the use of between-subjects design might have resulted in a “low power for detecting subtle changes induced by ambient light”. In addition, within-subjects design usually have higher power since individual differences in overall rating behaviour can be controlled for in the data analysis (Oberfeld et al., 2009). Based on this, we used a mixed experimental design to capture the effect of attention and environmental colour hue on taste.

The restaurant environment was the same during the whole experiment. The duration of the experiment was around 10 minutes in order to make the effect of the environmental perception more long-lasting (Spence et al., 2014). The same two experimenters conducted the whole experiment to make the experience as similar as possible for all participants. As one participant failed to answer several questions, the participant was removed from the analysis. Hence, 52 participants were split into two groups of 26 each and all of the participants within their respective group tested all environmental colour hues. One group was instructed to pay attention extensively to the virtual environment. The instructions were as followed: “Please take an extensive look around the environment and pay as much attention as possible to the happenings and details”. The other group did not receive any instructions in that regard. The group that was asked to pay more attention to the surroundings was expected to feel more immersed.

All participants tasted the coffee under the three different environmental colour hues and then judged it by answering an anonymous questionnaire on a computer after being introduced to each environmental colour hue. To ensure no order effect and to minimize the effect of carry-over and sensitization biases (Charness, Gneezy, & Kuhn, 2012), the different groups were presented with the

environmental colour hues and questions in random order. Each environmental colour hue was randomly coded by A (red), B (green), and C (white) on the questionnaire, and the experimenters found the matching environment in the VR headset before presenting the participant with the headset. The coffee was presented in white paper cups, so the participants had limited chance to make any expectations beforehand. The experimenters provided the cup to the participants after helping them putting on the VR headset. The coffee was grinded and brewed into a can that contained 1,8L every second hour in an own room in order to minimize the smell inside the laboratory. Both the coffee and the equipment were provided by Nordic Approach (Oslo, Norway).

4.2 Analyses and results

A Mann-Whitney U test was conducted on each control variable to compare differences between the group that was instructed to pay attention and the group that did not get such instructions. Medians for the control variables was conducted as well. To measure internal consistency in the immersion- and purchase intent scale, a Cronbach's alpha was calculated on the Likert questions for all the environmental colour hues. Following a mixed experimental design, a mixed design analysis of variance (ANOVA) with environmental colour hue as within-participants factor (three levels: red, green, and white), attention as between-participants factor (two levels: no attention and attention), and taste ratings as a dependent variable was conducted. An additional analysis was conducted with immersion as the dependent variable. For the significant interactions simple main effects were interpreted, while for the non-significant interactions main effects were interpreted. A univariate general linear model was conducted to generate simple main effects for the between-subjects variable. After organizing the output by groups, a repeated measures ANOVA was computed to generate simple main effects for the within-subjects variable. Further, significant simple main effects and significant main effects were analysed through pairwise comparisons and Bonferroni-corrected. Whenever sphericity was violated, Greenhouse-Geisser corrected values are presented. In order to evaluate the multidimensional coffee drinking experience, the following variables were analysed ("flavourful", "sweet", "acidic", "balanced", "warm", "enjoyment of taste", "drink experience likeability", "likelihood of purchase", "first choice", "effort of purchase", and "willingness to pay more").

4.2.1 Control variables

A Mann-Whitney U test was run separately for each of the control variables "how much experience the participant had with coffee", "how often the participant drank coffee", "what the participants adds in their coffee", "gender", and "age". For the "experience" variable an average variable including all the environmental colour hues was made in order to conduct the test. Distributions of the mean scores for the group that was instructed to pay attention and the group that got no such instruction were similar for all variables, as assessed by visual inspection. In addition, none of the scores had a statistically significant difference between the groups (see Appendix 2.1).

4.2.2 Immersion

The scale of immersion, which consisted of five questions, had a high level of consistency for each environmental colour hue, as determined by Cronbach's alphas of .854 (red), .900 (green), and .914 (white). Three average immersion variables were made for each environmental colour hue, in order to conduct our first mixed design analysis of variance (ANOVA). There was no statistically significant interaction between the different environmental colour hues and how much attention the participants were asked to pay on how immersed the participants felt. In addition, the main effect of environmental colour hue did not show any statistically significant difference in how immersed the participants felt in the different coloured VR atmospheres. However, the main effect of attention showed a statistically significant difference in how immersed the participants felt (see Table 1). The immersion scores were higher for the group instructed to pay attention to the atmosphere ($M = 5.54$, $SD = .21$), relative to the group without instructions ($M = 4.80$, $SD = .21$, $p = .017$) (see Appendix 2.2). This confirms that our manipulation was successful.

Table 1

Interaction and main effects of immersion in Experiment 1.

Immersion	F-value	p-value	Partial eta squared
Interaction	1.52	.226	.029
Environmental colour hue	1.60	.209	.031
Attention	**6.06**	**.017**	**.108**

Note: Significant values are highlighted in bold

4.2.3 Dependent variables

The scale of purchase intention, which consisted of three questions, had a high level of consistency for each environmental colour hue, as determined by Cronbach's alphas of .912 (red), .898 (green), and .839 (white). We intended to include "willingness to pay more", however the Cronbach's alpha tests showed too low values when this question was included as it was .168, .180, and .134 for the red, green, and white environmental colour hue, respectively. To ensure internal consistency this question was thus excluded from the "purchase intention" variable. Three average purchase intention variables were made for each environmental colour hue. We then conducted our second mixed design analysis of variance (ANOVA).

4.2.3.1 **Interaction and main effects**

There was a statistically significant interaction between environmental colour hue and attention on perceived balance, enjoyment of taste, and drink experience likeability. There were no other statistically significant interactions on any of the other dependent variables. Environmental colour hue had a statistically significant main effect on how flavourful the coffee was perceived. In addition, the main effect of attention was statistically significant for how flavourful and sweet the coffee was perceived. There were no other statistically significant main effects of environmental colour hue and attention on any of the other dependent variables (see Table 2).

Table 2

Interaction and main effects in Experiment 1.

Measure	Interaction			Environmental colour hue			Attention		
	F-value	p-value	Partial eta squared	F-value	p-value	Partial eta squared	F-value	p-value	Partial eta squared
Flavourful	1.43	.245	.028	**3.95**	**.022**	**.073**	**8.03**	**.007**	**.138**
Sweet	.30	.738	.006	.02	.985	<.001	**6.45**	**.014**	**.114**
Acidic	.34	.714	.007	.53	.592	.010	.01	.910	<.001
Balanced	**4.72**	**.015**	**.086**	**4.17**	**.023**	**.077**	3.22	.079	.060
Warm	1.97	.145	.038	.77	.465	.015	.78	.382	.015
Enjoyment of taste	**3.41**	**.037**	**.064**	1.03	.361	.020	.17	.682	.003
Drink experience likeability	**4.62**	**.012**	**.085**	**3.64**	**.030**	**.068**	.001	.972	<.001
Purchase intention	1.50	.228	.029	2.58	.081	.049	.24	.630	.005
Willingness to pay more	2.02	.138	.039	1.19	.308	.023	.01	.915	<.001

Note: Significant values are highlighted in bold

All pairwise comparisons were run for each statistically significant main effect with reported 95% confidence intervals and p-values. The flavourful scores for the coffee tasted in the red atmosphere were lower (M = 3.52, SD = .24), relative to the coffee tasted in the white atmosphere (M = 4.15, SD = .21, p = .025). The other pairwise comparisons did not show a statistically significant different flavourful score (see Appendix 2.3).

The flavourful scores were higher for the group instructed to pay attention to the atmosphere (M = 4.22, SD = .23), relative to the group without instructions (M = 3.31, SD = .23, p = .007). The sweet scores were also higher for the group

instructed to pay attention to the atmosphere (M = 2.90, SD = .22), relative to the group without instructions (M = 2.10, SD = .22, p = .014) (see Appendix 2.4).

4.2.3.2 Simple main effects of attention level at each atmosphere level

Attention had an effect on how balanced the coffee was perceived when it was tasted in the green atmosphere (see Table 3). The balanced scores for the coffee tasted in the green atmosphere were higher for the group instructed to pay attention to the atmosphere (M = 4.19, SD = .26), relative to the group without instructions (M = 2.85, SD = .26, p = .001). There were no other statistically significant pairwise comparisons (see Appendix 2.5).

Table 3

Simple main effects of attention level at each atmosphere level in Experiment 1.

Source	Environmental colour hue	Measure	F-value	p-value	Partial eta squared
Attention	Red	Balanced	<.001	>.999	<.000
		Enjoyment of taste	.76	.387	.015
		Drink experience likeability	.61	.437	.012
	Green	Balanced	**13.79**	**.001**	**.216**
		Enjoyment of taste	3.71	.060	.069
		Drink experience likeability	3.86	.055	.072
	White	Balanced	.82	.370	.016
		Enjoyment of taste	.007	.931	<.001

Drink experience likeability	1.42	.239	.028

Note: Significant values are highlighted in bold

4.2.3.3 Simple main effects of environmental colour hue at each attention level

Environmental colour hue had an effect on how balanced the coffee was perceived and the drink experience likeability for both attention groups. In addition, environmental colour hue had an effect on how much the participants that was instructed to pay attention, enjoyed the taste (see Table 4).

Table 4

Simple main effects of atmosphere level at each attention level in Experiment 1.

Source	Measure	No instructions			Instructions		
Environmental colour hue		F-value	p-value	Partial eta squared	F-value	p-value	Partial eta squared
	Balanced	**4.37**	**.018**	**.149**	**4.56**	**.026**	**.154**
	Enjoyment of taste	1.16	.323	.044	**3.35**	**.043**	**.118**
	Drink experience likeability	**4.52**	**.016**	**.153**	**3.78**	**.030**	**.131**

Note: Significant values are highlighted in bold

The balanced scores were lower for the coffee tasted in the green atmosphere (M = 3.85, SD = .26), relative to the coffee tasted in the white atmosphere for the group without instructions (M = 3.89, SD = .31, p = .017). The other pairwise comparisons did not show a statistically significant different balanced score. The drink experience likeability scores were lower for the coffee tasted in the green atmosphere (M = 3.77, SD = .37), relative to the coffee tasted in the white atmosphere for the group without instructions (M = 4.85, SD = .29, p = .021). The other pairwise comparisons did not show a statistically significant different drink experience likeability score for the group that did not receive instructions (see Appendix 2.6).

The enjoyment of taste scores was lower for the coffee tasted in the red atmosphere (M = 3.35, SD = .34), relative to the coffee tasted in the green atmosphere for the group instructed to pay attention (M = 4.27, SD = .34, p = .050). The other pairwise comparisons did not show a statistically significant different enjoyment of taste score. The drink experience likeability scores were lower for the coffee tasted in the red atmosphere (M = 3.65, SD = .33), relative to the coffee tasted in the green atmosphere for the group instructed to pay attention (M = 4.73, SD = .32, p = .031). The other pairwise comparisons did not show a statistically significant different drink experience likeability score for the group that received instructions (see Appendix 2.7).

4.3 Discussion

The results showed that the different coloured VR atmospheres, in which the participants tasted the coffee, did not exert a significant influence over their perceived taste ratings (sweet or acidic) of coffee. However, there was evidence that the participants that were instructed to pay attention felt more immersed compared to the group that got no such instructions. This showed that our manipulation of attention was successful as it led to different levels of immersion. Hence, there was an optimal level of presence for the participants which led to a greater feeling of immersion (Loureiro et al., 2019).

In addition, first, the participants found the coffee to be more flavourful in the white atmosphere compared to the red atmosphere. Second, the group that was instructed to pay attention found to the coffee to be both more flavourful and sweeter compared to the group that got no such instructions. Third, the group that was instructed to pay attention to the atmosphere found the coffee to be more balanced when tasted in the green atmosphere compared to the group that got no such instructions. They also enjoyed the taste and liked the drink experience more in the green atmosphere compared to the red atmosphere. On the other hand, the group that got no such instructions liked the drink experience more in the white atmosphere compared to the green atmosphere.

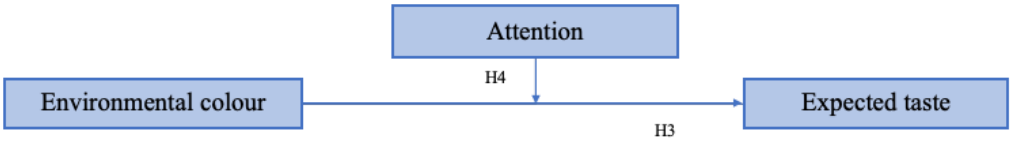
When interpreting the results of Experiment 1, it is important to bear in mind

that this experiment needed to be cancelled due to the coronavirus pandemic, and hence was analysed based on a much smaller sample size than the one intended. These results should be carefully replicated and extended before drawing any definitive conclusions. Considering the pandemic and the options available, Experiment 2 was conducted with a larger sample size, but with expectations rather than perception as the focus (the experiment had to be conducted digitally), in order to better explain the results obtained from Experiment 1. Whilst perception and expectations are not the same (e.g., Piqueras-Fiszman & Spence, 2015; Woods, Poliakoff, Lloyd, Dijksterhuis & Thomas, 2010) research has showed that how colour influence taste expectations parallels with how colour influence taste perceptions (Velasco et al., 2016). That is, the perception of the product is not only based on the sensory characteristics but is often biased by previous judgements and ideas about product properties (Schifferstein, 2001). For this reason, and considering the limitations imposed by the coronavirus pandemic, we moved on to evaluate consumers' expectations by presenting the recordings in 360-degree videos on YouTube (so called "drag and drop"). This type of technology is often used in, for instance, the online fashion industry (Shankar, Inman, Mantrala, Kelley, & Rizley, 2011), on Facebook where companies let the consumer investigate a specific environment often in combination with competitions, and video games. This technology, together with VR, is supposed to make the digital environment more real, and make the user more immersed relative to 2D images (Hebbel-Seeger, 2017). With this in mind, the hypotheses for Experiment 2 were:

H3: The red environmental colour hue in the 360-degree environment will increase the expectation that the coffee tastes sweeter, while the green environmental colour hue in the 360-degree environment will increase the expectation that the coffee taste more acidic, relative to the other conditions.
H4: The effect the environmental colour hues have on the expected coffee taste (sweet vs. acidic) will be enhanced for the participants that are instructed to pay attention (vs. no instructions) and conversely feel more immersed.

Model 3

Model for Experiment 2



5. Experiment 2

5.1 Participants

The experiment was conducted online over a period of one day with a random sample of 119 participants (51 men and 68 women) at the age of 18 to 74 years (M = 33.15, SD = 11.87) recruited through prolific.co. All participants agreed to take part in this experiment by signing a consent form at the beginning of the study. All participants were compensated with £0.8 for taking part in the experiment.

5.2 Apparatus and materials

Experiment 2 was similar to Experiment 1. However, it was conducted online using 360-degree environments as a tool to look at how attention moderated the effect between coloured lights and product expectations. The same 360-degree images as in Experiment 1 was used and turned into a 360-degree video format by using iMovie to transform the file into a .mp4 file, and then downloaded as a metadata insertion file by using Spatial Media Metadata Injector (https://github.com/google/spatial-media/releases/tag/v2.1?fbclid=IwAR1qDLCzETsZ3Hdz_VHKKdFJtwNNZvrNq2-01fq_Fu8qNSeilCFmDBlWmVA). The 360-degree videos were then uploaded to YouTube where the link was inserted into the questionnaire on Qualtrics.

5.3 Method and design

We used the same experimental design as in Experiment 1, and the duration of the experiment was approximately seven minutes. The 119 participants were split into two groups of 60 (instructions) and 59 (no instructions) each and all participants evaluated their expectations about coffee in all environmental colour

hues. The questionnaire followed the same format and questions as in Experiment 1. However, the questions were formulated different in order to capture the expectations of the participants instead of perceptions (see Appendix 1.2). First, eleven questions were included in the study. Four questions regarding the expected taste of the coffee; one for expected sweetness, one for expected acidity, one for expected flavour, and one for expected balance. In addition, two questions regarding the expected experience was included; one for the expected enjoyment of the taste and one for the expected drink experience likeability. One question regarding the expected temperature of the coffee was included as this may contribute to the literature on how colour can influence the expectations of temperature prior to consumption. In addition, a question about the participants coffee experience was included. All these questions were asked after being presented with each of the lighting conditions. Further, one question about expected likelihood of purchase, one for expected first choice, and one for expected effort of purchase was included. These are later referred to as "purchase intent", as in Experiment 1.

To measure the sense of immersion the same five questions as in Experiment 1 were included after each light condition. Further, the same control questions as in Experiment 1 and the participants expected willingness to pay more for the cup of the coffee in NOK compared to a normal cup of coffee, were included at the end of the questionnaire.

5.4 Analysis and results

The analyses were performed exactly as set out in Experiment 1, but with expectations as the dependent variable instead of perceptions. The same was also done for the purchase intention questions as described in Experiment 1. The Cronbach's alphas for the red, green, and white purchase intention variables were .833, .846, and .819, respectively.

5.4.1 Control variables

A Mann-Whitney U test was run separately for each of the control variables "how much experience the participant had with coffee", "how often the participant drank coffee", "what the participant adds in their coffee", "gender",

and “age”. For the “experience” variable an average variable, including all light conditions, was made in order to conduct the test. In addition, the question regarding “what the participants add in the coffee” was made a multiple-choice question in Experiment 2. Therefore, a separate test was conducted for each alternative. Medians for the control variables was also conducted. Distributions of the mean scores for attention and no attention were similar for all variables, as assessed by visual inspection. In addition, none of the scores had a statistically significant difference between the groups (see Appendix 3.1).

5.4.2 Immersion

The scale of immersion, which consisted of five questions, had a high level of consistency for each environmental colour hue, as determined by Cronbach’s alphas of .867 (red), .839 (green), and .888 (white). Three average immersion variables were made for each environmental colour hue, in order to conduct our first mixed design analysis of variance (ANOVA). The results showed that there was no statistically significant interaction between the environmental colour hues in the 360-degree environment and how much attention the participants were asked to pay on how immersed the participants felt. The main effect of environmental colour hue and attention did not show any effect on how immersed the participants felt (see Table 5). Hence, our manipulation was not successful.

Table 5

Interaction and main effects for Experiment 2.

Immersion	F-value	p-value	Partial eta squared
Interaction	1.57	.210	.013
Environmental colour hue	1.65	.194	.014
Attention	.09	.772	.001

5.4.3 Dependent variables

There were no statistically significant interactions between the different environmental colour hues in the 360-degree environment and how much attention the participant were asked to pay on any of the other dependent variables. The main effect of environmental colour hue showed a statistically

significant difference in expected warmth of the coffee and the expected drink experience likeability. There was no other statistically significant main effect of environmental colour hue nor attention on any of the other dependent variables (see Table 6).

Table 6

Interaction and main effects for experiment 2

	Interaction			Environmental colour hue			Attention		
Measure	F-value	p-value	Partial eta squared	F-value	p-value	Partial eta squared	F-value	p-value	Partial eta squared
Flavourful	.08	.925	.001	2.01	.125	.018	<.001	.986	<.001
Sweet	1.09	.337	.009	1.02	.363	.009	1.05	.307	.009
Acidic	1.48	.230	.013	1.57	.212	.013	.05	.819	<.001
Balanced	.09	.898	.001	.31	.713	.003	2.02	.158	.017
Warm	.54	.566	.005	**8.38**	**<.001**	**.067**	.48	.488	.004
Enjoyment of taste	.02	.981	<.001	.26	.775	.002	.27	.604	.002
Drink experience likeability	.76	.460	.006	**7.52**	**.001**	**.060**	.21	.645	.002
Purchase intention	1.09	.334	.009	2.66	.075	.022	.470	.494	.004

Note: Significant values are highlighted in bold

All pairwise comparisons were run for each statistically significant main effect with reported 95% confidence intervals and p-values. The warm scores for the coffee tasted in the green 360-degree environment were lower (M = 5.79, SD = .13), relative to the coffee tasted in the white 360-degree environment (M = 6.10 SD = .11, $p < .001$). The other pairwise comparisons did not show a statistically significant different warm score. The drink experience likeability scores for the coffee tasted in the green 360-degree environment was lower (M = 3.88, SD =

.17), relative to the coffee tasted in the white 360-degree environment (M = 4.31 SD = .19, p = .002). The other pairwise comparisons did not show a statistically significant different drink experience likeability score (see Appendix 3.2).

5.4.4 Willingness to pay more

The "willingness to pay more" question was only included in the questionnaire as an individual question and not after being exposed to each environmental colour hue, as set out in Experiment 1. This was mainly done as a mistake. The descriptive statistics showed that the mean score for how much more the participants were willing to pay was £1.45 (SD = 1.83). When comparing the means of willingness to pay more and the manipulation variable, attention, the results showed that those who were instructed to pay attention were willing to pay £1.50, while the group that got no such instructions were willing to pay £1.41 (see Appendix 3.3).

5.5 Discussion

The results showed that the different environmental colour hues in the 360-degree environment from which the participants generated the coffee expectations, did not exert a significant effect over their expected taste ratings (sweet or acidic) of the coffee. In addition, the results did not show a significant effect on the participants taste expectations and how immersed they felt. Hence, our manipulation for this type of digital environment was unsuccessful. As stated in the literature review, for immersion to be effective, a user must be able to explore what appears to be a life-sized VE and be able to change perspectives seamlessly (Strickland, 2007). The credibility of the virtual scenario is determined by the impression of being in the virtual world and user's interaction in real time (Ruotolo et al., 2013). In this experiment the lack of being in the virtual world and low level of interaction made this manipulation weak. This can also be seen by significant results of immersion in VR and by higher immersion ratings in the VR environment (see Table 7) compared to the 360-degree environment.

However, the results showed that the participants expected the coffee to be warmer and liked the drink experience more after looking at the white 360-degree environment compared to the green 360-degree environment. This is proof that

environmental colour hue can influence the expected drinking expectations. Finally, the participants that were instructed to pay attention to the atmosphere were willing to pay more compared to those who did not get such instructions. Paying more attention is showed to exert a greater stimulus selection, stimulus enhancement, feature binding, and recognition (Evans et. al., 2011). Hence, paying more attention to the surroundings may make people pay more because the experience becomes greater and better (Homburg, Koschate, & Hoyer, 2005).

6. General discussion and implications

The aims of the experiments were to evaluate the role of environmental colour hue on coffee taste expectations and perceptions, and also to explore attention as a possible underlying mechanism for the crossmodal effect. The results do not support the findings of Spence et al. (2014). However, as our results in Experiment 1 mainly showed lower ratings in the red atmosphere compared to the green atmosphere this can be supported by the mechanism between emotional valance and colour where red signals negative valence and danger/loss, which has been linked to avoidance behaviour in humans (Elliot, Maier, Moller, Friedman, & Meinhardt, 2007), while green has been associated with positive valence, gains, and approach behaviour (e.g., Mammarella, Di Domenico, Palumbo, & Fairfield, 2016; Spence et al., 2014).

Table 7 show that the overall flavour of the coffee was perceived as more acidic than sweet in Experiment 1. Initially, we though the coffee would be balanced in terms of sweetness and acidity (based on the flavour profile), something which we wanted in order to give more "room" for environmental colour hue to disambiguate the expected and perceived taste of the coffee. Yet, it appeared that the coffee was more acidic than we expected. However, in Experiment 2, we saw that generally (based on expectations) there was a higher overall sweet score compared to the overall acidic score. In general, Experiment 2 generated higher ratings compared to Experiment 1 which means that the expectations exceeded the perceptions. This may be explained by the participants having too high expectations towards the coffee prior to tasting, and when the environmental colour hue did not match the taste, this led to negatively valanced disconfirmation

of expectation (e.g., Carlsmith & Aronson, 1963; Spence, 2015a; Zellner, Strickhouser, & Tornow, 2004).

Table 7

Std. deviations and means of the different attributes in both experiments

	Experiment 1: Perceptions		Experiment 2: Expectations	
Measure	Std. deviation	Mean	Std. deviation	Mean
Flavourful	1.24	3.76	1.24	5.58
Sweet	1.19	2.50	1.68	3.86
Acidic	1.21	3.90	1.50	3.10
Balanced	1.16	3.68	1.17	5.11
Warm	.89	5.87	1.19	6.00
Enjoyment of taste	1.33	3.78	1.88	4.06
Drink experience likeability	1.29	4.22	1.87	4.10
Purchase intention	3.27	1.23	4.32	1.60
Willingness to pay more	18.25	19.90 (NOK)	1.83	£1.45

6.1 Expectations and perception in the customer experience

As we can see from Table 8, there are a few statistically significant effects in both experiments that can be compared with one another. This may be caused by the difference in measuring expectations and perceptions, as well as the technology used to present the atmospheres. As this study have measured sensory, hedonic, and market related variables, we can contribute to the understanding the customer experience in the pre-purchase and post-purchase stage as expectations and perceptions are generated in these stages, respectively.

Today, creating a strong customer journey is really important from a managerial perspective because of the increasing interaction between firms and customers through myriad touch points in multiple channels and medias. Customers are also more social in nature, and each customer are influencing experiences alone (Lemon & Verhoef, 2016). The customer experience is being described by De Keyser, Lemon, Klaus, and Keiningham (2015, p. 23) as

"comprised of the cognitive, emotional, physical, sensorial, spiritual, and social elements that mark the customer's direct or indirect interaction with (an)other market actor(s)".

The first stage in the customer journey is the pre-purchase stage which involves customer's interaction with the product, category, and environment before a purchase transaction (Lemon & Verhoef, 2016), and involves expectations and satisfaction. Expectations have been seen as predictors of product performance which will occur in some future period (e.g., De Lange, Heilbron, & Kok, 2018; Wu, Liao, Hung, & Ho, 2012; Zeithaml, Berry & Parasuraman, 1993) and can be defined as "belief elements in a cognitive structure" (Olson & Dover, 1976, p. 169). In Experiment 2 we studied expectations of the different sensory, hedonic, and market-related variables. The results showed that in the white 360-degree environment coffee was expected to feel warmer and the customer was expecting to like the drinking experience more compared to the green 360-degree environment. These results can be explained based on a too acidic coffee which can lead to avoidance and disgust (e.g., Herbert, Platte, Wiemer, Macht, & Blumenthal, 2014; Macht & Mueller, 2007), or that the illuminance was too weak for the participants in the green atmosphere leading to a less comfortable drinking experience (Boyce & Cuttle, 1990; Manav, 2007). An emerging body of empirical research has recently started to demonstrate the impact of even modest changes in ambient temperature on the food and beverage choices that are made, not to mention our satisfaction in the consumption experience (Andersen, Kraus, Ritz, & Bredie, 2019; Ho, Iwai, Yoshikawa, Watanabe, & Nishida, 2014). The results from Experiment 2 can further contribute to this body of literature as to how environmental colour hue can influence expectations of beverage temperature and drinking experience likeability. Hence, managers of coffee should especially focus on the expectations of beverage temperature and also how the drink experience can be made best in order to get the most satisfied customers. As Experiment 1 did not show evidence of environmental colour hue influencing beverage temperature, this might be due to the different experimental settings where the experimenters in Experiment 1 was able to control and hold the warmth of the coffee constant. Hence, there still might be some influence of environmental colour hue and attention on how warm the coffee is perceived when this is not controlled for.

The last stage in the customer journey is the post-purchase stage, which consists of interaction with the product and its environment after the actual purchase (Lemon & Verhoef, 2016), and is based on perceptions of the product. The results from Experiment 1 indicate that many aspects are important to consider during this stage. First, the white VR atmosphere made the coffee seem more flavourful compared to the red VR atmosphere. This might be because in the red atmosphere participants expected the coffee to taste sweet, however, the characteristics of the coffee was more acidic causing the participants to be confused and experiencing negatively valanced disconfirmation of expectations (Spence, 2015a) and hence experience the flavour as better in a neutral white atmosphere. Second, as the participants paid more attention to the atmosphere, the coffee was perceived as both more flavourful and sweeter. Since coffee is considered a complex product (Sunarharum, Williams & Smyth, 2014) it needs more attention to detect flavour (e.g., Lavie, 1995, 2005). Therefore, the attention manipulation may have made the coffee be perceived as more flavourful and sweeter. Third, the green VR atmosphere made the participants that was instructed to pay attention to perceive the coffee as more balanced compared to the other environments, and also enjoyed the taste more and liked the drink experience more compared to the red atmosphere. Spence et al. (2014) found that sour music affected the green atmosphere making the wine tasting fresher and less intense. These findings may help explain that the combination of a strong perceived acidic flavour and much attention, hence increased stimuli selection (Lavie, 1995, 2005), in the green environment, led to enhanced overall flavour and pleasant drink experience. On the other hand, the white VR atmosphere made the participants that got no such instructions to like the drink experience more compared to the green atmosphere. As less attention is showed to decrease our capability to select stimuli (Evans et al., 2011), this may have made the participants more relaxed (Scheufele, 2000) and hence liked the drinking experience more in the white atmosphere.

In order for managers to make the customers as satisfied as possible it is important to invest money and time to get the right environment. As being told to pay attention to the surroundings when making perceptions about coffee made the participants feel more immersed, managers should also invest in practices that

make the customer aware of their surroundings during consumption and not before as Experiment 2 did not show such evidence for expectations. Often marketers of restaurants or cafés portrays their environment in advertising to create expectations of a good experience when visiting. However, our results showed that doing so during the customer visit and consumption will complement the overall experience. Hence, the results of Experiment 1 can further contribute to the body of literature within immersive experiences and sensory marketing as it showed evidence of higher attention leading to higher immersion.

Table 8

Comparison of interaction and main effects between Experiment 1 and Experiment 2

Attributes	Interaction		Environmental colour hue		Attention	
	Exp. 1	Exp. 2	Exp. 1	Exp. 2	Exp. 1	Exp. 2
Flavourful	**No**	**No**	Yes	No	Yes	No
Sweet	**No**	**No**	**No**	**No**	Yes	No
Acidic	**No**	**No**	**No**	**No**	**No**	**No**
Balanced	Yes	No	Yes	No	**No**	**No**
Warm	**No**	**No**	No	Yes	**No**	**No**
Enjoyment of taste	Yes	No	**No**	**No**	**No**	**No**
Drink experience likeability	Yes	No	**Yes**	**Yes**	**No**	**No**
Purchase intention	**No**	**No**	**No**	**No**	**No**	**No**
Immersion	**No**	**No**	**No**	**No**	Yes	No

Note: Yes, if significant. No, if not significant. Those effects that were significant in both experiments are highlighted in bold.

6.2 Virtual reality and future marketing

This study showed that attributes of the virtual environment, such as environmental colour hue affects sensory variables. It is predicted that VR is going to have a big impact on the future of marketing, especially within industries such as retail, tourism, education, healthcare, entertainment, and research (Flavián

et al., 2019). It is also predicted that the value of VR devices sold is going to increase form US $1.5 billion in 2017 to US $9.1 billion by 2021 (CCSInsight, 2017). From this information one may draw the conclusion that VR is something that will be a key factor in several industries such as marketing. The fact that VR is becoming normalized, makes it fair to predict that people may want to act similar in a VR setting as in a real environment setting. For instance, enjoying coffee inside a virtual environment before purchase, socializing in a virtual environment while drinking a cup of coffee remotely with others, or in-store immersive experiences as in cafe's, restaurants, bars etc.

Some advantages with VR are, first, that it has the ability to give the user the true feeling of product ownership while demonstrating the product in true time, using user-defined parameters without having to ship the product home to the user. This makes it easier to enhance decision making as it makes prototyping and test factors easier for companies, as well as realize costs and time savings. Second, through sensory immersion, VR makes it possible to emotionally involve the user with the product (Ryan, 2001). Our study showed that by using different environmental colour hues in a virtual environment the perceived intensity of flavour of the coffee was influenced. Further, by increasing the customers attention and thereby their sense of immersion it is possible to influence how flavourful and sweet the beverage is perceived. In addition, by increasing the customers attention in combination with different environmental colour hues one can make the customers enjoy the coffee taste more as well as make the drinking experience better for the customers. By contrast, it is possible to make the drinking experience better by lowering the customers attention in combination with a white atmosphere. By using different environmental colour hues in a virtual environment one can also influence customers expected warmth of the beverage and their drink experience likeability.

On the other hand, VR tools can be very expensive, nevertheless, moving into the future, there is a good chance that the prices on such tools will decrease. Further, there are high expectations connected to VR and therefore marketing programs which if not measures up to the high standards may be unsuccessful. VR is not suitable in every situation or for every product category, however it is found

to be suited for products that requires a lot of interaction (Ryan, 2001) such as, for instance, beverage consumption, food consumption, and electronics.

7. Limitations and future research

Although our first experiment did not get as many significant results as hoped for when initially starting the experimental period, the experiment did still open for some interesting findings. As the biggest limitation for Experiment 1 was that we had to shut down the experiment early due to the coronavirus pandemic, future research may thus want to do the experiment in VR with a larger sample size to see if this will alter the results and give an even wider picture of how the variables connect with each other.

There are two characteristics that determine the sense of credibility of a virtual scenario, 1) Users are surrounded by the virtual environment and get the impression of being in the virtual world, and 2) Users can interact in real time (Ruotolo et al., 2013). Because Experiment 1 only fulfilled the first characteristic, this could reduce the participants sense of credibility of the virtual scenario. Hence, having a video instead of a picture where there is true motion inside the virtual environment, may make the user feel more present and immersed. While conducting Experiment 1 several participants commented on the person in the white atmosphere. This could have altered the results, and thus, made the participants pay extra attention to this environment. Another way to increase the credibility of the virtual environment is to simulate the person holding the coffee cup and moving the cup inside the VR environment. However, this would require more advanced technology, software and computer knowledge to be able to execute. The article of Rosa, Hürst, Vos, and Werkhoven (2015) explain different approaches to make the virtual scenario more real.

It is several possibilities to extend the research in order to gain more generalizable results and to contribute extensively to the multisensory research. First, one can conduct a new study which include other or more environmental colour hues such as blue and yellow which has been shown to be associated with salty and sour, respectively (e.g. see, O'Mahony, 1983; Saluja & Stevenson, 2018). Second, one can conduct the same experiment in another type of

environment such as a café, bar, or even a gym, and also use another type of products such as soda, biscuits, or energy drink to see if the results are comparable. At last, in order to gain more control over the environmental colour hues, one can conduct an experiment which controls for the hue, brightness and saturation. Researchers have reported that those who liked strong coffee tended to drink more under brighter ambient illumination conditions, whereas those who preferred weaker coffee tend to drink more under dimmer illumination (Spence, 2013). In our experiments the amount participants drank was not controlled for. Hence, controlling for this under different environmental colour hues may also influence the perceived taste, and is open for further investigation.

Previous research has also showed that expectations and perception of taste may differ across cultures (e.g. see, Van Doorn et al., 2017; Wright, Nancarrow, & Kwok, 2001). In both of these experiments people from different nations and cultures participated which may explain some of the results depending on where the majority of the participants came from. Unfortunately, we did not control for country of origin, however, there might be interesting to look at possible effects that may explain, for instance, why the majority of participants enjoyed the taste of coffee better in the white atmosphere. Hence, if the variables are affected by cultural differences.

Some studies have proven that how comfortable the participants are and how warm the environment is, affects the results between visual-taste congruence and product liking (Motoki, Saito, Nouchi, Kawashima, & Sugiura, 2018, 2019; Nouchi, Petit & Sieffermann, 2007). We did not control for this; thus, it could be interesting to further test how comfortable the participants are in order to contribute to the multisensory research. Further, research from the Crossmodal Research Laboratory (CRL) in Oxford, conducted together with Givaudan (one of the world's largest flavour houses), has demonstrated that whether or not a given colour, added to a food or beverage, affects a person's taste/flavour perception depends critically on the meaning that the person associate with food and drinks having that colour (e.g. see, Spence, 2013; Spence, 2015b; Wang et al., 2019, for review). Consequently, one need to know what expectations a consumer has in order to predict what they likely will experience when a particular colour is added to a given food or beverage in the marketplace. Therefore, by combining the two

experiments, one can investigate the participants expectations before making predictions on taste. In our case there might also be that we chose colours that were not typical in the context of coffee drinking, and hence the participants were not able to relate to those colours.

8. Conclusion

Environmental colour hue has showed to have an effect on taste perceptions and drink experience. In Experiment 1 there was evidence of environmental colour hue affecting how flavourful the coffee was perceived. There was also evidence of attention affecting how flavourful and sweet the coffee was perceived. In addition, there was evidence that environmental colour hue and attention in combination would affect how much the participants enjoyed the coffee taste and the drinking experience, as well as how balanced the coffee was perceived. Experiment 1 also had a successful manipulation of attention which lead to higher immersion ratings for the group that got instructions to pay attention. While in Experiment 2 the results showed that environmental colour hue affected how warm the coffee was expected to be and the expected drink experience in the different environmental colour hues. As Experiment 1 had to be cut short because of the Coronavirus pandemic, further research is needed to detect other possible variables that may affect the perception of these sensory, hedonic, and market related variables as investigated in this paper. However, the results of both experiments can further contribute to the understanding of management of the customer experience and multisensory research in virtual environments.

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