The role of expectations in improving consumers' oral and post-ingestive experience in the context of regular and non-alcoholic beer

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Thesis Submitted for the degree of Doctor of Philosophy

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May 2022

Declaration

The work in this thesis is presented in an 'article format' in which the 4 middle chapters consist of discrete articles written in a style that is appropriate for publication in peer-reviewed journals in the field. The first and final chapters present synthetic overviews and discussion of the field and the research undertaken.

Paper 1 is published in the journal *Food Quality and Preference* as:

Blackmore, H., Hidrio, C., Godineau, P., & Yeomans, M. R. (2020). The effect of implicit and explicit extrinsic cues on hedonic and sensory expectations in the context of beer. *Food Quality and Preference*, *81*(July 2019), 103855. https://doi.org/10.1016/j.foodqual.2019.103855

Paper 2 is published in the journal *Food Quality and Preference* as:

Blackmore, H., Hidrio, C., & Yeomans, M. R. (2021). A taste of things to come: The effect of extrinsic and intrinsic cues on perceived properties of beer mediated by expectations. *Food Quality and Preference*, 104326. https://doi.org/10.1016/j.foodqual.2021.104326

Paper 3 is published in the journal *Food Quality and Preference* as:

Blackmore, H., Hidrio, C., & Yeomans, M. R. (2022). How sensory and hedonic expectations shape perceived properties of regular and non-alcoholic beer. *Food Quality and Preference*, *99*, 104562. https://doi.org/10.1016/j.foodqual.2022.104562

Contributions from all authors are noted in the relevant chapters. The thesis author was responsible for the main study design, execution, analysis, and manuscript writing, across all studies. Co-authors provided commentary.

I hereby declare that this thesis has not been and will not be, submitted in whole or in part to another University for the award of any other degree.

Signature: H. Blackmore

Acknowledgements

The research in this thesis was made possible by the ***Fund Baillet Latour***. I am thankful for the funding and the opportunities it provided.

I would also like to thank the anonymous reviewers who took the time to read and comment on my work, allowing me to strengthen and improve it.

My gratitude also extends to ***Kallina Perrou***, who assisted me with data collection for one of the studies. You made my life so much easier!

Above all, I would like to thank ***Prof. Martin Yeomans*** for his constant support, enthusiastic encouragement, insightful advice, and unwavering optimism. It meant the world to me.

Finally, I would like to thank my husband ***Dennis***, who never complained about my workload Thank you for not questioning my dedication or doubting my abilities.

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Thesis summary

The role of expectations in improving consumers' oral and post-ingestive experience in the context of regular and non-alcoholic beer

What we experience is influenced not only by sensory inputs, but also by expectations. This thesis investigates, explains, and quantifies the relationship between product-related cues, expectancies, and consumers' oral and post-ingestive experience in the context of regular and non-alcoholic beer.

The first study, a series of four online experiments, investigated the role of extrinsic and intrinsic cues in the generation of expectancies. Overall, implicit cues such as design and colour were less effective in generating expectations than explicit cues such as sensory descriptor.

Understanding the process of expectation generation, the second study aimed to answer the question of whether beer labelling and colour may be used to modify customers' expectations and, together with taste, alter perception of taste, flavour, and mouthfeel of beer. Results of mediation analysis showed that not only did beer colour and sensory descriptor change consumers' perception, but that this effect was mediated by expectations.

Study 3 then expanded on previous findings by investigating how beer colour, label-based sensory descriptors, and labelled alcohol content affect expected and perceived properties of alcoholic and non-alcoholic beers. Beer colour and some sensory descriptors did, indeed, influence ratings of expected and perceived beer properties. However, it appears that a sensory descriptor must be relevant and percept-specific in order to alter perception.

The final experiment looked at whether and how consumer focus and alcohol content affect post-ingestive experience. The results confirmed the effects of alcohol on mood, cognitive performance, and satisfaction. The findings, however, did not show that consumer focus could improve sensory and hedonic perception or post-ingestive experience.

Overall, it appears that extrinsic and intrinsic product cues can shape consumer sensory and hedonic experience in the context of regular and reduced alcohol beers, but the effect of product cues on post-ingestive experience, including consumer satisfaction appears to be limited.

List of abbreviations

ABV, abv	Alcohol by volume
BAC	Blood alcohol concentration
BrAC	Breath alcohol concentration
EBC	European brewery convention
fMRI	Functional magnetic resonance imaging
GMO	Genetically modified organism
GM-free	Is not or does not contain genetically modified organism
IBU	International bittering units
ITT	Inspection time task
NA	Non-alcoholic
OFC	Orbitofrontal Cortex
RT	Reaction Time
VAS	Visual Analogue Scale
NHANES	National Health and Nutrition Survey
WTP	Willingness to pay

1 CHAPTER 1: GENERAL INTRODUCTION

1.1 BACKGROUND

Consumer attitudes and beliefs play a key role not only in decision-making, but also in their overall experience and satisfaction with a product. In psychology, these attitudes and beliefs are usually described in terms of expectancy. Expectancy or expectations are generated based on contextual product-related information at point of purchase or consumption, and from previous experience (Deliza & MacFie, 1996). The power of contextual information to not only generate expectations, but also to alter consumer behaviour and improve experience can be used to promote a range of desirable health behaviours and make them more enjoyable for consumers.

In the case of non-alcoholic and regular beer, manipulating context to optimise consumer oral and post-ingestive experience is particularly interesting. Because non-alcoholic beers are frequently disliked and thought to have a poor flavour profile (Sohrabvandi et al., 2010), changing consumers' sensory perception could improve both liking and perceived sensory profile. And because the effects of alcohol are also context-dependent (Bodnár et al., 2020), we may use this to improve consumers' post-ingestive experience of non-alcoholic beer by using contextual cues to replace the positive effects of alcohol (Bjork & Gilman, 2014; McCollam et al., 1980) or to highlight the benefits of non-alcoholic beer (Chrysochou, 2014; Osorio-Paz et al., 2019). Understanding how product-related cues change oral and post-ingestive experience could help to improve perception of, and attitudes towards, reduced alcohol beers. Thus, the primary aim of the research presented in this thesis was to explore and more importantly quantify the relationships between contextual product-related cues, consumer expectations and oral and post-ingestive experience in the context of non-alcoholic lager style beer.

1.1.1 Beer and non-alcoholic beer

Beer is one of the oldest and most popular man-made beverages (Wunderlich & Back, 2009). The first known mention of brewing dates back to Sumer civilisation, more than 6000 years ago (Cabras & Higgins, 2016), with lager types beers first appearing in 15th century Germany (Bing et al., 2014). The popularity of beer has continued since its discovery until this day, however in recent years we have seen an increase in demand for less traditional beer styles such as craft beers and non-alcoholic beers (Jaeger et al., 2020; Salanță et al., 2020). The increased consumer demand for beer with reduced alcohol content warrants an increase in scientific research to improve understanding of consumer preferences, beer sensory profiles and acceptability, to name just a few.

Alcohol content in beers typically varies between 2.5 – 13% abv[1], with the majority of commercially produced beers in the range of 3 – 6 % abv. Low-alcohol beers usually contain < 1.2 % abv (UK, Germany) and beers containing <2.5% abv tend to be considered 'reduced alcohol' (Sohrabvandi et al., 2010). The classification of low-alcohol and non-alcoholic beers is not universal, however and varies country by country. In the UK alcohol free beers are required to contain less than 0.05 % abv, in Spain 0.1% abv, in France 1.2% abv, and in Germany, Poland and Netherlands non-alcoholic beers can contain up to 0.5% abv (beveragedaily.com, 2018; Jackowski & Trusek, 2018; *Low-Alcohol Descriptors Guidance*, 2018; Sohrabvandi et al., 2010). While in the UK the term 'non-alcoholic' is discouraged in favour of 'alcohol-free' when talking about alcoholic beverages such as beer (*Low-Alcohol Descriptors Guidance*, 2018), I

[1] abv or ABV refers to 'alcohol by volume', a measure of how much alcohol is in an alcoholic beverage. It is defined as the number of millilitres of ethanol in 100 ml of solution at 20 °C.

will use the term non-alcoholic, as that is a term commonly used by both consumers and manufacturers. In all studies in this thesis, non-alcoholic beer with less than 0.05% abv. was used Figure 1.1 is a schematic representation of terminology associated with beer alcohol content.

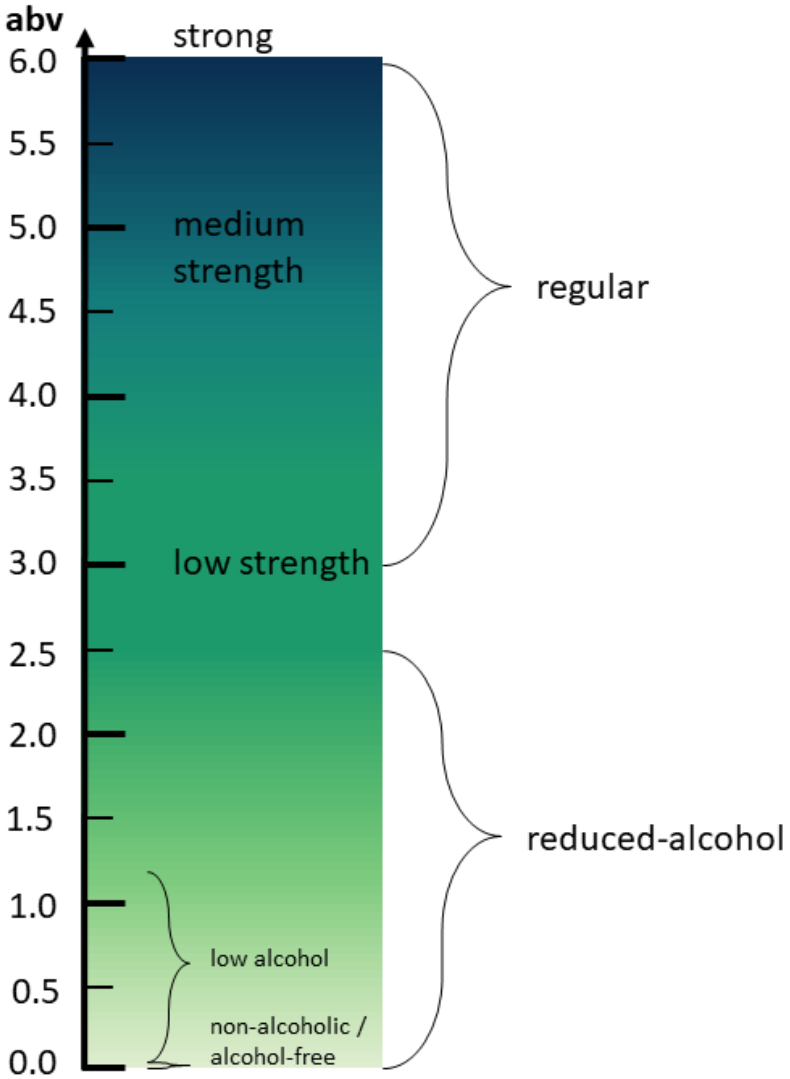

Figure 1.1. A schematic depiction of the range of alcohol content in commercially available beer and associated descriptors

There is a long-standing history of low strength beer. In Britain, as well as other parts of Europe, a beverage called *small beer* or *table beer* containing around 1-3 % abv was commonly consumed since the middle ages until the mid-19th century (Oliver & Colicchio, 2013). Another low alcohol beer, even

weaker than small beer, was consumed on ships, termed ship's beer (Unger, 2004). Small beer typically contained lower alcohol content than regular beer and was consumed for its nutritional value as well as a safe alternative to water.

The first truly non-alcoholic beer made an appearance during the Prohibition era in the USA (1920 – 1933), during which beer was replaced by a cereal beverage referred to as 'near beer', containing around 0.5% abv (Feldman, 1930). While a small market for non-alcoholic beer remained after the prohibition laws were scrapped, non-alcoholic beer did not start rising in popularity until more recently. In recent years demand for non-alcoholic beer has skyrocketed and sales more than doubled between 2013 and 2019. This trend is believed to continue (Kokole et al., 2021), as the health consequences of alcohol consumption are becoming better understood (Burton & Sheron, 2018; Nutt, 2020), more and more people are choosing to avoid alcohol altogether or at least to reduce their intake (Törrönen et al., 2019).

Despite the increase in demand for reduced alcohol beer in recent years and the work to improve the flavour profile of non-alcoholic beers, consumers still complain about the flavour deficits and many consumers have negative sensory and hedonic expectations associated with non-alcoholic beers (Liguori et al., 2015; Silva, Jager, et al., 2017; Sohrabvandi et al., 2010). This is not surprising given that alcohol influences perception of mouthfeel (Gawel et al., 2007; Langstaff et al., 1991; Niimi et al., 2017), and drinks with higher alcohol content are perceived as having fuller body, sweetness, an alcohol warming sensation, and increased complexity, whereas drinks with lower alcohol content are perceived as lacking body and other aspects of mouthfeel (Clark et al., 2011; Ramsey et al., 2018; Sohrabvandi et al., 2010). The issues of taste, flavour and liking are discussed in the following sections.

1.1.2 Taste, flavour and liking

Our lives revolve around food and eating, so it is not surprising that eating, drinking, taste and flavour are often discussed topics. However, the terms taste and flavour are often used interchangeably. Taste can be defined as a sensation caused by direct stimulation of gustatory receptors on a tongue and elsewhere in the mouth. Taste is one of the sensory modalities comprising of five broadly agreed on qualities: bitter, sweet, sour, salty, umami (savoury), which are represented in the gustatory system. Flavour, on the other hand is a complex multisensory percept resulting from a combination of gustatory (taste), olfactory (aroma) and somatosensory input (e.g. mouthfeel) (Buck & Bargmann, 2013; Lawless et al., 2004). Because taste is a component of flavour and because taste, flavour and smell are normally perceived at the same time, during tasting/consumption, it can be difficult to separate them (Spence et al., 2014; Spence, 2015a). Consistent with the definitions, aromas and odours are important for flavour but not taste perception. Yet, certain smells can affect perception of basic tastes. For example, stimuli often taste sweeter when they are paired with certain aromas such as vanilla or strawberry odour (Mojet et al., 2005; Stevenson et al., 1999; Yeomans et al., 2006).

In a similar way, beers and non-alcoholic beers have a complex flavour profile (Langstaff & Lewis, 1993; Schmelzle, 2009). Aroma wheels describing the tastes, flavours, aromas and mouthfeel properties of beer offer a sensory language that allows accurate but intuitive description of sensory properties of beer (Schmelzle, 2009), see Figure 1.1. While these terms can in principle be understood by a lay person, consumers rarely use these terms to describe salient aspects of beer (Ivanova et al., 2022). Based on an extensive qualitative investigation, Ivanova and colleagues have shown that most consumers rely on basic terms referring to taste, flavour, mouthfeel and aroma. Researchers

should be careful what they ask participants, who are untrained consumers, to evaluate complex attributes they might be unfamiliar with.

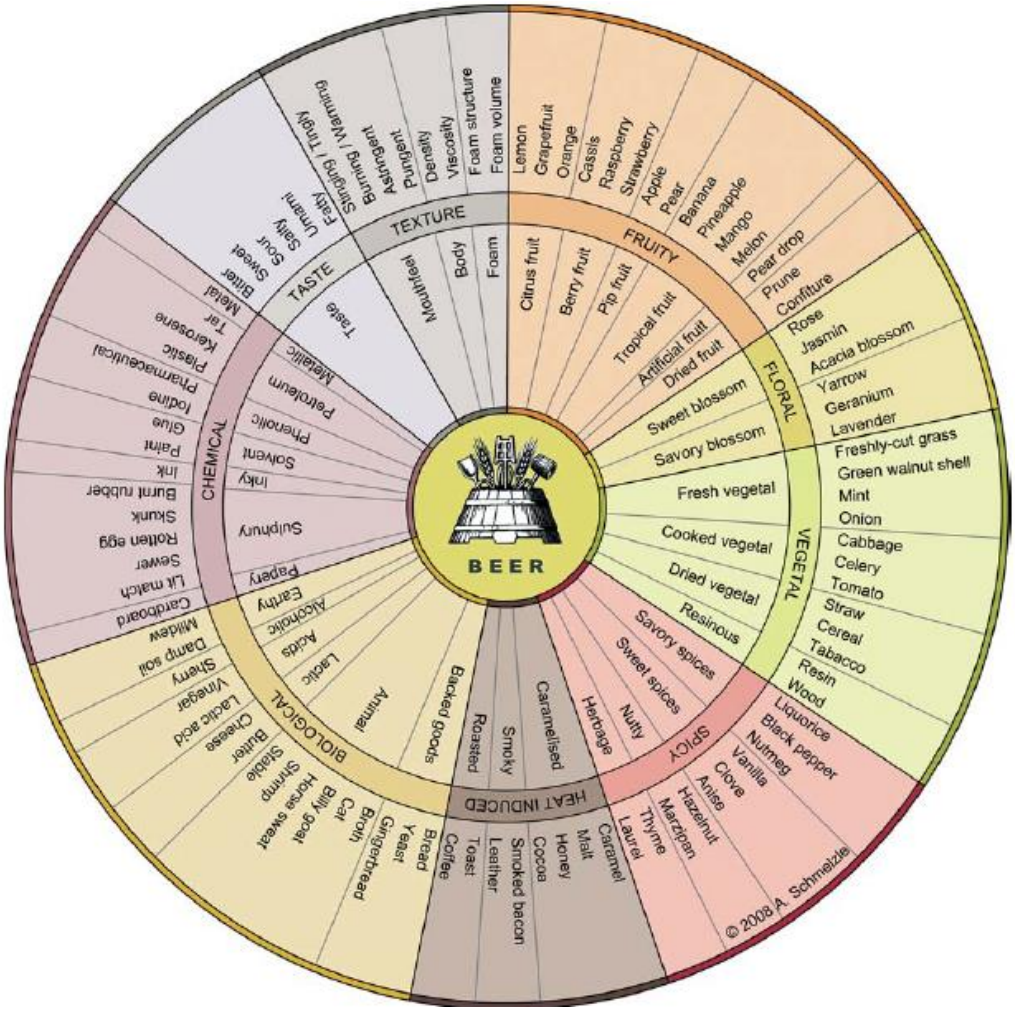

Figure 1.2. Attribute list for the description of sensory perceptions in beer. *Reproduced with permission from Schmelzle(2009)*

While taste and flavour are sensory percepts, they also carry affective value (Okamoto & Dan, 2013). Both taste and flavour are associated with pleasant and unpleasant memories and experiences. Even in the scientific literature sweet and bitter tastes are referred to as pleasant and unpleasant taste respectively (Carlsmith & Aronson, 1963; Nitschke et al., 2006; Sarinopoulos et al.,

2006). There is evidence that sensory and hedonic evaluations, in other words rating of taste and liking or flavour perception, are underpinned by separate neural processes (Grabenhorst et al., 2008b; Sarinopoulos et al., 2006) and even though there is a close link between taste perception and liking, they need to be considered as separate. In conclusion, taste, flavour and liking are all related with liking being closely linked to product acceptability and consumer behaviour.

1.1.3 Sensory properties of beer

Beer has a well-defined and complex sensory profile (Blanco et al., 2016) which is also desirable in reduced alcohol beers (Ramsey et al., 2018). However, despite continuous work to improve the production of reduced alcohol beers so as to perfect their sensory profile, consumers often report that the flavour profile of non-alcoholic beer is inferior compared to regular beer and complain about off-taste and low body (Moss et al., 2022; Sohrabvandi et al., 2010). The lack of alcohol can cause these sensory issues, as ethanol is an important trigeminal and olfactory stimulus which affects perception of mouthfeel, as well as taste and aroma (Clark et al., 2011; Ramsey et al., 2018). There is a need to find alternatives of how to improve the perceived taste, flavour and mouthfeel of non-alcoholic beers without the help of alcohol.

1.1.3.1 Sensory evaluation

Beer is a beverage with a complex sensory profile (Langstaff & Lewis, 1993; Schmelzle, 2009). Sensory evaluation of beer, as well as other products, can be done instrumentally, using technology such as tribology machines, electronic tongues and noses or rely on human assessors. The latter can be either a trained sensory panel or naïve consumers. Each of these methods has its advantages and disadvantages. Instrumental methods are fast, precise and relatively cheap, however, given how complex and multisensory ingestive

experience tends to be, instrumental methods can never replace human sensory evaluation. As will be discussed in more detail, human gustatory perception does not only depend on chemosensory properties of the food or beverage, but also on individual differences related to genetics, past experiences, expectations and more.

In contrast to instrumental methods, humans can and do rely on multiple sensory modalities when evaluating sensory properties of foods and drinks. This is undoubtedly an advantage of using human participants for sensory evaluation. Trained sensory panels for descriptive sensory profiles is a standard practice in sensory evaluation (King et al., 2001) The advantage of using a trained sensory panel is that they can be trained to evaluate a wide range of sensory attributes that a naïve consumer would not be familiar with. These trained panels, however, tend be to relatively small, as most panels will consist of fewer than 12 judges (Djekic et al., 2021) and any findings are thus sensitive to the influences of individual differences (King et al., 2001).

Moreover, the way panellists are trained to assess products differs from the way consumers usually consume food and beverages in everyday life. Judges in sensory panels are usually instructed to engage in deep analytical processing, which consumers rarely do (Ares & Varela, 2017). Thus, studies using trained sensory panels, while accurate, lack ecological validity. If we want to understand how regular consumers perceive a product and investigate ways to make a product more acceptable, it makes sense to recruit participants directly from the consumer population. However, regular consumers might not be familiar with all of the sensory attributes usually assessed by trained sensory panels and thus researchers need to make sure that participants understand what they are asked to evaluate.

While sensory panels and chemical analyses using objective instruments such as electronic nose have their place in sensory evaluations (Lawless & Heymann, 1999; Rudnitskaya et al., 2009), perception of taste and flavour by its nature is subjective (Liu et al., 2012) and considering ratings by naïve consumers in certain contexts makes sense as it has been shown that consumers are able to accurately and reliably assess sensory properties of products (Ares & Varela, 2017).

1.1.3.2 Mouthfeel

While possibly one of the most important characteristics of alcoholic beverages, mouthfeel is also the most difficult attribute to measure and research (Ivanova et al., 2022; Langstaff & Lewis, 1993). Mouthfeel has been defined as all the tactile properties of a food or beverage (Van der Stelt et al., 2019) and is distinct from taste and flavour. Mouthfeel is evaluated by rating a number of attributes and varies depending on the context and the product being evaluated. With beer, mouthfeel covers attributes such as alkaline, mouthcoating, metallic, astringent, powdery, carbonated or warming (Meilgaard et al., 1979).

Body is an interesting sensory attribute closely related to both mouthfeel and flavour. Body is a term commonly used when talking about alcoholic beverages such as wine or beer (Ivanova et al., 2022) and refers to both fullness of flavour and aspects of mouthfeel (Van der Stelt et al., 2019). Beer body was defined by the American Society of brewing Chemists as ‘ fullness of flavour and mouthfeel’, which is relatively well mirrored by consumer understanding of the term body, with ratings of body influenced by the drinks taste, flavour, aftertaste, mouthfeel, including alcohol warming, aroma and appearance (Ivanova et al., 2022).

Body of beer is associated with its alcohol content and is closely related to liking and consumer preference (Langstaff & Lewis, 1993; Ramsey et al.,

2018). It is thus not surprising that consumers often describe non-alcoholic beers as lacking body, among other perceived defects, such as off-flavour and lack of balance (Catarino & Mendes, 2011; Moss et al., 2022; Sohrabvandi et al., 2010). Thus, body is a key sensory attribute in beer and understanding how to improve perceived body in reduced alcohol beers is invaluable.

1.1.3.3 Bitterness

Bitterness is an important and salient characteristic of beer flavour profile. Bitterness of beer is due to the presence of isoalpha acids, a chemical compound present in hops used during the brewing process (Spearot, 2016). The intensity of bitterness in beers is measured using the International Bittering Units (IBU) scale. This is an objective bitterness measure based on chemical composition of beer, namely on the content of iso-alpha and non-iso-alpha acids. It should be noted that perceived bitterness as reported by consumers can vary, as perception of bitterness in humans is complex and relies on more than just chemical composition of the product, but also on individual differences in taste related to physiological differences in the gustatory system, cognitive processing and genetics (Kishimoto et al., 2021). While an important beer characteristic bitterness is generally disliked by consumers and perception of too high bitterness reduces the acceptability of non-alcoholic beers (Chrysochou, 2014; Lafontaine et al., 2020).

Interestingly, in the UK context, 'bitter' is also a UK beer style, a type of an ale. Contrary to what the name suggests, the bitterness and alcohol content of an 'ordinary bitter' is relatively low (20-35 IBU, 3.2-3.8 % abv) compared to the popular English or American style IPAs (40-60+ IBU, 5.5- 7.5 % abv) ('Brewers Association Beer Style Guidelines', 2022.; Pavsler & Buiatti, 2009). Currently, lager is the most popular beer style in the UK (On Trade beer report 2019/2020, 2019) and approximately 90% of beer produced worldwide is lager (Pavsler & Buiatti, 2009). In this thesis I focus solely on lager style beers.

1.1.3.4 Beer colour

While hops are responsible for bitterness of beer, malt is responsible for the colour[2]. Therefore, colour and bitterness of beer are, at least in a chemical sense, independent characteristics. Perception of beer colour is also to some extent subjective (Koren et al., 2020), but arguably less so than perception of bitterness. To objectively measure beer colour the European Brewing Convention (EBC) colour scale is used. While the EBC colour is derived from the beer absorbency of light at 430 nm wavelength, Figure 1.3 shows the approximate relationship between hue and EBC colour rating.

Figure 1.3. An approximate beer colour and EBC colour units. Modified from Van Doorn et al. (2019)

1.1.3.5 Refreshment

The ability of drinks to quench thirst is a key motivator for drinking (Guinard et al., 1998). In the context of beverages, refreshment, sometimes referred to as 'thirst quenching' character or perceived freshness is a higher order multisensory percept and similarly as flavour is characterised by perceptual and semantic content (Roque et al., 2018). With respect to sensory characteristics, coldness, sourness and carbonation were shown to enhance perceived freshness, while sweetness and thickness were associated with decreased freshness perception. In terms of extrinsic and intrinsic product cues,

[2] While malt is the main determinant of colour there are others as well, for example candi sugar (caramelised invert sugar syrup) in dark Belgian beers, or colorants (e.g. Farbebier and Porterine)

both drink colour, aroma and other aspects such as labelling and colour of a receptacle can change perceived refreshment (for a recent review see: Roque et al., 2018). Importantly, the association between perceived refreshment and product-related cues seems to be product-specific. While brown colour enhanced the perceived refreshment of a vanilla flavoured drink (Zellner & Durlach, 2003), dark or brown colour resulted in a decrease in thirst-quenching properties of beers (Guinard et al., 1998). Overall, perceived refreshment is an important, although complex and multisensory percept of beer.

1.1.4 Expectations

1.1.4.1 Expectations and consumer experience

To understand the relationship between product information and sensory perception we must first explore the relationship between information and expectations. In the context of eating and drinking, expectations are predictions about the upcoming gustatory and post-ingestive experience, such as aspects of taste, flavour, satisfaction, satiation or even mood and cognitive performance (especially in the case of alcoholic beverages). While our prior experiences and external information have an impact on the way we perceive the world around us (de Lange et al., 2018), and together with other individual differences profoundly shape the process of expectation generation, we can also alter expectations by relying on product-related information (Cardello, 2007; Deliza & MacFie, 1996; Fernqvist & Ekelund, 2014). While previous experience and to some extend individual differences are difficult to study, product cues can be manipulated relatively easily. When product cues are related to the chemosensory properties of the product itself, they are referred to as *intrinsic cues* (Cardello, 2007), an example would be an aroma or colour of a product. All other product cues, generally cues that are relevant to the product, but not part of it, typically aspects of marketing such as information

about the product on the label, are referred to as *extrinsic cues* (Deliza & MacFie, 1996; Piqueras-Fiszman & Spence, 2015).

As mentioned above, labels are an example of an extrinsic product cue which can easily and conveniently communicate information about a product. Explicit information about a product, including ethical information (Napolitano et al., 2007, 2010), information about production (Caporale & Monteleone, 2004; Cardello, 2003), nutrition (Liem, Miremadi, et al., 2012), but also about taste and sensory properties of the product (Okamoto & Dan, 2013; Yeomans et al., 2008) as well as more implicit information conveyed by brand (Allison & Uhl, 1964; Varela et al., 2010), packaging colour (Piqueras-Fiszman & Spence, 2012a; Spence et al., 2015) or imagery (Gil-Pérez et al., 2019; Rebollar et al., 2017) have all been shown to alter consumers' expectations and/or perception.

1.1.4.2 Behavioural theories of expectancy

When we experience the flavour of a product, in the context of expectations there are several possible scenarios. Sometimes, what we consume tastes exactly as we expected it to taste like, our expectations are confirmed. What is more likely to happen, however is disconfirmation of expectations. Disconfirmation is a mismatch between expected and actual perceived properties of a stimulus, in this case a discrepancy between expected and actual taste or flavour of a food or drink. This mismatch can be either positive, when actual experience exceeds our expectations, or negative, when the perceived properties of the stimulus are inferior to the expected ones. In the case of disparity, several outcomes are possible. Expectations can either enhance, reduce or not change the experience. There are four psychological models that attempt to explain the effect of expectations on experience: generalised negativity, assimilation, contrast and assimilation-contrast theory.

First, the theory of generalised negativity (Carlsmith & Aronson, 1963) claims that any mismatch between expectations and experience will be perceived negatively and lead to lower evaluation of a product regardless of the direction or size of this mismatch/disparity. This model is relevant more to liking and less to sensory perception. Carlsmith and Aronson (1963) carried out an experiment in which they asked participants to taste and evaluate expected and perceived bitterness and sweetness of solutions using hedonic terms (pleasant and aversive, respectively) and found that any disconfirmation of expectation lead to perception of the taste being less pleasant, thus less sweet or more bitter. Only participants who rated sweet stimuli as pleasant and bitter ones as unpleasant were used for the experiment. Moreover, Carlsmith and Aronson employed a slightly unusual gambling paradigm. Before participants tasted each stimulus, they were asked to rate their expectations (in terms of expected sweetness/bitterness) of the coming stimulus based on nonverbal cues (a kind of an extrinsic factor): if their guess (i.e., expected taste) was correct they won money. This could explain why any mismatch between expectations and actual experience led to negative evaluation. Apart from that study, there is little support for the generalised negativity theory.

Assimilation theory on the other hand suggests that expectations will shift experience in the direction of the expectations. In other words, a product will taste better (or taste/flavour will be perceived as more intense) when expectations are high and worse (less intense) when expectations are low. This effect has been widely reported in both behavioural (for example: Liem, Miremadi, et al., 2012; Olson & Dover, 1978; Woods et al., 2010) and some neuroimaging studies (Grabenhorst et al., 2008b; Nitschke et al., 2006; Sarinopoulos et al., 2006; Woods et al., 2011). Indeed, assimilation seems to be the most commonly observed effect of mismatch between expectations and experience. Nevertheless, occasionally a contrast occurs (Yeomans et al., 2008;

Zellner et al., 2004). Contrast, compared to assimilation predicts that disconfirmed expectations will further increase the mismatch between experience and expectations.

While there is little support for the generalised negativity model, both assimilation and contrast have been demonstrated experimentally. Only the assimilation/contrast model accounts for both phenomena. This theory considers the size of the mismatch and other factors such as the strength of the belief, which determines whether assimilation or contrast occur. The assimilation-contrast model suggests that a small difference between expectations and experience will lead to assimilation, while a large mismatch is likely to result in contrast (Cardello, 2007; Deliza & MacFie, 1996). Overall, the assimilation/contrast model is currently the best psychological model able to explain the effect of expectations on consumer experience.

The assimilation/contrast theory describes the conceptual relationship between expectations and perception. Considering this and the research demonstrating the association between product cues and expectations, led researchers to suggest that the effect of product cues is thought to be mediated through expectations (Cardello, 2007; Deliza & MacFie, 1996). In other words, prior to tasting a food or drink we often have expectations (perhaps based on the label information, context in which it is consumed or previous experience) which in turn can alter the way we perceive and experience the product. While it is widely believed that expectations act as a mediator and transfer the effect of contextual cues on sensory perception (Cardello & Sawyer, 1992; Deliza & MacFie, 1996; Lee et al., 2006; Okamoto & Dan, 2013; Schifferstein et al., 1999; Shankar et al., 2009; Yeomans et al., 2008) nobody has used mediation analysis to explicitly test this claim. Modelling the complex relationships between product cues, expectations and gustatory experience

would also allow us to not only qualitatively describe these associations, but also quantify the strength of the relationships.

1.1.4.3 Neural underpinnings of expectations

While research suggests that there is an effect of extrinsic cues on taste perception, critics might say that the altered taste ratings after label exposure might be a result of bias or perhaps only appear during decision-making rather than during sensory processing. However, this position is hard to maintain if we consider results from neuroimaging studies.

In an FMRI experiment, Grabenhorst and colleagues (2008) asked participants to taste solutions that were labelled either as 'MSG' or 'rich and delicious'. Sensory ratings (flavour intensity in this case) and perceived liking were then correlated with brain activity. Researchers did not find any change in flavour intensity ratings, which was consistent with the lack of change in brain activity in the insula and frontal operculum, parts of the primary taste cortex (Kobayashi, 2006). Participants however liked the solution labelled as 'rich and delicious' significantly more than the same solution labelled as 'MSG', which also correlated with a change of BOLD signal in the OFC. Even though the labels used in this study failed to alter participants' perception of flavour intensity, the researchers found a change in liking when participants were exposed to a hedonic, 'rich and delicious' label.

Nitschke et al. (2006) used a similar procedure to investigate the effect of information on taste perception, but unlike Grabenhorst et al. (2008) explicitly measured participants' expectations. In this study, researchers investigated the effect of expectations on neural response to bitter and sweet stimuli. When participants expected a mildly unpleasant/bitter stimulus and actually tasted the very bitter solution, the neural activation in the primary taste cortex was reduced and the perceived pleasantness higher than when the same stimulus

was preceded by a congruent label (i.e. ‘very aversive stimulus’ preceded by a ‘very aversive’ label).

In another study with an almost identical design Sarinopulos et al. (2006) investigated how expectation affected sensory taste transmission by looking at whether brain activation during the expectancy period predicts activity in the insula and amygdala. They demonstrated that for the bitter stimulus the activity in the taste cortex correlated with participants’ ratings of bitterness/unpleasantness. Moreover, they showed that activation of amygdala and insula can be predicted by prior increased activation in the orbitofrontal cortex (OFC), rostral anterior cingulate and dorsolateral prefrontal cortex measured during the expectancy period. The results of both studies support the notion that labelling can alter gustatory perception, and that expectations modulate subsequent taste perception.

More recently Woods et al. (2011) investigated how expectancy affects basic taste perception of sweetness. Using fMRI, they found that expectation of a very sweet drink (orange juice) while tasting a mildly sweet drink (mix of orange juice and water) enhanced the reported sweetness and increased activity in the taste cortex, relative to the same stimulus when expectations and label were congruent. The results clearly showed the effect of expectations generated by extrinsic information on taste perception.

Overall, we can conclude that expectations directly modulate sensory perception (Sarinopoulos et al., 2006), and that expectations generated by extrinsic information can alter perception of taste (Woods et al., 2011) and liking (Grabenhorst et al., 2008b). In other words, the above-discussed neuroimaging studies back up the tentative conclusion made based on the behavioural results that extrinsic product information can and does alter taste perception, a process mediated by expectations.

1.2 PRE-INGESTIVE PHASE

The pre-ingestive phase is a period of time before consumption of a food or a beverage. While this can include experiences in the distant past, the psychological and sensory research usually focuses on the time immediately preceding consumption. During this time, consumers evaluate accessible attributes of the product, claims and information associated with the product to form expectations about its sensory (taste, flavour, aroma, texture) and hedonic (liking, satisfaction) properties. While there are a range of intrinsic cues that can contribute to expectation generation, such as viscosity of a drink, texture and aroma, these are rarely examined, as these are often obscured by packaging. Arguably, cues associated with visual appearance are important intrinsic cues, with product colour the most relevant/ easily noticed (Spence, 2015b). While extrinsic cues again can vary from a close friends' recommendation to a health warning, here the focus will be on information that can be displayed on a label. The reason for this is that label information can be easily manipulated and controlled. Previous research has demonstrated that both intrinsic and extrinsic product cues can and do affect consumers' expectations about the product sensory properties and how much they would like it (Piqueras-Fiszman & Spence, 2015).

1.2.1 Intrinsic cues

1.2.1.1 Colour

For people, vision is considered to be the dominant modality: we often rely on vision to extract information about our environment, including foods and beverages (Lelièvre et al., 2009; Schifferstein, 2006). Therefore appearance and particularly colour is an important marketing tool (Singh, 2006). There is abundant evidence that colour can shape expectations about taste, flavour, liking and even intensity or refreshment (Garber et al., 2000; Spence, 2015b;

Spence et al., 2015). For example, Zellner and Durlach (2003), investigated how colour changes the perception and expectations about drinks. They asked participants to taste mint, lemon and vanilla solutions that varied in colour. They found that colour was an important determinant of ratings of expected refreshment, intensity and liking.

In a more relevant example, Carvalho and colleagues (Carvalho et al., 2017) investigated how adding colouring to beer affects expected and perceived properties of the drink. They found that the lighter beer was expected to be liked more, taste stronger, have lighter body and be less bitter than the darker beer. A similar subsequent study replicated these findings and additionally demonstrated that darker beer was additionally expected to have a higher alcohol content than the lighter beer (Reinoso-Carvalho et al., 2019).

While a detailed review of product colour on consumer expectations is beyond the scope of this thesis (see reviews: Shankar et al., 2010; Spence et al., 2010), There are other visual cues specific to beer that can affect consumer experience. These visual cues include but are not limited to clarity of the beer, its head (foam on top) and lacing (how well foam adheres to the sides of a glass)(Van Doorn et al., 2019). While these characteristics are relevant for enjoyment and overall impression and to some extent perception of body, carbonation and refreshment (Guinard et al., 1998; Van Doorn et al., 2019), we can argue that their contribution to expectations is limited and hard to study. For example, lacing we can usually only observe and evaluate after we consume at least some of the beer and head is an attribute which is very difficult to manipulate in experimental settings. This may be the reason why the research on beer appearance (excluding beer colour) is relatively scant and often poor, with researcher using suboptimal statistical methods, small participant samples and vague terms (e.g. “drinkable”).

1.2.2 Extrinsic cues

1.2.2.1 Sensory descriptors

Labelling is a convenient way to elicit expectations and provide information to consumers. We as consumers are accustomed to seeing numerous claims and design features on food and drink labels. A range of extrinsic cues have been shown to have an impact on expectation generation process. These cues include nutritional information (Schouteten et al., 2015), health claims (Carrillo et al., 2012), claims about hedonic (Oliveira et al., 2018) and sensory properties of a product (Yeomans et al., 2008), as well as images related to the product (Gil-Pérez et al., 2019; Rebollar et al., 2017) and other design features of the label including typeface (Velasco et al., 2015), label colour (Guéguen, 2003), and even material of packaging (Rebollar et al., 2017) or receptacle shape (Van Doorn et al., 2017).

In this thesis, I will focus on the effect of sensory descriptors on hedonic and sensory expectations. The reason for this is that the literature seems to suggest that while it is relatively simple to generate expectations using extrinsic cues, this often fails to translate to changes in sensory perception (Piqueras-Fiszman & Spence, 2015). A label-based cue that consistently affects both expected and perceived ratings is a label-based descriptor relating to specific sensory properties. It appears that simple, explicit descriptions, such as 'reduced salt', 'savoury', 'creamy' or 'bitter' generate strong sensory expectations (Liem, Miremadi, et al., 2012; Olson & Dover, 1978; Yeomans et al., 2001, 2008).

For example, Yeomans and colleagues (Yeomans et al., 2008) showed that sensory food descriptors reliably affected consumer expectations and perception. The researchers asked participants to taste frozen salmon mousse labelled as either ice-cream, savoury mousse, or Food 386. They found that these labels significantly affected both sensory and hedonic expectations. More

specifically, participants expected to like the savoury mousse significantly more when it was labelled as ice cream, similarly, they expected it to taste significantly sweeter, creamier, fruitier, and less salty than when labelled as savoury mouse or Food 386. In another study, when participants tasted soups with varying salt content, a 'reduced salt' label lead to reductions in expected saltiness and liking, when compared to no label and 'healthy' label conditions (Liem, Miremadi, et al., 2012) . It is however important to point out that in a similar study Liem and colleagues did not replicate these findings (Liem, Toraman Aydin, et al., 2012).

Overall, sensory descriptor appears to be a product-extrinsic cue with the capacity to generate consumers' expectations about the sensory qualities of a variety of products. The use of extrinsic product cues in the context of beer has not been examined, nor has research been conducted to determine what types of descriptors are effective in influencing consumers' perception of taste, flavour and mouthfeel and what percepts are changed by them or whether they interact with other product-related cues (e.g., beer colour and labelled alcohol content) and characteristics (e.g., taste and actual alcohol content).

1.2.2.2 Other Information

For alcoholic beverages, another key source of information, compulsory in most countries, is the displayed alcohol content. In the EU and UK, the alcohol content must be displayed on all products containing more than 1.2% ABV (REGULATION (EU) No 1169/2011, 2011). Labelled alcohol content has been associated with expected and perceived body and liking, with lower alcohol content linked to decreased liking and lighter body (Meillon et al., 2010; Niimi et al., 2017; Silva et al., 2017). For instance, Meillon et al. (2010), investigated the effect of labelled alcohol content on liking of partially dealcoholized wines. Labelling wine as 9.5% ABV vs. 12% ABV significantly reduced both expected and actual liking. Similarly, Silva et al. (2017) showed

that in the context of beer, the label ‘non-alcoholic beer’ resulted in lower expectations of liking than the label ‘beer’.

More recently, more vague or implicit cues, such as typeface curvilinearity or imagery, have been studied. For example, Velasco and colleagues showed that there are associations between typefaces and tastes (Velasco et al., 2015). They demonstrated that participants tasting jellybeans described as ‘candy’ using more angular typeface were expected and perceived to be more sour than jelly beans described using a round typeface (Velasco et al., 2018). Similarly, images can not only attract consumer attention but also convey information about a product and shape consumer expectations (Ares et al., 2011; Gil-Pérez et al., 2019). For example, Gil-Pérez and colleagues demonstrated that expected spiciness of a product could be manipulated by the angularity of an image of flames depicted on the product packaging. However, to date there has been no research that specifically addressed the use of imagery or typeface in the context of alcoholic beverages. Arguably, implicit messages generated by imagery, typeface and other features of label design may be less relevant than explicit information such as alcohol content or indeed sensory descriptors.

1.2.3 Summary

Overall, there is no doubt that product related cues, whether they are intrinsic to the product, such as product colour or other aspects of appearance, or extrinsic cues related to product description and labelling, can generate expectations about the product sensory properties as well as overall liking. However, it is possible that the way cues elicit expectations is context and product specific. For example, while the brown colour beverage can lead to expectations of increased liking for a vanilla flavoured beverage (Zellner & Durlach, 2003), it can generate expectations of lower liking for a beer (Reinoso-Carvalho et al., 2019). What cues generate sensory and hedonic expectations in

the context of beer will be covered in chapter 2 of this thesis. Moreover, generating expectations is only valuable if we can relate it to consumer perception or behaviour. The following section will extend the process of expectation generation based on product cues to changes of sensory and hedonic experience during the oral phase during which consumers consume the product.

1.3 ORAL PHASE

A product inspection, whether a detailed conscious examination or a passive processing of available visual information, is typically followed by consumption, and the pre-ingestive phase transitions to the oral phase. Oral phase here refers to the time during which we consume and thus experience and evaluate the sensory and hedonic properties of a product, a time during which we experience taste, flavour, mouthfeel, aspects of texture, carbonation and we become aware of how much we like the product.

While sensory properties of a product are key drivers of liking and sensory evaluation (Forde, 2018), these are not the only variables we should consider. It has been shown that expectations can play an important role in sensory and hedonic evaluations of food and beverages and should thus be considered (Cardello, 2007; de Lange et al., 2018; Deliza & MacFie, 1996; Piqueras-Fiszman & Spence, 2015). While most manufacturers and researchers focus on chemosensory properties of a product as determinants of liking, as well as evaluation of its sensory properties (Palczak et al., 2019), as explained above expectations can play an important role in sensory and hedonic perception. Namely, expectations and the size of the mismatch between expected and actual properties of a product shapes what we perceive and how much we like a product.

While sensory properties drive perception of taste, flavour and liking, they are not the sole determinants of sensory evaluation. In a classical study Carlsmith and Aronson (Carlsmith and Aronson (1963) asked participants to taste sweet and bitter solutions and rate how much they liked them. They found that if participants were presented with cues leading them to believe they will taste a bitter solution, but were given a sweet one, they rated the solution as more bitter than when presented with a correct cue. This study is important because it is one of the first ones to demonstrate the key role expectancy plays in sensory evaluations. This study, however, nicely demonstrates common issues with expectations-perception research.

First, Carlsmith and Aronson did not explicitly measure expectations, thus they could not quantify and check that the cues presented to participants were believed and actually generated desired expectations. This is not uncommon: a large number of sensory studies, especially those studying the effects of labelling, only assume expectations are generated and do not measure them. This assumption, while reasonable, makes any conclusions questionable. Additionally, if we do not quantify the expectations themselves, it is impossible to quantify the relationship between expected and perceived ratings.

Secondly, Carlsmith and Aronson used bitterness and unpleasant, and sweet and pleasant interchangeably. While they made sure that all participants found the sweet solutions pleasant and bitter solutions unpleasant, we have to question this approach, as it is known that perception of sweetness and bitterness and liking do not necessarily map onto each other (Garcia-Burgos & Zamora, 2015; Iatridi et al., 2019; Vecchio & Cavallo, 2019). Again, this issue is not unique, and a number of researchers failed to disambiguate between hedonic and sensory evaluations. While it is necessary to measure both hedonic and sensory ratings, these should be measured and evaluated separately and

vague terms such as “drinkable” or “just about right” should be avoided when researching expectations and their effect on consumer experience.

Lastly, Carlsmith and Aronson (1963) describe the relationship between expected and perceived ratings only in qualitative terms. While this is important and understandable in early studies such as this one, in more recent studies there is a need to model and quantify the relationship between product cues, expectations, and perception. Expectations are thought to mediate the effect of product cues on perception of taste and flavour (Okamoto & Dan, 2013). However, expectancy is rarely modelled using a mediation analysis. Mediation analysis is a statistical tool, type of structural equation modelling that can help us describe and quantify complex relationships between multiple variables. In its simplest form, mediation analysis allows to establish a causal effect between independent (IV), mediator (M) and dependent variable (DV), where the mediating variable transmits the effect of an independent variable on a dependent variable (see Figure 1.4). This final point, the need to establish the mediating role of expectancy in the relationship between contextual information and sensory perception is addressed in this thesis. Keeping these research limitations in mind, I will now review available research to demonstrate that expectancy generated by different product cues has the potential to alter perception of taste, flavour and liking.

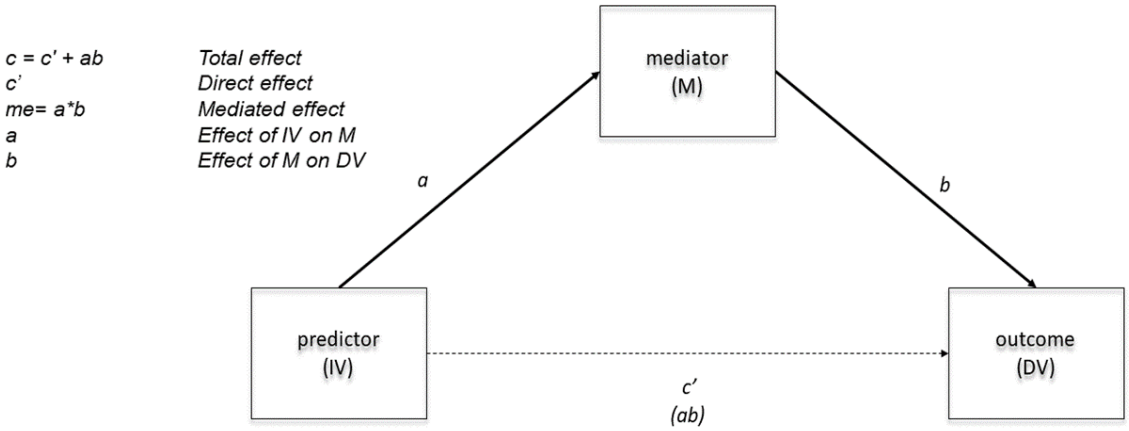

Figure 1.4. An example of a simple mediation model

1.3.1 Liking

It appears that it is easier to alter consumers' perceived hedonic perception - liking -than to change their sensory perception of taste, flavour or mouthfeel. General product information (Cardello, 2003; Tuorila et al., 1994), information about the product origin (Stolzenbach et al., 2013), production processes, quality (Siegrist & Cousin, 2009), nutritional information (Schouteten et al., 2015), and alcohol content (Meillon et al., 2010; Silva et al., 2017) have all been shown to influence liking.

An example of liking changing as a result of altered expectations is a study by Siegrist and Cousin (2009). In that study, researchers asked participants to taste and evaluate wines. Some of the participants before tasting received information about the wine quality (fictitious Parker rating). Participants who received positive information about the wine reported liking it significantly more and were willing to pay more for the wine than participants who received negative information prior to tasting the same wine. This is an excellent example of extrinsic information changing consumers' perceived liking, although notably expectations were not measured, only assumed.

Similarly, providing information about alcohol content can change liking (Silva et al., 2017). In a well-designed study, Silva and colleagues measured, among other things, participants' expected as well as perceived liking of beer with and without alcohol, which was either labelled as beer or non-alcoholic beer. One of the study findings suggests that non-alcoholic beer labelled as such was expected to be liked less than non-alcoholic beer labelled as beer, and more interestingly, once tasted the correctly labelled non-alcoholic beer was rated as liked less than non-alcoholic beer labelled as beer. While the researchers did not statistically quantify the causal link between expectations and hedonic perception, it suggests that the expected liking had an effect on ratings of perceived liking.

Even intrinsic cues, such as colour have been shown to affect some measures of expected and perceived liking of drinks. Colour of drink samples altered both expected and perceived liking, as well as other evaluations, such as refreshment (Zellner & Durlach, 2003).

While there is abundant evidence that liking can be affected by product-related cues, it is not always the case. Some researchers failed to find any effect of cues, or even expectations on hedonic ratings. Two studies that examined the effect of beer colour on consumer experience serve as examples (Carvalho et al., 2017; Reinoso-Carvalho et al., 2019). In both of these studies, researchers measured expected and perceived liking as well as taste and mouthfeel of beer. While in both of these studies colour of beer generated expectations, no effect of colour on perception was observed. Similarly, Tijssen et al.(2019) showed that label design can affect expectations, but they failed to observe any effect of label design on perceived hedonic ratings of biscuits. Explanations for null findings are many, either false negatives or relatively small sample sizes or perhaps we need to develop a better understanding of consumer segmentation and how the relationship between product cues, expectations and perception

changes in different product contexts. So, while the relationship between product cues, expectations, and liking is likely to be complex and nuanced, it is apparent that contextual information in the form of product cues can and does alter expected and perceived liking.

1.3.2 Perception of taste, Flavour and mouthfeel

While it is clear why the study of liking and how this can be manipulated is important, as liking is a determinant of choice, purchase intent and even satiation (Hascher et al., 2021; Nguyen & Varela, 2021; Reverdy et al., 2010), investigating gustatory perception, on the other hand, might appear less useful. However, a detailed understanding of changes in sensory perception as a result of product cues and expectations is valuable not only in the practical sense of helping us tweak and improve perceived sensory profiles of products, but also in the theoretical sense of helping researchers further develop neural models of expectancy in relation to perception of taste, flavour, and mouthfeel, some of which were discussed in section 1.1.4.3.

With an increased health awareness of consumers, manufacturers are often required to reduce the amount of salt, sugar fat or alcohol content. These changes inevitably change the product properties and with it, consumer experience. Many researchers have studied the effects of product cues on sensory perception, including perception of taste, flavour and mouthfeel (see reviews Fernqvist & Ekelund, 2014; Okamoto & Dan, 2013; Piqueras-Fiszman & Spence, 2015; Skaczkowski et al., 2016). As noted earlier in section 1.2.2.2, Velasco and colleagues have shown that typeface curvilinearity, an important label design feature, has influenced both consumer's expectations and perception sweet and sour taste in candy (Velasco et al., 2018). Similarly Parker and Penfield demonstrated that the label "natural vanilla" enhanced perceived ratings of vanilla flavour, as well as liking (Parker et al., 2005). Likewise, Barnett and Spence (Barnett & Spence, 2016) showed how label colour, or more

accurately label design, affected consumers ratings of perceived flavour ("citrusy") of beer as well as liking ("taste").

There is even an indication that product cues, such as labelling, auditory cues or aroma can affect oro-sensory perception and mouthfeel. Soups that were labelled as "high fat" resulted in ratings of higher creaminess, regardless of actual fat content (Yeomans et al., 2001). In another study researchers investigated the role of packaging texture, a rarely investigated extrinsic product cue, on oral-sensory perception of food texture, demonstrating that there is an association between packaging texture and ratings of crunchiness (Piqueras-Fiszman & Spence, 2012b). Information about healthiness and nutritional content was shown to alter ratings of perceived body of chocolate milk samples (Shepherd et al., 1991). Notably, none of these studies directly measured expectations, a major limitation of studies focusing on the association between product cues and consumer experience.

It should be noted that there are also numerous studies which failed to observe any effect of extrinsic and intrinsic cues on gustatory perception. For example, studies examining the effect of product-related cues on sensory perception showed that 'reduced salt' labels did not decrease perceived saltiness of soup (Liem, Toraman Aydin, et al., 2012), colour of beer failed to alter sensory all aspects of sensory perception (Carvalho et al., 2017; Reinoso-Carvalho et al., 2019), 'reduced fat' labels did not alter perception of taste and flavour of soup (Yeomans et al., 2001), labelling juices as 'local' had no effect on the perceived taste and flavour (Stolzenbach et al., 2013), sustainability information had no effect on ratings of chocolate (Silva et al., 2017), GM-free[3] labelling did not change perception of taste of crisps, biscuits and yoghurt

[3] GM-free is a label that a product is not or does not contain a genetically modified organism (GMO)

(Schouteten et al., 2015), and MSG label had no effect on consumer experience including taste (Prescott & Young, 2002).

Carefully looking at the literature, it seems that even vague descriptors about quality and design features can result in change in liking. However, it would seem that to achieve a change in gustatory perception, be it taste, flavour or mouthfeel, there has to be a strong cross-modal correspondence between the cue and the percept, such as the association between angular typeface and sourness (Velasco et al., 2016), or the cue must explicitly evoke the relevant sensory percept, most likely as a sensory descriptor such as “creamy”, “reduced salt” and “sweet”. Given the mixed results in the literature it is clear that more clarity is needed. We could develop better understanding by studying the relationships between product cues, expectations and consumer experience in product specific contexts, as some cue-percept relationships are likely to be product-specific. Another way forward is to improve research methods. Researchers should measure participants’ responses in both blind and informed conditions, explicitly measure expectations, avoid both vague language and the interchangeable use of sensory and hedonic concepts, such as using the word “taste” to measure liking, and the use of just-about-right scales to measure perception of taste. Finally, research questions need to be based on established theories, which then need to be carefully tested, rather than producing exploratory studies one after another.

1.3.3 Summary

The research considering changes in perception, both sensory and hedonic, as a result of product-related cues are somewhat mixed. While there is evidence that product cues can result in changes in liking and sometimes in changes of sensory ratings, there is a clear lack of understanding of the relationship between product cues, expectations, and oral experience (sensory and hedonic perception). This gap in knowledge will be addressed in this thesis. More

specifically, chapters 2 and 3 will present a model of how extrinsic and intrinsic product cues, affect expected and perceived properties of alcoholic and non-alcoholic beer.

1.4 POST-INGESTIVE PHASE

Eating and drinking have long-term implications in addition to providing sensory and hedonic sensations during consumption. We continue to feel the effects of eating and drinking for a length of time after consumption, referred to here as the post-ingestive phase. The post-ingestive effects of food and beverages are varied: foods and beverages may fill us up, quench our thirst, and satisfy our hunger, and some foods and beverages, such as those containing alcohol or caffeine, can even alter our mood or cognitive performance. Food can induce feelings of guilt, but also reduce negative emotions, bring back memories and provide comfort.

A key motivator for eating and drinking is indeed the potential of food to reduce our hunger or beverages to quench our thirst and thus satisfy our biological need for energy and water. As a result, food and drink are considered primary reinforcers and eating and drinking is in itself rewarding (Berridge, 1996; Grabenhorst, 2014; Higgs, 2016). Food has an incentive value beyond satiation, and the joy of eating is also a major motivator. So, while reducing feelings of hunger and thirst are rewarding, and so is eating itself and can thus generate positive emotions, ingestion of foods/beverages containing psychoactive substances such as caffeine or alcohol, will lead to more direct mood changes post-ingestion. It has been shown that both caffeine and alcohol can change mood (Curtin & Lang, 2007; Nehlig, 2010; Pohorecky, 1977) as well as aspects of cognitive performance (Glade, 2010; Nehlig, 2010; Tzambazis & Stough, 2000).

However, we should note that the post-ingestive effects of both psychoactive substances, as well as the effects of food and water to satisfy thirst and hunger, are often context dependent. This context can relate to our expectations (how filling a food/beverage is), sensory properties (beverage viscosity), and our motivational state (e.g. thirst, hunger). For example, both expected satiety and sensory properties, especially those relating to texture, of a product can reduce future food intake (Chambers et al., 2015; Yeomans & Chambers, 2011). Similarly, the sensory properties of a product, as well as product-related cues, can alter perception of how thirst-quenching a drink is (Guinard et al., 1998). And the effects of caffeine on cognitive performance and mood depend will depend on how caffeine deprived participants are (Yeomans et al., 2002). A recent systematic review showed that even only believing that one consumed a caffeinated drink can improve some aspects of cognitive performance (Galindo et al., 2020). Finally, alcohol has the ability to change mood in line with cultural expectations, as Lindman and colleagues showed (Lindman et al., 2015; Lindman & Lang, 1994).

It is therefore important, especially in the case of alcoholic and reduced-alcohol beverages, to consider consumers' post-ingestive experience. However, we cannot ignore the role of context, especially motivational and product-related cues and expectations, as these can have a profound impact on aspects of post-ingestive experience. And understanding the relationship between motivation/focus and post-ingestive experience can be used to improve consumers experience of reduced alcohol beers as well as other healthy products. While drinks and foods can affect us in many ways post-ingestion, this thesis will focus on mood and cognitive performance with a reference to overall consumer satisfaction. Consumer motivation and the specific post-ingestive effects of alcohol (mood, cognitive performance, and satisfaction) are discussed in more detail in the following sections.

1.4.1 Utilitarian and hedonic motivation

Consumer choices, as well as evaluation of most products are based on hedonic and utilitarian considerations (Dhar & Wertenbroch, 2000). In terms of definitions, the utilitarian dimension refers to instrumentality or functionality, that is how useful or beneficial the product is, while hedonic dimension refers to experiential affect associated with the product or its consumption (Batra & Ahtola, 1990; Dhar & Wertenbroch, 2000). While there are many products which are consumed primarily for either their hedonic properties (vice products) or their utilitarian properties (virtue products), hedonic and utilitarian motivations are rarely mutually exclusive (Batra & Ahtola, 1990; Muñoz-Vilches et al., 2019). Indeed, most products are consumed for both utilitarian and hedonic reasons. Both beer and non-alcoholic beer are good examples of this, as they are consumed both because of the sensory properties (taste, flavour mouthfeel) and because of their medium- and long-term effects (e.g. thirst reduction, health, mood, cognitive performance) (Chrysochou, 2014; Guéguen, 2003).

In the specific case of foods and beverages hedonic aspects of a product are based on short-term experience during consumption, while utilitarian aspects relate to relatively long-term effects of the product. To guide consumers to consider either the hedonic or utilitarian aspects we can use process simulation and outcome simulation, respectively (Escalas & Luce, 2004). Hedonic focus can be elicited by process simulation during which consumers think about the consumption, and utilitarian focus can be elicited by an outcome simulation during which participants focus on the consequences of consumption (Escalas & Luce, 2004; Muñoz-Vilches et al., 2019). Indeed, Muñoz-Vilches and colleagues in their recent study demonstrated that in the context of healthy and unhealthy snack foods participants' choice and wanting could be to some extend manipulated using brief process or outcome mental simulations (Muñoz-Vilches et al., 2019).

As reduced alcohol beer is consumed both because of its sensory properties and health benefits (Chrysochou, 2014), while regular beer is consumed both because of its sensory characteristics and effects of alcohol, they are an excellent example of products which require consumers to evaluate both their hedonic and utilitarian value. It is therefore possible that paying attention to either hedonic or utilitarian/functional aspects of the product may interact with the drink's alcohol content and affect consumers' hedonic, sensory, and post-ingestive experience. Since labels are primarily used to communicate information to customers, they are an ideal medium for directing consumer's attention to desired aspects of a product. Labels could be used to shift consumers' focus and potentially, together with the presence or absence of alcohol alter/ improve consumers' post-ingestive experience and overall satisfaction.

1.4.2 Mood

Ethanol is the key pharmacological component of alcoholic drinks, and the experienced effects of ethanol are the reason why we enjoy alcoholic drinks so much. Alcohol, a psychoactive substance, has been shown to affect human mood, behaviour and cognitive processes (Curtin & Lang, 2007; Heinz et al., 2011; Kumar Yadav & Velaga, 2021; McCollam et al., 1980; Tzambazis & Stough, 2000). However, the psychological and to some extend physiological changes can arise from expectation-driven placebo effect (Bjork & Gilman, 2014; Bodnár et al., 2020; Schlauch et al., 2010).

For example, Lindman and colleagues showed that feelings of positive affect or aggression after ingesting alcohol vary among cultures and are likely due to expectations rather than direct pharmacological action of alcohol (Lindman et al., 2015; Lindman & Lang, 1994). Similarly, Bodnár and colleagues also showed a classical placebo effect of alcohol on mood, that is they found no difference between participants emotion ratings for those who consumed

alcoholic beverage and those who only believed to have consumed an alcoholic beverage (Bodnár et al., 2020). More interestingly, the same researchers also demonstrated that when participants who had consumed alcohol but believed they had consumed a non-alcoholic beverage adjusted their behaviour and reported feeling less inebriated than those participants who were aware of their alcohol consumption.

As the sensory properties of non-alcoholic beers resemble regular alcoholic beer but lack alcohol, it is important to understand the role of expectancy and whether or how drawing attention away from cues signalling lack of alcohol (e.g. 0.0 % label) can impact drinkers' mood as well as other post-ingestive ratings, such as consumer satisfaction. For example, Smeets and de Graaf in an fMRI study (Smeets & de Graaf, 2019) did not find any differences in brain reward as a result of consumption of non-alcoholic beer in a context in which alcoholic beer was expected: the researchers concluded that it is beer flavour rather than presence of alcohol that drives the consumer experience.

1.4.3 Cognitive performance

It is well known that alcohol interferes with cognitive performance and negatively impacts performance on a range of laboratory as well as realistic tasks such as driving (Dry et al., 2012; Dunaway et al., 2011; Jongen et al., 2014; Kumar Yadav & Velaga, 2021; van Dijken et al., 2020). More specifically alcohol has been shown to impair information processing (Koelega, 1995), reaction time (Landauer & Howat, 1982; Tzambazis & Stough, 2000), response inhibition (Schweizer & Vogel-Sprott, 2008), memory (Molnár et al., 2009) and attention (Bjork & Gilman, 2014; Maylor et al., 1990). Early stages of information processing have been shown to be especially vulnerable even at low doses of alcohol blood or breath alcohol concentration (Cash et al., 2015; Dry et al.,

2012). A detailed review of effects of acute alcohol consumption on cognitive performance can be found in a review by Schweizer & Vogel-Sprott, (2008).

While cognitive performance, as an objective measure, may be less susceptible to the effects of expectancy, than more subjective measures such as mood, cognition is nonetheless affected by participants' expectations and situational context (Bodnár et al., 2020). For example, when participants believed they had consumed an alcoholic drink and expected cognitive impairment they performed poorly on a Rapid Information Processing Task compared to those who did not consume any beverage (Fillmore et al., 1998). In another study, participants who received placebo showed a slower reaction times on covert attentional processing task, not too dissimilar to RT of those who consumed alcohol (Gilbertson et al., 2010) (for a review see: Galindo et al., 2020).

However, the decline in cognitive performance is only partially driven by the effects of alcohol and expectations. In part it is driven by the conditioned response due to the repeated association between sensory properties (particularly taste and flavour) of an alcoholic beverage and alcohol. Fukuda, in her multi experiment study, demonstrated that even when participants knew they were consuming non-alcoholic beer, their performance on a Go/No Go task was worse compared to those who consumed water (Fukuda, 2019). As, in the case of mood, the effects of alcoholic beverages on performance are far from simple. This, however, may be used to consumers' advantage when trying to improve their experience. At the moment, however relevant research on post-ingestive experience in the context of reduced alcohol beverages is missing.

1.4.4 Satisfaction

Overall satisfaction is an important concept in sensory science and consumer research, not least because it directly affects consumer purchase intentions and product success (Andersen & Hyldig, 2015; Tsiotsou, 2006). In the context of food and drink, satisfaction is a complex measure of general appreciation and is determined by a multitude of factors, including product sensory characteristics alongside situational factors. While I discuss consumer satisfaction within the post-ingestive phase, it should be pointed out that satisfaction is determined by factors before, during and after consumption (Andersen & Hyldig, 2015). Previous research demonstrated that satisfaction is determined by expected liking and actual liking, confirmation of expectations, situational appropriateness and post-ingestive feelings (Andersen et al., 2017; Cardello et al., 2000; Vad Andersen & Hyldig, 2015). Moreover, Mano and Oliver (1993) demonstrated, using a consumer survey, that both utilitarian and hedonic evaluations of a product (see section 1.4.1) contribute to consumer satisfaction. And while satisfaction is not the primary topic of this thesis, it will be discussed in Chapter 5 as part of a study of the impact of customer focus on post-ingestive experience in the context of alcoholic and non-alcoholic beer.

1.4.5 Summary

Eating and drinking has the potential to affect our mood and emotions, feelings of thirst and hunger, alter our cognitive performance post-consumption. The way foods and beverages affect consumer post-ingestive experience depends on consumers' expectations, the product's sensory properties as well as other motivational factors or reasons for consumption (e.g. hunger, utilitarian or hedonic evaluations). Overall, post-ingestive experience is complex, especially in the context of products containing psychoactive substance such as alcohol, as it can affect post-ingestive experience both directly (physiological effects of alcohol) and indirectly through expectancy and

prior flavour-effect associations. While this complexity requires extensive research, understanding what roles situational factors and consumers' beliefs play in creating post-ingestive experience, including satisfaction can be further used to improve this experience and support customers. Chapter 5 of this thesis will begin to uncover the relationships between motivational focus, sensory properties and post-ingestive experience of regular and non-alcoholic beers.

1.5 SUMMARY

Beer has been a part of our civilisation for millennia now and it is safe to say that it is here to stay. However, in recent years we have seen a rise in demand for reduced alcohol beverages, including low- and non-alcoholic beers. Given this trend and the issue with perceived sensory properties of reduced alcohol beers as well as potential negative attitudes to dealcoholized beverages, especially in some consumer segments (Meillon et al., 2010), it is important to understand what can be done to improve consumer acceptance of reduced alcohol beers and how to improve their experience and thus satisfaction.

Instead of focusing on bottom-up chemosensory properties of reduced alcohol beers we wanted to investigate the top-down influences of expectancy generated by product-related cues. For this purpose, I have identified 3 stages of consumption: the pre-ingestive phase, oral phase and post-ingestive phase. After reviewing the existing literature, I have identified common methodological issues as well as questions pertinent to each of these stages and designed experimental studies to answer these questions. These studies make up the body of this thesis.

1.5.1 Pre-ingestive Phase

Study 1 (Chapter 2) was a series of 4 online experiments investigating what extrinsic cues (sensory descriptors, label colour, label design, size of descriptors, labelled alcohol content) generated sensory and hedonic expectations (bitter, smoothness, sweetness, refreshment, body, liking and beer colour). This then guided design of studies 2, 3 and 4.

1.5.2 Oral Phase

Studies 2 and 3 addressed the relationships between product cues, expectations and gustatory experience. More specifically, Study 2 (Chapter 3) investigated the effect of beer colour, taste (bitterness) and sensory descriptor ("bitter") on expected and perceived bitterness, refreshment, body and liking. Study 3 (Chapter 4) then extended the outcome of Study 2 to examine the effect of product cues (labelled alcohol content, sensory descriptors, beer colour) on expected and perceived bitterness, refreshment, body and liking. Notably, Studies 2 and 3 introduced mediation analysis as a tool to model and quantify the relationships between products cues, expectations, and perception.

1.5.3 Post-ingestive phase

Finally, Study 4 (Chapter 5) aimed to address the effects of consumer focus (manipulated using information on beer labels) and alcohol content on post-ingestive experience (mood, cognitive performance, and satisfaction).

1.5.4 Conclusion

To summarise, the aim of this thesis is to investigate and describe the relationship between expectations and gustatory and post-ingestive experience in the context of alcoholic and non-alcoholic beer. The potential application of this research is to improve consumer experience and acceptance of reduced-alcohol beers. The consequences, implications as well as limitations of the research are discussed in the discussion.

2 CHAPTER 2: THE EFFECT OF IMPLICIT AND EXPLICIT EXTRINSIC CUES ON HEDONIC AND SENSORY EXPECTATIONS IN THE CONTEXT OF BEER

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Running head: Effects of label on expectations about beer

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Declaration of interest:

This experiment was carried out as a part of a PhD project funded by Fund Baillet Latour. Claire Hidrio and Philippe Godineau are employees of AB InBev, and while they have provided feedback on the design of the study and assisted with sourcing the samples, they did not contribute to the data analysis or interpretation of the results. Helena Blackmore and Prof. Martin Yeomans have no conflicts of interest to declare.

Acknowledgements

This study is a part of a PhD project funded by Fonds Baillet Latour.

Author contributions

Conceptualization: H.B, and M.R.Y.; methodology: H.B., and M.R.Y.; software, H.B; Sourcing samples: H.B, P.G, C.H.; formal analysis: HB; interpretation: HB; writing—original draft preparation: H.B; review and editing: H.B, M.R.Y, C.H; P.G supervision: M.R.Y; C.H.; Y.; funding acquisition, M.R.Y

Abstract

While the demand for non-alcoholic beer has increased, consumers often complain about its inferior sensory characteristics. As expectations mediate the effect of extrinsic product cues on sensory perception, we could utilise these cues to improve consumers' experience of such products. The current study, comprising four repeated measures experiments, investigated the role of extrinsic cues in generating sensory and hedonic expectations of beer. A hundred and sixty-six beer drinkers viewed realistic beer labels, which varied in their colour, design, labelled alcohol content and sensory descriptor, in response to which they rated their expectations of bitterness, smoothness, sweetness, refreshment, beer colour, body and liking. In summary, across these four experiments, label colour, labelled alcohol content and sensory descriptor all had significant and replicable effects on consumer expectations. However, the size of these effects depended on how explicit or implicit the information of a cue was relative to the presence and specificity of other cues on the label. For example, red and brown labels increased expected bitterness ($F(3,108)=16.58$, $p<0.001$, $\eta_g^2=0.102$), but this effect decreased ($F(1,38)=7.92$, $p=0.008$, $\eta_g^2=0.026$) when labelled alcohol content was also manipulated and disappeared ($F(1, 37)=2.1$, $p=0.156$) when an explicit cue, a sensory descriptor, was added. Overall, the study provides new insights into how labelling shapes expectations, and illustrates the disproportionate influence of different extrinsic cues. Finally, the findings highlight the need to use realistic stimuli: the information different extrinsic cues carry and the way we combine them influences expectations.

2.1 INTRODUCTION

Consumer demand for healthier alternatives, particularly in response to the encouragement to moderate their alcohol intake (Department of Health, 2016; Rehm et al., 2016) has led to the need to develop reduced or no alcohol versions of alcoholic beverages. With beer being one of the most popular alcoholic beverages in the world (Ritchie & Rosser, 2019) it is not surprising that the sale of non-alcoholic beer (NAB) has risen steadily over the past 10 years (Abboud, 2019). Yet, consumers often complain that commercially available reduced alcohol alternatives do not match the sensory properties of popular beverages such as wine or beer (Sohrabvandi et al., 2010). Indeed, it has been repeatedly shown that consumers perceive non-alcoholic beer negatively and expect its taste to be inferior compared to standard beer (Silva et al., 2017; Wigmore & Hinson, 1991). While this can be a result of negative attitudes towards unfamiliar products and novel technologies used to manufacture them (Cardello, 2003; Tuorila et al., 1994), consumers also complain that non-alcoholic beer is lacking in sensory characteristics, often describing existing low-alcohol or alcohol-free products as dull in flavour and lacking body (Blanco et al., 2016; Chrysochou, 2014; Sohrabvandi et al., 2010). To improve acceptability of non-alcoholic and low alcohol beers and thus provide a healthier alternative to beer drinkers, we have to not only improve sensory properties of beers with lower alcohol content, but also shift consumer attitudes and expectations.

Expectations have been shown to depend on previous experience, individual differences and product-related information, either intrinsic or extrinsic to the product (Deliza & MacFie, 1996). Intrinsic cues are aspects of a product that are directly related to its physiochemical and sensory properties, such as colour or aroma (Cardello, 2007). Extrinsic cues on the other hand are related to the product, but not part of it (Piqueras-Fiszman & Spence, 2015)*:*

these typically relate to the product packaging and labels. To understand the relationship between product information and sensory perception we must first explore the relationship between information and expectations, as expectations mediate the effect of extrinsic product cues on consumer experience (Deliza & MacFie, 1996; Lee et al., 2006; Piqueras-Fiszman & Spence, 2015; Sarinopoulos et al., 2006; Woods et al., 2011).

As mentioned above, labels are an example of an extrinsic product cue which can easily and conveniently communicate information about a product. Explicit information about a product, including ethical information (Napolitano et al., 2007, 2010), information about production (Caporale & Monteleone, 2004; Cardello, 2003), nutrition (Liem, Miremadi, et al., 2012), but also about taste and sensory properties of the product (Okamoto & Dan, 2013; Yeomans et al., 2008) as well as more implicit information conveyed by brand (Allison & Uhl, 1964; Varela et al., 2010), packaging colour (Piqueras-Fiszman & Spence, 2012a; Spence et al., 2015) or imagery (Gil-Pérez et al., 2019; Rebollar et al., 2017) have all been shown to alter consumers' expectations and/or perception. Label attributes directly relevant to sensory expectations about beer are therefore discussed in more detail below.

2.1.1 Colour

Colour is widely used in marketing for different purposes, such as eliciting specific emotions in customers or influencing participants' appetite (Singh, 2006). For example, Piqueras-Fiszman and Spence (2012a) showed that liking, flavour, taste and even aroma ratings of hot chocolate were influenced by the colour of the cup it had been served in. There is a large body of evidence supporting the notion that colour can affect taste and flavour perception (see Spence et al., 2015). However, it is not only taste and flavour perception that can be altered by colour of packaging or labels. For example, Guéguen (2003)

showed that, the colour of a cup has an effect on expected refreshment of a drink.

In a more relevant experiment, Barnett & Spence (2016) demonstrated that beer drunk from bottles with a green label was perceived as having a more citrusy flavour than beer from a bottle with a brown label. However, the labels used in that study differed in overall design, as well as colour, so it is likely that only part of the observed effect can be attributed to the influence of colour per se. In another study, Sugrue & Dando (2018) explored how extrinsic and intrinsic factors of cider (colour of cider and cider packaging) affected sensory ratings such as body, sweetness and refreshment. They found that the colour of the label (green and red) altered perceived liking, sweetness, fruitiness and refreshment of the drink. There is thus evidence that extrinsic colour cues have the potential to alter expectations as well as sensory perception and liking.

2.1.2 Sensory descriptors

It is not surprising that a simple, explicit description, such as ‘low salt’, ‘reduced fat’, ‘savoury’, ‘creamy’ or ‘bitter’ would generate strong expectations and even alter taste perception. Indeed, it has been repeatedly shown that sensory descriptors can alter both expectations and perception of liking, taste, flavour and mouthfeel (Liem, Miremadi, et al., 2012; Olson & Dover, 1978; Yeomans et al., 2001, 2008).

For example, Liem and colleagues (2012) presented participants with soups that differed in salt content and labelling. In a within-participant study, participants tasted soups differing in labelled and actual salt content and rated expected liking and saltiness. The findings showed that the ‘reduced salt’ label generated expectations of lower liking and saltiness, which translated into decreased ratings of perceived saltiness and liking. The notion that expectations can affect perception of taste are further supported by neuroimaging studies

(Nitschke et al., 2006; Sarinopoulos et al., 2006; Woods et al., 2011). For instance, Woods et al. ((Woods et al., 2011) illustrated that information about sweetness of a drink not only altered expected and perceived sweetness, it also changed participants' neural activity. More specifically, when a participant expected a very sweet drink (100% juice) and instead were offered a drink of medium sweetness (50% juice, 50% water) the increase in perceived sweetness was accompanied by increased activation in their primary taste cortex. These findings further strengthen the evidence put forward by behavioural studies, as they show that the change in participants' ratings is not the result of demand characteristics.

2.1.3 OTHER INFORMATION

One of the most important pieces of information displayed on alcoholic beverages, including beer, is its alcohol content. In line with EU regulations, the alcohol content of alcoholic drinks must be displayed on all products sold in the EU that contain more than 1.2 % ABV. (REGULATION (EU) No 1169/2011, 2011). Information about alcohol content has been previously linked to expectations and evaluation of body and liking (Meillon et al., 2010; Niimi et al., 2017; Silva et al., 2017). However, most research to date has focused on the relationship between alcohol content and expected liking, largely ignoring the effect of labelled alcohol content on sensory expectations. For instance, Meillon et al. (2010), investigated the effect of labelled alcohol content on liking of partially dealcoholized wines. Lower labelled alcohol content on the bottle significantly reduced both expected and actual enjoyment. Similarly, Silva et al. (2017) investigated how labelling beer as 'beer' or 'non-alcoholic beer' affected expected and actual liking of these beverages. Not surprisingly, the label 'non-alcoholic beer' generated expectations of lower liking than the label 'beer'.

More recently, the design of packaging, specifically typeface curvilinearity, has attracted interest. Some researchers suggested that even characteristics such as curvilinearity of shapes and fonts can alter perception of sweet and sour tastes (Velasco, Salgado-Montejo, et al., 2014; Velasco et al., 2018). In his study, Velasco et al. (2018), displayed the word 'candy' either using angular or rounded face type and asked participants to rate the taste of jellybeans. Those participants who tasted the sweets looking at an angular word 'candy' rated the jellybeans as more sour, while those who did the tasting being exposed to a rounded word rated it as more sweet. Thus, even shapes and fonts displayed on packaging can affect expectation generation.

2.1.4 Aims of the study

In summary, to improve consumer experience of beer with reduced alcohol content through manipulating consumer expectations we first need to understand the way expectations are generated. The aim of this study is to understand the effect of different extrinsic cues on expectations of taste, flavour and mouthfeel. With the knowledge how extrinsic cues generate sensory and hedonic expectations and how they interact, we may be able to use these cues to improve consumer experience of reduced alcohol beers, which may ultimately lead to reduced alcohol consumption. So, while the aim of the study is not to directly reduce consumers' alcohol intake, it may be a consequence if the insights produced by this study are further developed and eventually applied.

To address the need to understand how combining and manipulating multiple extrinsic cues affects consumers' expectations, we designed a series of four experiments to test the effect of extrinsic cues (label colour, design, labelled alcohol content and sensory descriptor) on sensory and hedonic expectations. Based on the body of literature discussed above we hypothesised

that the extrinsic cues manipulated in these experiments will have the potential to alter participants' expectations of liking, taste and mouthfeel.

2.2 METHOD

2.2.1 DESIGN

A series of four web-based experiments investigated the effects of label design (experiment 1), label colour (experiments 1, 2, 3, and 4), labelled alcohol content (experiments 2 and 4) and sensory descriptor (experiments 3 and 4) on expectations of liking, bitterness, smoothness, sweetness, refreshment, body and colour of beer. Results of each experiment were used to optimise the design of the subsequent experiments: see Table 2.1 for more details about independent and dependent variables and Figure 2.1 for example stimuli used in these experiments.

Table 2.1. Summary of main features of experiments 1-4

	Experiment 1 (*n=37)*	**Experiment 2** (*n=39)*	**Experiment 3** (*n=52)*	**Experiment 4** (*n=38)*
Design	3x4 repeated measures	2x3x5 repeated measures	2x3x4 repeated measures	2x3x4 repeated measures
What aspects of the label were manipulated?	Label colour (brown, red, green, blue) Label design (classic, modern, simple)	Label colour (blue, brown) Size of text (50%, 100%, 150%) Labelled ABV (0.0%, 1.5%, 3.0%, 4.5%, 6.0%)	Label colour (blue, brown) Size of text (50%, 100%, 150%) Sensory descriptor (standard, bitter, refreshing, full body)	Label colour (blue, brown) Labelled ABV (0.0%, 3.0%, 6.0%) Sensory descriptor (standard, bitter, refreshing, full body)
Number of stimuli	12 (each 2x) See Figure 2.1A	30 See **Error! Reference source not found.**B	24 See Figure 2.1**Error! Reference source not found.**C	24 See Figure 2.1D
What was measured?	Expected: bitterness, smoothness, sweetness, refreshment, liking, body, beer colour			
Results	Figure 2.2, Table 2.3	Figure 2.3, Table 2.4	Figure 2.4, Table 2.5	Figure 2.5, Figure 2.6, Table 2.6
Highlights	When label colour and design were manipulated while other attributes were held constant, participants relied heavily on colour to generate expectations	When information about alcohol content was added, the effect of colour on expectations decreased	When the label colour and sensory descriptor were manipulated, consumer expectations were determined primarily by sensory descriptor	Overall, consumer expectations were mostly influenced by sensory descriptor, followed by labelled alcohol content, with the effect of label colour being markedly diminished compared to experiments 1,2,3

A. **Variations in label colour and design from Experiment 1**

B. **Variation in label colour, labelled alcohol content and size of alcohol information from Experiment 2**

C. **Variation in label colour, sensory descriptor and size of sensory descriptor from Experiment 3**

D. **Variation in label colour, sensory descriptor and labelled alcohol content from Experiment 4**

Figure 2.1.Example of label designs in the four experiments

2.2.2 PARTICIPANTS

Altogether 166 participants took part in the study, each participating in only one of the four experiments. All participants were over 18 years old, without history of alcohol use disorder and who characterised themselves as occasional beer drinkers, which was specified as drinking on average at least one beer a month. All participants gave informed consent in the accordance with the Declaration of Helsinki. The experimental protocol was approved by the Sciences & Technology Cross-Schools Research Ethics Committee at the University of Sussex (application ER/HB315/3), and the study conducted in accordance with the ethical standards defined by the British Psychological Society.

Participants were recruited online through the University of Sussex recruitment system and social media. Participants did not differ significantly in age, gender distribution or preference for ale or lager between the four experiments (see *Table 2.2* for data and analysis summary). By chance, however, participants did differ in how often they drank alcoholic and non-alcoholic beer: a Chi-square test contrasting participants who drank alcoholic and NA beers more often than once a month or less frequently revealed a significant difference between participants who took part in different experiments (see Table ***2.2***). This was mainly due to a higher number of regular drinkers of NA beer in experiment 3 and a relatively low number of participants who drank beer at least fortnightly experiment 1 (see Table ***2.2***).

Table 2.2. Participants' characteristics: mean and standard error of age and percentage of all beer drunk that was ale or lager, percentage of males and percentage of participants who consumed beer and non-alcoholic beer at least fortnightly, and comparison of these across experiments*. * p<0.05, ** p <0.01, *** p <0.001*

		E1 (*n*=37)	E2 (*n*=39)	E3 (*n*=52)	E4 (*n*=38)	statistic	*p*
	age	29.2 (1.7)	34.1 (1.5)	26.5 (1.1)	31.7 (1.7)	adj R^2=-0.006	0.848
	male (%)	38	41	37	55	$X^2(1)$= 0.370	0.544
Type of beer consumed	ale (%)	------	40.38 (5.35)	30.53 (3.19)	29.68 (4.33)	adj R^2=0.015	0.089
	lager (%)	------	49.18 (5.16)	49.76 (3.24)	47.57 (4.23)	adj R^2=-0.007	0.798
Participants consuming beer at least fortnightly	**beer (%)**	**45.95**	**71.80**	**82.35**	**83.78**	**$X^2(3)=17.70$**	**<0.001*** **
	NAB (%)	**2.70**	**10.26**	**38.46**	**15.79**	**$X^2(3)=19.19$**	**<0.001*** **

2.2.3 PROCEDURE

All four experiments were designed and administered as online surveys using Qualtrics software (*Qualtrics*, 2018) and each participant completed the relevant survey in their own time and environment of choice. There was no time limit. At the beginning, the instructions explained that the purpose of the study was to investigate hedonic and sensory expectations generated by beer labels, but the specific dimensions being manipulated were not mentioned to minimise demand effects. So, while the participants were aware of the aim of study, they were naïve to the research hypotheses. Together with the instructions, specific definitions of those sensory attributes of beer that some

participants may have been less familiar with, notably smoothness and body, were provided as follows: *"The body of a beer is characterised as the fullness of the flavour and mouthfeel. Smoothness of a beer refers to its texture and feeling in the mouth."* The explanation of these terms was to ensure that all participants understood what aspect of the described beer they were being asked to rate. Each participant was presented with a series of fictitious beer labels, using a neutral, fictitious beer company name, presented in a random order (see Figure 2.1 for example stimuli). Participants used 0-100 visual analogue scales (VAS) to rate their expectations of liking (dislike extremely- like extremely), colour (light-dark), body (light-full), smoothness (not at all smooth-extremely smooth), sweetness (not at all sweet-extremely sweet), bitterness (not at all bitter-extremely bitter), refreshment (not at all refreshing-extremely refreshing). The order in which these hedonic and sensory attributes were rated was also randomised for each label. On completion of the study, participants were compensated with a £3 Amazon reward voucher. See Table 2.1 for details about individual experiments.

2.2.4 DATA ANALYSIS

Data from all four experiments were analysed using R studio, R 3.4.3. RM ANOVA (ezANOVA) was used to determine the effect of the independent variables (colour and label design) on each of the sensory and hedonic expectations. Where necessary, degrees of freedom were corrected using Greenhouse-Geisser correction. Additionally, the standard Bonferroni correction was manually applied for multiple comparisons (Experiment 1: α=0.017, Experiments 2-4: α=0.007) (Cao & Zhang, 2014; Cramer et al., 2016). The main analysis was followed by pair-wise t-tests with planned contrasts using Bonferroni correction. The full outcome of all analyses are reported in Tables 4-7. Only significant results are discussed in the following text for brevity.

2.3 RESULTS

2.3.1 EXPERIMENT 1

2.3.1.1 Bitterness

The results showed that the label colour significantly affected expected bitterness ($F(3,108)=16.58$, $p<0.001$, $\eta_g^2=0.102$). Post-hoc tests showed that beer with red labels was expected to be more bitter than beer with blue labels ($p=0.05$), and brown labels generated expectation of higher bitterness compared to blue, green and red labels ($p<0.001$ for all three comparisons). There was no significant effect of label design on ratings of expected bitterness. (Table 2.3, Figure 2.2A).

2.3.1.2 Smoothness

Neither label colour nor label design significantly affected expected liking of the beer (Table 2.3, Figure 2.2B).

2.3.1.3 Sweetness

The label colour significantly altered participants' expectations of sweetness ($F(3,108) = 23.47$, $p<0.001$, $\eta_g^2=0.159$). Post hoc analyses revealed that brown labelled beer was expected to be less sweet than beer with labels of any other colour ($p<0.001$), additionally red labels generated expectations of lower sweetness than blue labels ($p=0.03$). Neither label design, nor the interaction between label design and colour, significantly affected ratings of expected beer sweetness. (Table 2.3, Figure 2.2C).

2.3.1.4 Liking

The analysis revealed a significant effect of label colour on expected liking ($F(2.3, 81)=4.46$, $p=0.012$, $\eta_g^2=0.035$). More specifically, brown labels elicited significantly lower expected liking than blue ($p=0.003$), green ($p=0.013$) or red ($p=0.012$) labels. (Table 2.3, Figure 2.2D).

2.3.1.5 Refreshment

The results again showed a significant effect of colour ($F(3, 108) = 18.18$, $p < 0.001$, $\eta_g^2 = 0.168$) on expected refreshment. Specifically, brown and red labels elicited expectations of lower refreshment than green and blue labels ($p < 0.001$ for all comparisons). Expected refreshment was not significantly affected by label design. (Table 2.3, Figure 2.2E)

2.3.1.6 Body

Analysis of expected body revealed a main effect of label colour ($F(2.4, 86.4) = 18.11$, $p < 0.001$, $\eta_g^2 = 0.158$). Post hoc tests showed that the brown label was expected to have significantly higher body than labels of any other colour ($p < 0.001$ for all comparisons). Additionally, red label generated expectation of higher body compared to blue ($p < 0.001$) and green ($p = 0.028$) labels. (Table 2.3, Figure 2.2F).

2.3.1.7 Beer Colour

The results showed a significant effect of label colour ($F(3,108) = 44.66$, $p < 0.001$, $\eta_g^2 = 0.315$) on expectations of the colour of the beer, but no significant effect of label design on expectations was detected. Post hoc analysis revealed that brown labels were associated with expectations of darker colour than blue, green and red labels ($p < 0.001$) and similarly red labels were associated with expectation of darker colour than blue and green labels ($p < 0.001$). (Table 2.3, Figure 2.2G).

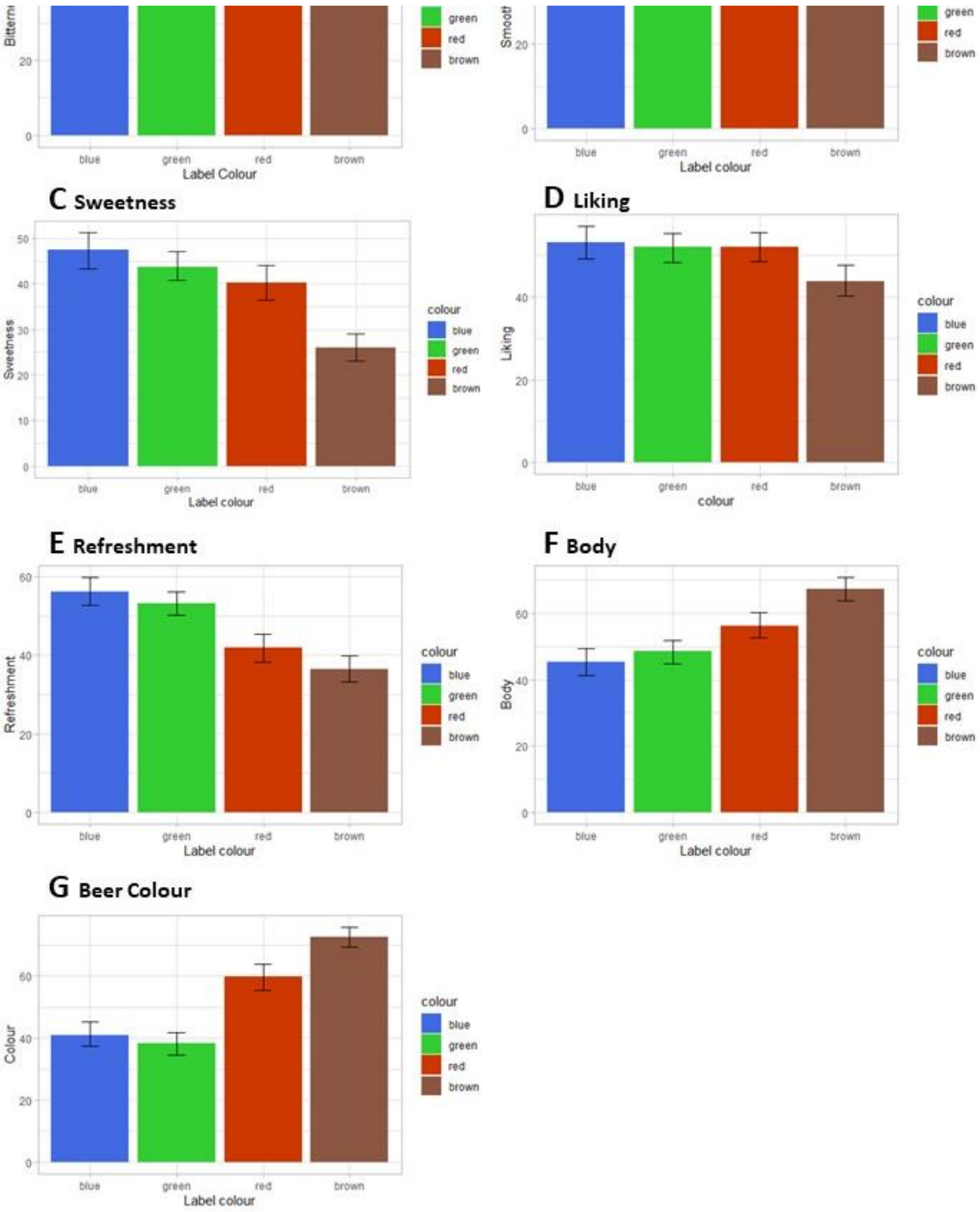

Figure 2.2. Experiment 1: The effect of label colour on rated expectations for the sensory and hedonic characteristics of beer. *All data are mean with 95% CI (Boot), n=37. * p<0.05, ** p <0.01, ** p <0.01, **** p<0.0001.*

Table 2.3. Experiment 1: Effects of Label colour and design and their interactions on all sensory and hedonic expectations. *Significant effects (p < 0.017) are shown in bold*

	Effect	df	Error df	F	p	η_g^2
Bitterness	**Colour**	**3**	**108**	**16.58**	**<0.001**	**0.102**
	Design	1.7	61.3	0.54	0.557	0.002
	Colour X Design	6	216	0.40	0.878	0.0003
Smoothness	Colour	2.1	76.0	0.39	0.687	0.004
	Design	1.7	61.6	1.96	0.155	0.008
	Colour X Design	6	216	0.34	0.916	0.003
Sweetness	**Colour**	**3**	**108**	**23.47**	**<0.001**	**0.159**
	Design	2	72	0.28	0.758	<0.001
	Colour X Design	4.9	161.8	1.87	0.111	0.017
Liking	**Colour**	**2.3**	**81**	**4.46**	**0.012**	**0.035**
	Design	2	72	0.84	0.435	0.003
	Colour X Design	4.8	172.8	1.17	0.327	0.011
Refreshment	**Colour**	**3**	**108**	**18.18**	**<0.001**	**0.168**
	Design	2	72	0.32	0.729	0.001
	Colour X Design	4.3	154.9	2.62	0.033	0.021
Body	**Colour**	**2.4**	**86.4**	**18.11**	**<0.001**	**0.158**
	Design	2	72	0.03	0.966	<0.001
	Colour X Design	4.7	167.8	2.68	0.026	0.022
Beer colour	**Colour**	**3**	**108**	**44.66**	**<0.001**	**0.315**
	Design	2	72	1.86	0.164	0.008
	Colour X Design	6	216	2.55	0.021	0.021

2.3.1.8 Conclusion

The results of the first experiment showed that label colour significantly affected consumer expectations. Notably, the size of the effect was $0.108<\eta_g^2<0.3$ which is considered a large effect (Cohen, 1988). The results of this study served as a rationale for the second experiment in which only two label colours were used, blue to represent cool and brown to represent warm colours. The second experiment focused on the effect of labelled alcohol content on expectations: alcohol levels were chosen in line with Sohrabvandi et al.'s (2010) classification and to reflect commercially available beers. The 0.0% represented non-alcoholic beer, 1.5% low alcohol beer, 3.0% light beer, 4.5% standard strength beer and 6.0% high alcohol beer. We also manipulated size of the labelled alcohol content to investigate whether drawing attention to the information about alcohol content affects expectation generation, as visual cues have been shown to impact visual attention (Proulx, 2010).

2.3.2 EXPERIMENT 2

2.3.2.1 Bitterness

The analysis revealed a marginally significant effect of colour ($F(1, 38) = 7.92$, $p = 0.008$, $\eta_g^2 = 0.026$), and a significant effect of labelled alcohol content ($F(2.2, 84.1) = 19.94$, $p < 0.001$, $\eta_g^2 = 0.072$) on expected bitterness of beer. Overall, brown labels generated expectations of higher bitterness compared to blue labels, moreover expected bitterness increased with labelled alcohol content. More specifically, the label 6.0% generated expectations of higher bitterness than any other alcohol content (0.0%: $p < 0.001$, 1.5%: $p < 0.001$, 3.0%: $p < 0.001$, 4.5%: $p = 0.041$), while beer with 4.5 % alcohol content was expected to be more bitter than low alcohol (1.5%: $p < 0.001$) and non-alcoholic beer (0.0%: $p < 0.001$). Finally, the label 3.0% generated expectations of higher bitterness than the 0.0% label ($p = 0.025$). (Table 2.4, Figure 2.3A)

2.3.2.2 Smoothness

There were no significant effects of colour, size or labelled alcohol content on participants' expectations of smoothness (Table 2.4, Figure 2.3B).

2.3.2.3 Sweetness

The analysis showed a significant effect of labelled alcohol content on expectations of sweet taste ($F(2.5, 95.8) = 10.42$, $p<0.001$, $\eta_g^2=0.039$). As Figure 2.3C shows, expectations of sweetness decreased with increasing labelled alcohol content. Beer with high alcohol content (6.0%) was expected to be less sweet than low alcohol (1.5%) ($p<0.001$) and non-alcoholic (0.0%) beer ($p=0.003$). Similarly, beer with 4.5% alcohol was expected to taste less sweet than low alcohol (1.5%) ($p=0.056$) and non-alcoholic (0.0%) beer ($p<0.001$). Finally, the 3.0% alcohol content label generated expectations of lower sweetness than 0.0% label ($p<0.001$). (Table 2.4, Figure 2.3C).

2.3.2.4 Liking

Surprisingly, neither labelled alcohol content nor label colour significantly affected expectations of liking (Table 2.4, Figure 2.3D).

2.3.2.5 Refreshment

With regard to expected refreshment, the analysis showed that expectations were significantly affected by label colour ($F(1,38)=27.98$, $p<0.001$, $\eta_g^2=0.074$) but not by labelled alcohol content. Beers with blue labels were expected to be more refreshing than beers with brown labels. (Table 2.4, Figure 2.3E)

2.3.2.6 Body

There was a main effect of label colour ($F(1, 38) = 9.85$, $p=0.003$, $\eta g2=0.041$), and labelled alcohol content ($F(1.8, 67.2) = 40.26$, $p<0.001$, $\eta g2=0.156$) on expectations of body. Generally, brown beers and beers with

higher labelled alcohol content were expected to have fuller body. Specifically, beer with high alcohol content (6.0%) was expected to have fuller body than beers with lower alcohol content (p<0.001 for all comparisons). Moreover, non-alcoholic beer (0.0%) was expected to have lighter body than beer with 3.0% or 4.5% or 6.0% alcohol content (p<0.001 for all comparisons). Additionally, low alcohol beer (1.5%) was expected to have lighter body than beer with 3.0%, 4.5% or 6.0% (p<0.001 for all comparisons). (Table 2.4, Figure 2.3).

2.3.2.7 Beer Colour

The analysis revealed a significant effect of label colour (F (1, 38) =13.21, p<0.001, η_g^2=0.080), and labelled alcohol content (F (2.0, 77.2) =19.08, p<0.001, η_g^2=0.075) on expected colour of the beer. Brown labels generated expectations of darker beer colour than did blue labels. Moreover, beer with a high labelled alcohol content (6.0%) was expected to be darker than beer with lower alcohol content, also beer with 4.5% alcohol resulted in expectations of darker colour than beer with 1.5% alcohol (p=0.004) or non-alcoholic (0.0%) beer (p<0.001*)*. Similarly, 3.0% beer was also expected to be darker than the low alcohol (1.5%) (p=0.029) or the non-alcoholic (0.0%) beer (p<0.001). (Table 2.4, Figure 2.3G)

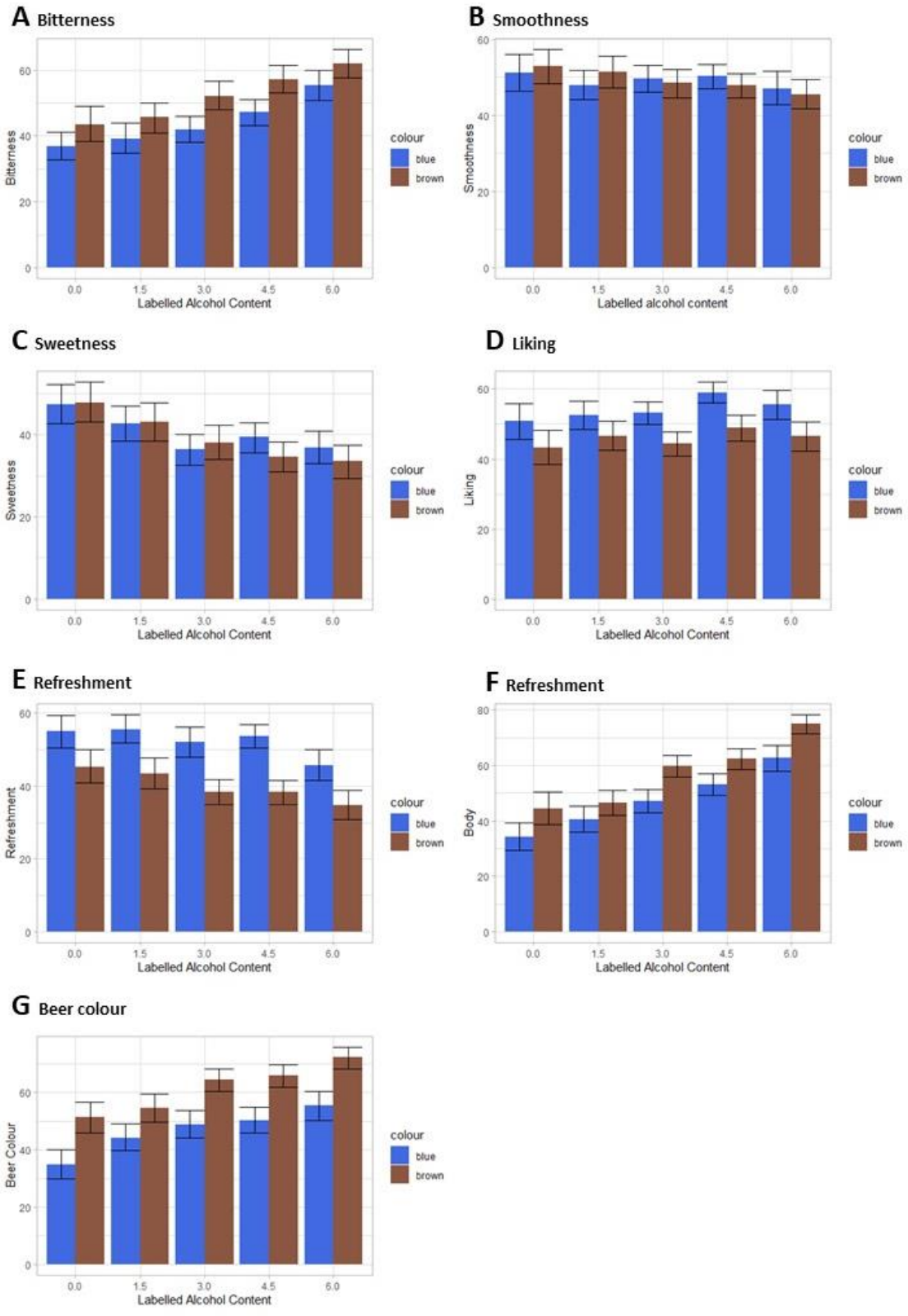

Figure 2.3. Experiment 2: The effect of label alcohol content on rated expectations for the sensory and hedonic characteristics of beer. *All data are mean with 95% CI (Boot), n=39.*

Table 2.4. Experiment 2: Effects of Label colour, labelled alcohol content and size of labelled alcohol content and their interactions on all sensory and hedonic expectations. *Significant effects (p < 0.007) are shown in bold*

	Effect	df	Error df	F	p	η_g^2
Bitterness	**Colour**	**1**	**38**	**7.92**	**0.008 (marginal)**	**0.026**
	Alcohol	**2.2**	**84.1**	**19.94**	**<0.001**	**0.072**
	Size	2	76	0.40	0.672	<0.001
	Colour X Alcohol	4	152	0.69	0.597	0.001
	Colour X Size	2	76	0.98	0.382	<0.001
	Alcohol X Size	8	304	0.80	0.606	0.002
	Colour X Alcohol X Size	5.0	190.6	0.14	0.984	<0.001
Smoothness	Colour	1	38	0.001	0.970	<0.001
	Alcohol	2.0	77.2	1.33	0.269	0.007
	Size	2	76	0.72	0.491	<0.001
	Colour X Alcohol	4	152	1.46	0.216	0.003
	Colour X Size	2	76	1.03	0.361	<0.001
	Alcohol X Size	8	304	1.01	0.428	0.003
	Colour X Alcohol X Size	8	304	0.48	0.872	0.002
Sweetness	Colour	1	38	0.33	0.571	<0.001
	Alcohol	**2.5**	**95.76**	**10.42**	**<0.001**	**0.039**
	Size	2	76	0.12	0.884	<0.001
	Colour X Alcohol	3.0	114.3	1.47	0.228	0.003
	Colour X Size	1.6	60.23	0.77	0.441	<0.001
	Alcohol X Size	5.8	219.5	1.98	0.073	0.006

	Colour X Alcohol X Size	5.2	196.1	0.77	0.574	0.003
Liking	**Colour**	**1**	**38**	**6.42**	**0.016**	**0.033**
	Alcohol	1.9	71.4	1.47	0.237	0.011
	Size	1.7	64.3	1.72	0.192	0.001
	Colour X Alcohol	4	152	0.81	0.518	0.001
	Colour X Size	2	76	0.18	0.839	<0.001
	Alcohol X Size	6.1	232.9	0.75	0.611	0.002
	Colour X Alcohol X Size	6.1	230.1	1.29	0.264	0.004
Refreshment	**Colour**	**1**	**38**	**27.98**	**<0.001**	**0.074**
	Alcohol	2.0	76.8	4.25	0.018	0.003
	Size	2	76	3.28	0.043	0.003
	Colour X Alcohol	4	152	1.24	0.296	0.002
	Colour X Size	2	76	1.33	0.270	0.001
	Alcohol X Size	8	304	0.96	0.467	0.003
	Colour X Alcohol X Size	5.7	215.8	0.49	0.806	0.002
Body	**Colour**	**1**	**38**	**9.85**	**0.003**	**0.041**
	Alcohol	**1.8**	**67.2**	**40.26**	**<0.001**	**0.156**
	Size	2	76	2.57	0.083	0.002
	Colour X Alcohol	4	152	1.38	0.243	0.002
	Colour X Size	2	76	0.98	0.379	<0.001
	Alcohol X Size	8	304	0.58	0.797	0.002
	Colour X Alcohol X Size	8	304	1.22	0.285	0.003
Beer colour	**Colour**	**1**	**38**	**13.21**	**<0.001**	**0.080**
	Alcohol	**2.0**	**77.2**	**19.08**	**<0.001**	**0.075**

Size	1.7	65.4	4.74	0.016	0.003
Colour X Alcohol	3.2	121.8	2.41	0.066	0.002
Colour X Size	1.9	62.7	0.21	0.766	<0.001
Alcohol X Size	5.3	200.6	0.53	0.766	0.001
Colour X Alcohol X Size	6.1	230.1	0.53	0.785	0.001

2.3.2.8 Conclusion

The focus of Experiment 2 was on the effect of labelled alcohol content on sensory and hedonic expectations. While the alcohol content affected participants' sensory expectations, it had no significant effect on expected liking. Interestingly, with the addition of more explicit information (alcohol content) to the label, the effect of label colour was diminished. The label colour had a significant effect on expected bitterness, refreshment and colour of the beer, but the effect sizes ($0.072<\eta_g^2<0.080$) were considerably smaller than in Experiment 1 ($0.108<\eta_g^2<0.3$). Experiment 3 was similar to Experiment 2, but instead of alcohol content, it explored the effect of sensory descriptors: 'bitter', 'refreshing', 'full body' and 'standard' on sensory and hedonic expectations about beer, with the prediction that describing beer as "bitter" (a traditional descriptor of beer in the UK) would in particular generate expectations of a more bitter taste.

2.3.3 EXPERIMENT 3

2.3.3.1 Bitterness

Analysis revealed significant effects of label colour ($F(1, 51) = 12.02$, $p<0.001$, $\eta_g^2=0.012$) and descriptor ($F(1.9, 95.8) = 16.96$, $p<0.001$ $\eta_g^2=0.045$) on expectations of bitterness. Overall, brown labels generated expectations of higher bitterness than blue labels. Post hoc tests also showed that labels with

the descriptor 'bitter' were expected to be significantly more bitter than labels with descriptors 'standard' (p<0.001 for all comparisons). (Table 2.5, Figure 2.4A).

2.3.3.2 Smoothness

The results showed a significant effect of sensory descriptor on expected smoothness. More specifically beers labelled as 'refreshing' were expected to be smother than those labelled as bitter (p=0.010). (Table 2.5 and Figure 2.4B)

2.3.3.3 Sweetness

The analysis revealed a significant effect of descriptor on expectations of how sweet the beer would taste (F (2.3, 116.0) =7.72, p<0.001, η_g^2=0.012). Overall, the descriptor 'bitter' generated expectations of lower sweetness than descriptors 'refreshing' (p=0.005) and 'standard' (p=0.005). (Table 2.5, Figure 2.4C).

2.3.3.4 Liking

The results showed a significant effect of descriptor on expected liking (F (3,153) =4.53, p=0.004, η_g^2=0.007). Participants expected to like beers labelled as 'refreshing' more than those labelled 'bitter' (p=0.048). There was no significant effect of label colour on expected liking. (Table 2.5, Figure 2.4D).

2.3.3.5 Refreshment

The analysis revealed a main effect of descriptor (F (2.5, 128.5) =7.41, p<0.001, η_g^2=0.015, and the descriptor size (F (2,102) =7.10, p=0.001, η_g^2=0.005) on expected refreshment The post hoc tests showed that the 'refreshing' label generated expectations of higher refreshment than descriptors 'bitter' (p=0.002), 'standard' (p=0.027) and 'full body' (p<0.001). Further, when the descriptor 'refreshing' was presented in a medium size, it generated

expectations of more refreshment compared to a small descriptor size (p=0.044). (Table 2.5, Figure 2.4E)

2.3.3.6 Body

Ratings of expected body were significantly affected by label colour (F (1, 51) =16.58, p<0.001, η_g^2=0.022) and sensory descriptor (F (2.0, 101.0) =9.84, p<0.001, η_g^2=0.038). Post hoc tests showed that the descriptor 'full body' generated expectations of fuller body than all the other descriptors (p<0.001 for all comparisons), moreover brown labels generated expectations of fuller body than blue labels. (Table 2.5, Figure 2.4F).

2.3.3.7 Beer Colour

The results showed a significant effect of label colour (F (1,51)=14.50, p<0.001, η_g^2=0.033) on expected colour of beer. More specifically, brown labels generated expectations of darker beer than blue labels. (Table 2.5, Figure 2.4G).

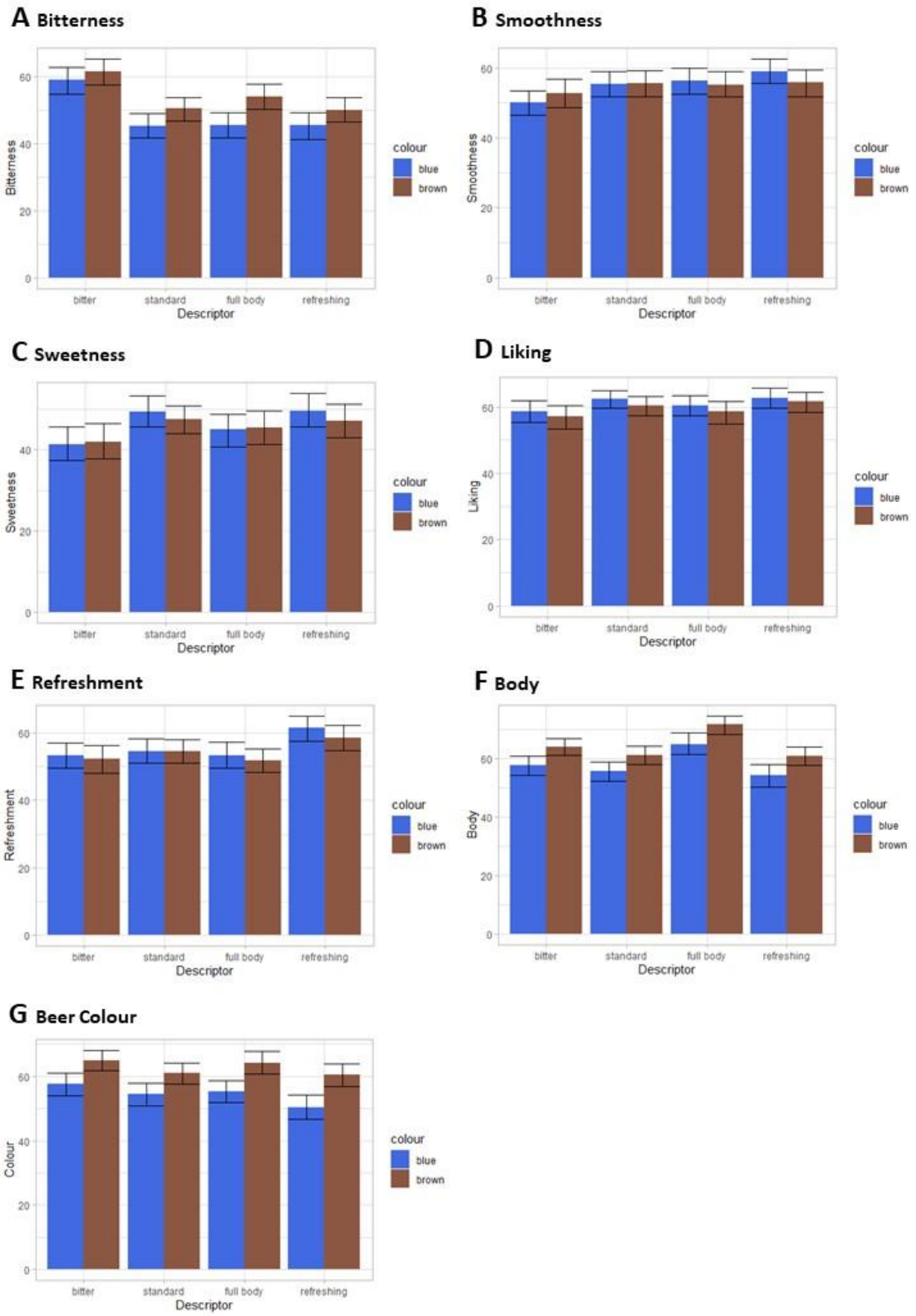

Figure 2.4. Experiment 3: The effect of different label descriptors (bitter, standard, full body, refreshing) on rated expectations for the sensory and hedonic characteristics of beer. *All data are mean with 95% CI (Boot), n=52.*

Table 2.5. Experiment 3: Effects of label colour, sensory descriptor and size of the descriptor and their interactions on all sensory and hedonic expectations. *Significant effects ($p < 0.007$) are shown in bold.*

	Effect	df	Error df	F	p	η_g^2
Bitterness	**Colour**	**1**	**51**	**12.02**	**0.001**	**0.012**
	Descriptor	**1.9**	**95.8**	**16.96**	**<0.001**	**0.045**
	Size	2	102	0.99	0.374	0.001
	Colour X Descriptor	3	153	1.49	0.220	0.002
	Colour X Size	2	102	0.55	0.577	<0.001
	Descriptor X Size	6	306	1.21	0.298	0.003
	Colour X Descriptor X Size	6	306	0.71	0.639	0.002
Smoothness	Colour	1	51	0.05	0.826	<0.001
	Descriptor	**2.1**	**132.8**	**5.64**	**0.002**	**0.009**
	Size	2	102	1.49	0.230	<0.001
	Colour X Descriptor	3	153	1.48	0.221	0.002
	Colour X Size	2	102	1.62	0.203	0.001
	Descriptor X Size	6	306	0.54	0.780	0.001
	Colour X Descriptor X Size	6	306	2.44	0.025	0.005
Sweetness	Colour	1	51	0.36	0.552	<0.001
	Descriptor	**2.3**	**116.0**	**7.72**	**<0.001**	**0.012**
	Size	2	102	1.61	0.205	0.001
	Colour X Descriptor	3	153	0.78	0.509	<0.001
	Colour X Size	2	102	1.12	0.329	<0.001
	Descriptor X Size	6	306	1.07	0.383	0.002
	Colour X Descriptor X Size	6	306	2.18	0.045	0.005

	Colour	1	51	1.67	0.202	0.002
	Descriptor	**3**	**153**	**4.53**	**0.004**	**0.007**
	Size	2	102	1.10	0.337	<0.001
Liking	Colour X Descriptor	3	153	0.06	0.983	<0.001
	Colour X Size	2	102	3.04	0.052	0.003
	Descriptor X Size	6	306	1.81	0.096	0.004
	Colour X Descriptor X Size	4.4	223.7	1.99	0.091	0.004
	Colour	1	51	0.82	0.370	<0.001
	Descriptor	**2.5**	**128.5**	**7.41**	**<0.001**	**0.015**
	Size	**2**	**102**	**7.10**	**0.001**	**0.005**
Refreshment	Colour X Descriptor	3	153	0.30	0.826	<0.001
	Colour X Size	2	102	0.49	0.612	<0.001
	Descriptor X Size	6	306	1.57	0.156	0.004
	Colour X Descriptor X Size	6	306	1.98	0.068	0.004
	Colour	**1**	**51**	**16.58**	**<0.001**	**0.022**
	Descriptor	**2.0**	**101.0**	**9.84**	**<0.001**	**0.038**
	Size	2	102	4.28	0.016	0.004
Body	Colour X Descriptor	3	153	0.09	0.965	<0.001
	Colour X Size	2	102	0.29	0.745	<0.001
	Descriptor X Size	4.8	243.0	0.79	0.555	0.002
	Colour X Descriptor X Size	6	306	1.25	0.279	0.003
	Colour	**1**	**51**	**14.50**	**<0.001**	**0.033**
Colour	Descriptor	3	153	3.81	0.011	0.009
	Size	2	102	0.32	0.724	<0.001

Colour X Descriptor	3	153	0.74	0.530	0.001
Colour X Size	1.7	85.2	0.25	0.741	<0.001
Descriptor X Size	6	306	0.66	0.685	0.002
Colour X Descriptor X Size	4.4	223.7	1.01	0.409	0.003

2.3.3.8 Conclusion

The results of Experiment 3 showed that sensory descriptor had a significant effect on both sensory and hedonic expectations. Similarly to Experiment 2 the effect of label colour on expectations was reduced compared to Experiment 1, and it could be reasoned that this was caused by the addition of more explicit information to the label (sensory descriptor). To explore this idea, the outcomes from Experiments 1-3 were integrated when designing Experiment 4, which aimed to investigate the relative effects of label colour, labelled alcohol content and sensory descriptor on participants' expectations to test how these different influences might interact.

2.3.4 EXPERIMENT 4

2.3.4.1 Bitterness

Replicating the findings from Experiments 2 and 3, there was a significant main effect of descriptor ($F(1.8, 65.7) = 15.95$, $p < 0.001$, $\eta_g^2 = 0.090$) on expected bitterness. Overall, the descriptor 'bitter' generated expectations of higher bitterness than any other label ($p < 0.001$ for all comparisons). In contrast to previous experiments there was no significant effect of label colour (experiments 1, 2 and 3) or alcohol content (experiment 2) on expected bitterness. (Table 2.6, Figure 2.5A and Figure 2.6A)

2.3.4.2 Smoothness

There was no significant effect of label colour, labelled alcohol content or sensory descriptor on participants' ratings of expected smoothness. (Table 2.6, Figure 2.5B and Figure 2.6B)

2.3.4.3 Sweetness

The analysis showed no significant effect of labelled alcohol content, colour or sensory descriptor on expectations of sweetness (Table 2.6, Figure 2.5C and Figure 2.6C).

2.3.4.4 Liking

The analysis showed that expected liking was significantly affected by sensory descriptor ($F(1.6, 60.1) = 7.00$, $p = 0.003$, $\eta_g^2 = 0.03$), while the label colour and labelled alcohol content had no significant effects. With regards to the sensory descriptor, beer described as 'refreshing' was expected to be liked significantly more than beer described as 'bitter' ($p < 0.001$). Additionally, the descriptor 'bitter' elicited expectations of lower liking than the control label 'standard' ($p = 0.005$). (Table 2.6, Figure 2.5D and Figure 2.6D).

2.3.4.5 Refreshment

The analysis revealed that expected refreshment was affected by colour ($F(1, 37) = 12.57$, $p = 0.001$, $\eta_g^2 = 0.009$) and descriptor ($F(2.1, 77.8) = 8.17$, $p < 0.001$, $\eta_g^2 = 0.047$). Overall, beer with blue label was expected to be more refreshing than beer with brown label. With regard to sensory descriptors, beer with the descriptor 'refreshing' was expected to be more refreshing than beer with descriptors 'bitter' ($p < 0.001$), 'full body' ($p < 0.001$) and 'standard' ($p = 0.013$). Additionally, the descriptor 'bitter' was associated with lower expected refreshment than the control label 'standard' ($p = 0.020$). (Table 2.6, Figure 2.5E and Figure 2.6E).

2.3.4.6 Body

The expected body was affected by labelled alcohol content (F (1.5, 54.8) =8.81, p=0.001, η_g^2=0.025) and sensory descriptor (F (2.3, 84.0) =10.74, p<0.0001, η_g^2=0.070), but not by label colour. Beer with high alcohol content (6.0%) was expected to have fuller body than low (3.0%) (p=0.032) and non-alcoholic (0.0%) beer (p<0.001). However, there was no significant difference between non-alcoholic and low alcoholic beer. The label 'full body' generated expectations of fuller body than all other descriptors: 'standard' (p=0.004), 'bitter' (p<0.001) and 'refreshing' (p<0.001). Moreover, beer labelled as 'bitter' was expected to have marginally fuller body than beer labelled as 'standard', i.e. control label (p=0.056). (Table 2.6, Figure 2.5F and Figure 2.6F).

2.3.4.7 Beer Colour

The analysis revealed a main effect of label colour (F (1, 37) =12.02, p=0.001, η_g^2=0.041) and sensory descriptor (F (1.9, 68.7) =6.50, p=0.003, η_g^2=0.028). Brown labels elicited expectations of darker beer colour than blue labels. Additionally, the descriptor 'refreshing' resulted in expectations of lighter colour than descriptors 'full body' (p=0.048) and 'bitter' (p<0.001). In addition, beer described as 'bitter' was expected to be darker than beer labelled as 'standard' (p<0.001). (Table 2.6, Figure 2.5G and Figure 2.6G).

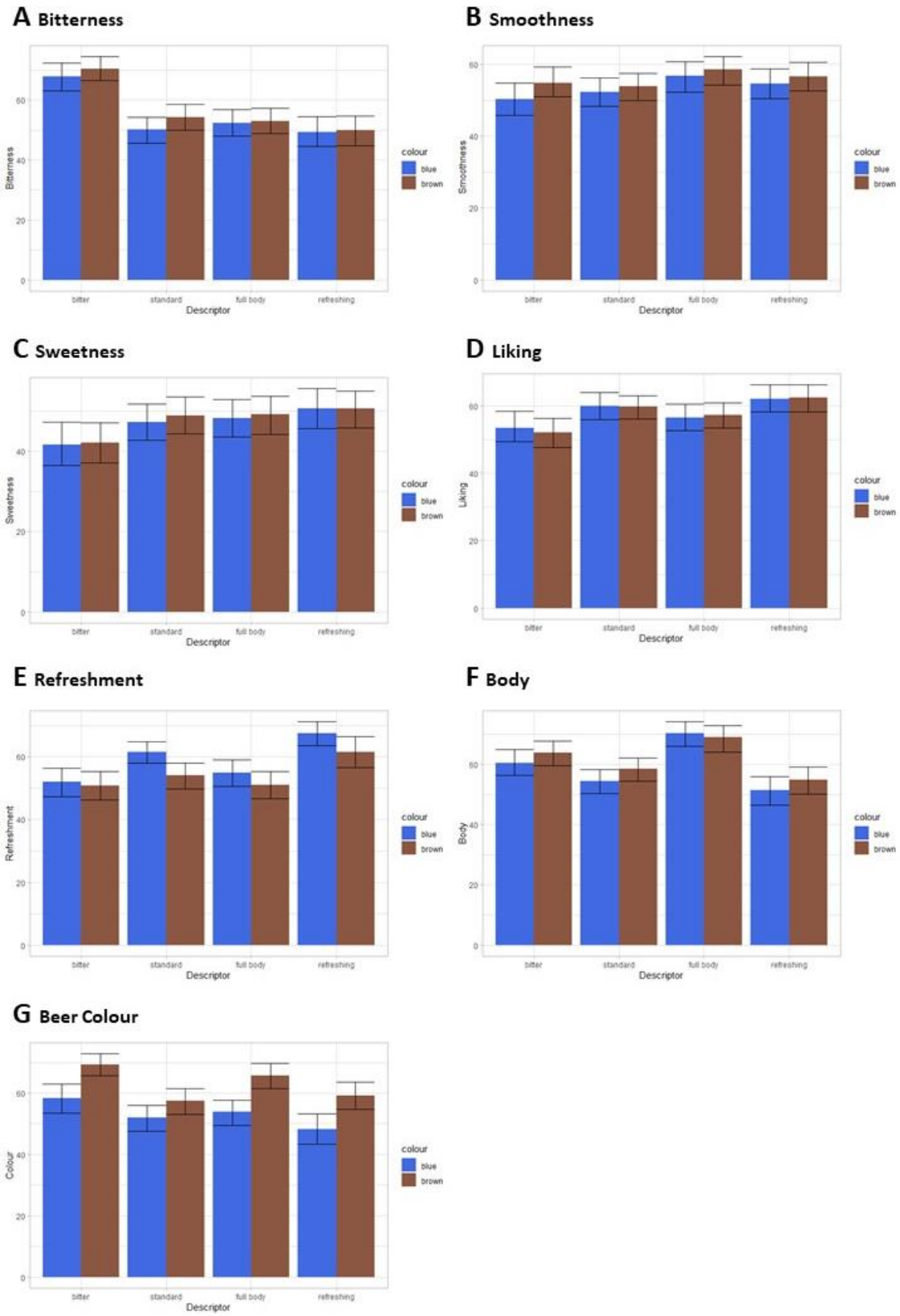

Figure 2.5. Experiment 4: The effect of different label descriptors (bitter, standard, full body, refreshing) on rated expectations for the sensory and hedonic characteristics of beer. *All data are mean with 95% CI (Boot), n=38.*

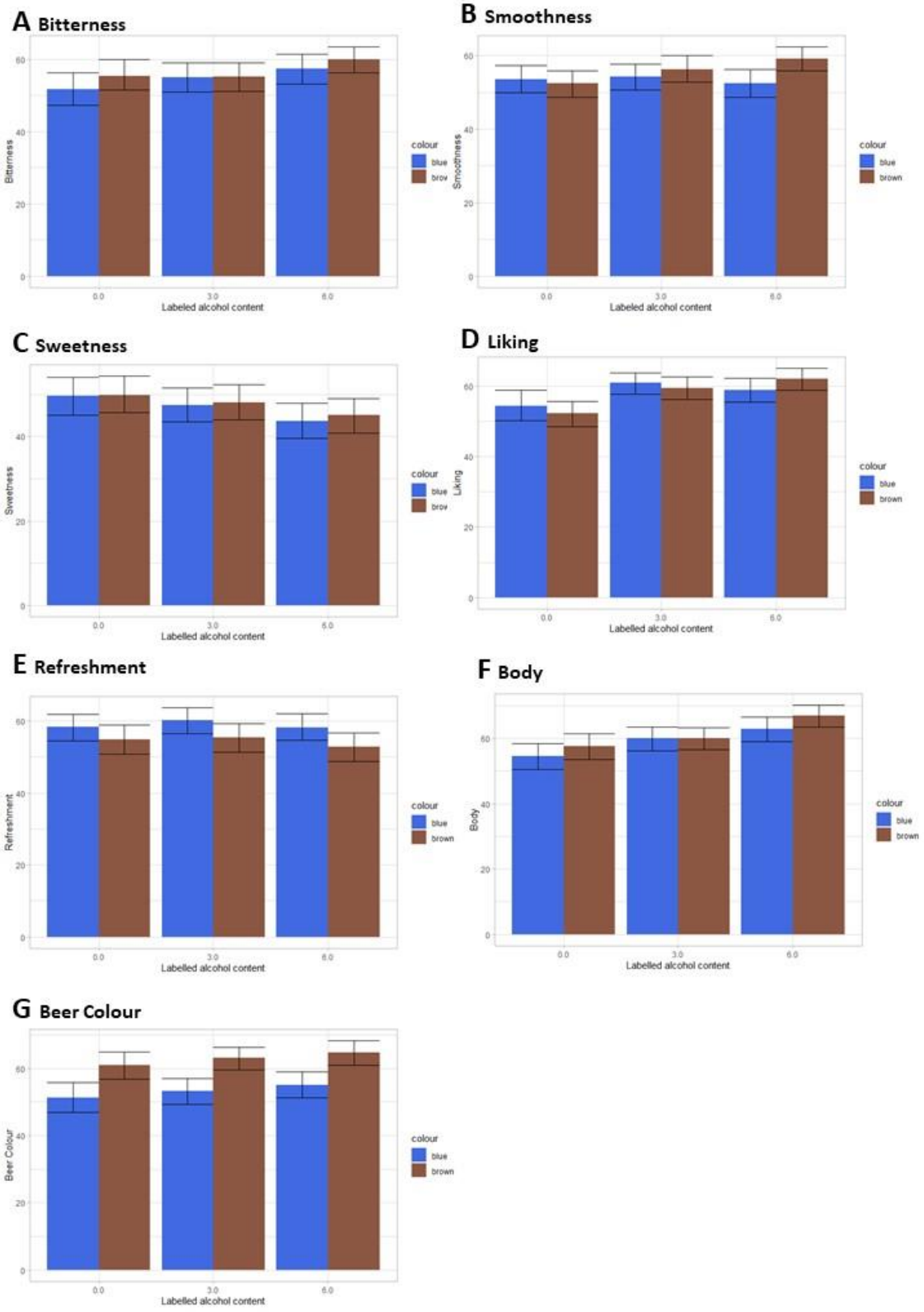

Figure 2.6. Experiment 4: The effect of label alcohol content on rated expectations for the sensory and hedonic characteristics of beer*. All data are mean with 95% CI (Boot), n=38.*

Table 2.6. Experiment 4: Effects of label colour, sensory descriptor and labelled alcohol content and their interactions on all sensory and hedonic expectations. *Significant effects (p < 0.007) are shown in bold.*

		df	Error df	F	p	η_g^2
Bitterness	Colour	1	37	2.10	0.156	0.002
	Descriptor	**1.8**	**65.7**	**15.95**	**<0.0001**	**0.090**
	Alcohol	1.7	62.5	3.26	0.053	0.007
	Colour X Descriptor	3	111	0.65	0.582	<0.001
	Colour X Alcohol	2	74	0.89	0.416	<0.001
	Descriptor X Alcohol	6	222	0.77	0.594	0.002
	Colour X Descriptor X Alcohol	6	222	0.72	0.636	0.002
Smoothness	Colour	1	37	3.30	0.077	0.003
	Descriptor	2.0	73.3	1.60	0.209	0.008
	Alcohol	1.7	61.1	1.61	0.211	0.003
	Colour X Descriptor	3	111	0.46	0.713	<0.001
	Colour X Alcohol	1.7	61.1	4.72	0.017	0.005
	Descriptor X Alcohol	4.4	161.2	0.95	0.442	0.004
	Colour X Descriptor X Alcohol	4.7	174.7	1.07	0.377	0.003
Sweetness	Colour	1	37	0.37	0.544	<0.001
	Descriptor	1.9	70.4	5.05	0.010	0.016
	Alcohol	1.6	60.5	4.01	0.031	0.007
	Colour X Descriptor	3	111	0.09	0.965	<0.001
	Colour X Alcohol	2	74	0.10	0.909	<0.001
	Descriptor X Alcohol	4.5	167.6	0.71	0.601	0.002
	Colour X Descriptor X Alcohol	6	222	0.80	0.571	0.002
Liking	Colour	1	37	0.02	0.888	<0.001

	Descriptor	1.6	60.1	7.00	0.003	0.025
	Alcohol	1.3	48.8	6.14	0.011	0.023
	Colour X Descriptor	3	111	0.17	0.915	<0.001
	Colour X Alcohol	2	74	3.26	0.044	0.003
	Descriptor X Alcohol	6	222	1.48	0.188	0.006
	Colour X Descriptor X Alcohol	6	222	0.46	0.837	0.001
	Colour	**1**	**37**	**12.57**	**0.001**	**0.10**
	Descriptor	**2.1**	**77.8**	**8.17**	**<0.001**	**0.047**
	Alcohol	2	74	1.18	0.312	0.002
Refreshment	Colour X Descriptor	2.4	87.9	0.99	0.385	0.002
	Colour X Alcohol	2	74	0.27	0.761	<0.001
	Descriptor X Alcohol	4.5	167.2	1.78	0.127	0.006
	Colour X Descriptor X Alcohol	6	222	2.12	0.052	0.007
	Colour	1	37	2.40	0.130	0.003
	Descriptor	**2.3**	**84.0**	**10.74**	**<0.001**	**0.070**
	Alcohol	**1.5**	**54.8**	**8.81**	**0.001**	**0.025**
Body	Colour X Descriptor	2.5	92.8	1.22	0.304	0.002
	Colour X Alcohol	2	74	1.26	0.290	0.001
	Descriptor X Alcohol	6	222	0.39	0.885	0.001
	Colour X Descriptor X Alcohol	6	222	0.33	0.920	0.001
	Colour	**1**	**37**	**12.02**	**0.001**	**0.041**
	Descriptor	**1.9**	**68.7**	**6.50**	**0.003**	**0.028**
Colour	Alcohol	1.7	63.6	2.36	0.110	0.004
	Colour X Descriptor	3	111	2.07	0.108	0.003

Colour X Alcohol	2	74	0.001	0.999	<0.001
Descriptor X Alcohol	6	222	0.16	0.986	<0.001
Colour X Descriptor X Alcohol	4.7	174.9	0.61	0.687	0.002

2.3.4.8 Conclusion

Finally, in the fourth experiment we investigated the effects and relative importance of attributes that significantly affected participants' expectations in experiments 1, 2 and 3. Label colour, labelled alcohol content and sensory descriptor were manipulated to establish relative importance of these label attributes in regard to expectations. Describing sensory qualities of beer using a sensory descriptor had a larger effect than labelled alcohol content and label colour. The results of experiment 4 suggested that sensory descriptor was the most influential aspect of a label.

2.4 DISCUSSION

The present study aimed to investigate the effect of extrinsic product cues on sensory and hedonic expectations in the context of beer with the aim to understand what label features are important in the process of expectation generation. While understanding how expectations are generated in the context of beer will not lead to immediate decrease in alcohol consumption, it can enable us to use these cues to generate specific expectations, with the goal of improving consumer experience and satisfaction. As consumer satisfaction is predictive of future purchase (Tsiotsou, 2006), improved consumer experience of reduced alcohol beers increases the likelihood of future purchase and consumption of low and non-alcoholic beers.

Overall, the results showed that label colour, labelled alcohol content and sensory descriptor had the potential to generate or alter participants' expectations, but the design of the label and the size of the information did not seem to play a role. While the effects of colour and sensory descriptor on expectations of liking and sensory experience are in line with previous research (Liem, Miremadi, et al., 2012; Piqueras-Fiszman & Spence, 2012a, 2015; Sugrue & Dando, 2018; Yeomans et al., 2008) some effects of colour were specific to beer. In other contexts, red has previously been associated with sweet taste (Spence et al., 2010), but this was not the case with beer. The results of the present study showed that red-labelled beer was expected to be significantly more bitter than beer with green or blue labels. These expectations would be predicted to arise from prior associations of the stimulus colour with prototypical products (Kauppinen-Räisänen & Luomala, 2010), suggesting that red and brown may be colours frequently used in packaging and associated materials of sweet products, but bitter beers. An alternative explanation is that since red is often associated with effectiveness, intensity and strength (Adams & Osgood, 1973; Kauppinen-Räisänen & Luomala, 2010; Sailis & Buckalew, 1984), red beer labels would generate expectations of greater intensity, i.e. bitter taste. While the effects of colour have been widely studied, results of this study serve as a reminder that the effect of colour on expectations and arguably perception of taste and flavour is product-specific and context dependent.

Another novel finding was the effect of labelled alcohol content on sensory expectations. The present study suggests that labelled alcohol content conveys information about taste, flavour and mouthfeel that consumers use to generate sensory expectations of beer and perhaps other alcoholic drinks. Results showed that alcohol content is associated with expectations of reduced sweetness, increased bitterness, darker colour and especially fuller body. As

mentioned in the introduction, this knowledge can be used when designing labels. For example, non-alcoholic beer displaying 0.0% alcohol content will be expected to have light body, and this could be counteracted by manipulating the specific label colour or by adding a sensory descriptor.

Surprisingly, data from Experiments 2 and 4 showed no effect of labelled alcohol content on expected liking. Indeed, there are several studies that while not primarily concerned with the effect of alcohol content on liking, commented on the surprising finding that labelled alcohol content had no or little effect on expected or perceived liking. For example, Thong et al. (2018) reported that alcohol content was a significantly worse predictor of consumer choice of beer than a brand or packaging format. Similarly, Jaeger et al. (2018) concluded that alcohol content was not a primary determinant of consumer's product evaluations, including liking. This finding may be due to consumer segmentation in the beer market. As Meillon et al., (2010) showed, while labelled alcohol content overall reduces expected liking, there is a marked segmentation of consumers and individual differences in age and familiarity with the beverage play an important role. In their study, negative hedonic expectations of partially dealcoholized red wine were more typical for older participants (>50) than for younger ones (<39). This is in line with Mejlholm & Martens (2006) who showed that older participants (30-59) preferred stronger lager (vs. regular lager or wheat beer) compared to younger participants (18-29). In the case of the present study, the average age of participants was 30 years old with most participants aged below 30. The segmentation of beer consumers in terms of their attitudes towards lower alcohol content, and the relatively low age of participants in our study, may thus explain the failure to observe any effect of labelled alcohol content on expected liking.

However, the current study not only investigated the effect of different extrinsic cues, but also what happens when they are combined. We use past experiences to build a model of the world around us and use these to generate predictions. Expectations can be thought of as predictions of future outcomes, including, but not limited to perception of taste and flavour. Before tasting a product, we will use this previous experience (based on our individual history with related products) and the available data to generate a prediction of the forthcoming experience (de Lange et al., 2018; Yon et al., 2019). The extrinsic cues discussed in this paper are an example of such observable data which consumers use to generate expectations. Consumers commonly evaluate several different product cues simultaneously (Olson & Jacoby, 1972), and each tends to be assigned different importance when evaluating product quality (Andrews & Valenzi, 1971; Olson & Jacoby, 1972; Thorelli et al., 1989). Thus, it is not surprising that when participants in our study had to assess a number of extrinsic product cues to generate a prediction about a product's taste, cues were assigned different importance and did not affect expectations equally. The effect that a cue exerts is likely to be determined by the strength of the association between the cue and the percept. More specifically, if a descriptor "bitter" was in the past more reliably predictive of something bitter than presence of alcohol, or brown packaging, it will have a larger effect on expectations of bitterness.

The results illustrate the disparate effect of the extrinsic cues. Experiment 1 explored the effect of label design and colour; the results showed that while the label design had no significant effect, there was a medium-large effect of label colour on participants' expectations. However, when label colour was combined with an extrinsic cue conveying more explicit information, such as labelled alcohol content (Experiment 2, 4), the effect of label colour was reduced. When label colour was combined with a sensory descriptor

(Experiment 3, 4) which very explicitly described the sensory experience to be expected, the effect of label colour negligible. Similarly, the effect of labelled alcohol content was generally larger when combined with label colour and size than when it was combined with a sensory descriptor, which is arguably more informative than labelled alcohol content. We hypothesise that this change in effect size was due to the relative importance of the cue in a given context, which is likely to be linked to how implicit or explicit the extrinsic cue is compared to other cues that are present. In other words, how informative a given cue is compared to other cues will determine how much participants rely on it when generating expectations of a product. This is an important finding, as it is not uncommon for studies that examine extrinsic factors to focus on only one at the time. Such an approach not only lacks in ecological validity, but also, as implied above, can result in an inflated effect size.

To summarise, the study contributes to the literature with four main findings. First, colour red was in the context of beer associated with bitter taste, which is highly product-specific and may be due to the association between red and intensity. Second, we explained the effects of labelled alcohol content on sensory expectations, mainly bitterness, body, and beer colour, which again appear to be linked to beer strength and intensity of the flavour. Third, we did not find any effect of labelled alcohol content on expected liking, a somewhat surprising result, possibly due to the relatively young age of our participants or the current trend in favour of reduced alcohol beverages. And finally, the results of the study suggest that the effect of extrinsic cues on expectations depends on the strength of association between the cue and the percept: sensory descriptor generating the strongest expectations, followed by labelled alcohol content and label colour.

If we are presented with an ambiguous sensory stimulus, our expectations, or the mismatch between expectations and actual properties of the stimulus, can bias our perception (de Lange et al., 2018). Understanding how expectations arise enables us to take advantage of this phenomenon. As beer has a complex flavour profile (Gamero et al., 2014), expectations can change how its flavour is perceived and thus affect consumer satisfaction. Specifically, in the case of reduced-alcohol beer which lacks body , we can use aspects of labelling to generate expectations of a fuller-bodied beverage, which in turn is likely to increase consumers' perception of body and thus improve their experience and satisfaction, and increasing the chances of future purchase (Tsiotsou, 2006).

While the present study helped to gain insight into expectation generation, the results do not tell us anything about actual consumer experience. This needs to be investigated further. Having expectations about a beverage can affect consumers' experience in three possible ways. First, if the expectations are not strong enough to affect perception of the product and it is perceived as it would be during a blind tasting. A second possibility is that expectations and perception will be assimilated, in which case the sensory and hedonic perception will be moved in the direction of expectations. For example, a bitter beer described as bitter may be rated as more bitter than the same beer without the descriptor. Finally, it is also possible that if the mismatch between expectations and actual properties of the beer are too large it will result in a contrast effect (Cardello, 2007; Cardello & Sawyer, 1992; Deliza & MacFie, 1996) and accentuate the undesirable properties. This can be problematic for non-alcoholic beer- it is possible that if we describe non-alcoholic beer as full-bodied consumers might perceive it as having even lighter body than if no expectations were generated, which would decrease liking. Future studies should examine the size of mismatch between expectations and

actual properties of beer that results in assimilation and contrast, and how this affects consumer liking and overall satisfaction.

2.4.1 LIMITATIONS

While the study has answered the questions about the role of different extrinsic cues and their combinations on hedonic and sensory expectations, there were several limitations. Firstly, the study was conducted online, so the researchers had no control over the participants' environment, including the size of the screen on which they viewed the stimuli and the recruitment process. So, while we recruited regular beer consumers, the specific drinking habits of participants who took part in the different experiments somewhat differed. As discussed earlier, this was driven by an unexpectedly high number of regular consumers of NA beer in experiment 3 and a relatively low number of participants who consumed beer at least fortnightly in experiment 1. However, this should not have affected results as experiment 1 and experiment 3 did not manipulate labelled alcohol content. So, while some participants drank beer more often than others, they all liked and consumed beer at least monthly and were thus familiar with the beverage and information normally displayed on beer bottles.

That said, even though the consent sheet specified that participants must be regular beer drinkers and that they can participate only once and only in one of the experiments, it cannot be guaranteed that this was indeed the case although the software would have prevented multiple entries from the same IP address. On the other hand, web-based experiments have the potential to reach a more diverse sample of participants as well as allowing participants to participate in a non-laboratory setting, increasing ecological validity and meaningfulness of results (Reips, 2002), which can outweigh the limitations mentioned above.

Additionally, due to the repeated measures design of the study and labels being presented one at the time with no time limit, it is likely that participants paid more attention to the label than they would in a real life. This might have led to an overestimation of the effect sizes. Unfortunately, this is a common issue in all experimental studies in which conditions are carefully controlled, often to the detriment of ecological validity.

None of the extrinsic factors tested consistently affected ratings of expected smoothness. The reason for this might be that participants did not fully understand that term in this study context. Although the instructions provided a simple definition, stating that '*smoothness of a beer refers to its texture and feeling in the mouth*', it might not have been a sufficient explanation. Alternatively, perhaps extrinsic cues used in this study did not generate expectations of smoothness; in that case, it might be worth investigating consumer's understanding of the term and to explore further alternative ways through which expectations and perception of smoothness of beer might be altered and, indeed, whether expected smoothness is relevant to consumer experience of beer.

While not a limitation, we should also point out that label colour was used to generate and alter expectations with the assumption that colour conveys some, albeit implicit information about the product. It should however be noted that colour serves other purposes as well, such as drawing attention or eliciting emotions (Singh, 2006). Moreover, colour has different meanings in different cultures (Jacobs et al., 1991; Madden et al., 2000) and as discussed above, colour can communicate different information in the context of different products. Thus, while the present study showed that colour can potentially alter expectations of beer, the relationship between colour and expectations and other aspects of cognition and perception are likely to be complex and context dependent.

2.4.2 Conclusion

While the present study contributed to the literature by shedding more light on expectation generation in the context of beer, many questions relating to expectations and related sensory experience and liking are left unanswered. For example, the present study only focused on expectation generation, thus future studies need to investigate how these extrinsic cues affect sensory perception and actual liking, while taking into consideration previous research on this topic (e.g. Barnett & Spence, 2016; Carvalho et al., 2017; Reinoso-Carvalho et al., 2019). Future research should also include both intrinsic and extrinsic product cues and examine their interaction, as both play a role in expectation generation and can ultimately alter perception of taste, flavour and even mouthfeel, yet extrinsic and intrinsic cues are rarely studied together. Finally, in any future studies there should be a focus on using naturalistic stimuli and studying combinations of extrinsic cues to increase ecological validity of findings. This is important, because consumers rarely encounter simplistic labels that are often used in laboratory, and consumers are surrounded by complex packages and labels with multiple sources of information that need to be looked as a whole if such research is ever to be applied.

3 CHAPTER 3: A TASTE OF THINGS TO COME: THE EFFECT OF EXTRINSIC AND INTRINSIC CUES ON PERCEIVED PROPERTIES OF BEER MEDIATED BY EXPECTATIONS

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Running head: Perceived properties of beer mediated by expectations

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Declaration of interest:

This experiment was carried out as a part of a PhD project funded by Fund Baillet Latour. Claire Hidrio is an employee of AB InBev, and while she has provided feedback on the design of the study and assisted with sourcing the samples, she did not contribute to the data analysis or interpretation of the results. Helena Blackmore and Prof. Martin Yeomans have no conflicts of interest to declare.

Acknowledgements

This study is a part of a PhD project funded by fonds Baillet Latour.

Author contributions

Conceptualization: H.B, and M.R.Y.; methodology: H.B., and M.R.Y.; software, H.B;

formal analysis: HB; interpretation: HB; writing—original draft preparation: H.B;

review and editing: H.B, M.R.Y, C.H; supervision: M.R.Y; C.H.; Y.; funding acquisition, M.R.Y.

Abstract

Before consuming a food or beverage, consumers are exposed to many sources of information related to the product. Such product-related cues can generate expectations, some of which can improve consumers' sensory perception and liking of the product. The question posed in the current study is whether labelling and colour of beer can be used to modify consumers' expectations and improve perception of its taste, flavour and mouthfeel, as these properties can be problematic in reduced alcohol beers. The aim of the current study was to explore how the most salient extrinsic and intrinsic cues affect expectations and perception in the context of beer. Using a repeated measures design, 76 participants viewed label-based sensory information and tasted 16 beer samples differing in colour and bitterness. Participants rated expected and perceived liking, bitterness, refreshment, and body. As predicted, both sensory descriptor and beer colour generated sensory and hedonic expectations. We have also demonstrated that expectations mediate the effect of product related cues on perception and liking. Beer colour affected perceived liking, bitterness, refreshment, and body both directly and indirectly, yet the sensory descriptor 'bitter' only affected sensory perception and liking indirectly. Overall, we conclude that extrinsic and intrinsic cues can together change expectations and more importantly perception and thus potentially compensate for the perceived deficits in taste, flavour and mouthfeel commonly found in reduced alcohol beers.

3.1 INTRODUCTION

Past research has showed that different aspects of product appearance, labelling and marketing can and do influence consumers' expectations and orosensory perception of a product (Olson & Dover, 1978; Piqueras-Fiszman & Spence, 2015; Spence, 2019). Beer is one of the most popular beverages in the world (Salanță et al., 2020; Van Doorn et al., 2019), yet it has until recently been somewhat understudied. Current trends suggest, that beer consumption patterns are changing, partially due to an increase in demand of reduced alcohol beverages, including non-alcoholic beer (Betancur et al., 2020). In order to effectively respond to the changing consumer demand and improve consumer experience, it is crucial to understand the complex relationships between product-related cues that shape consumer experience, consumer expectations and perception. The aim of the present study was to investigate the relationship between product-related cues, expectations, and perceived sensory and hedonic properties of beer, specifically focusing on the role of expectations. More broadly, we wanted to test whether consumer perception can be modified without changing chemosensory properties of the product itself.

3.1.1 Expectations

Our interaction with food and beverages starts before we put them in the mouth. Before taking the first sip or bite, we might look at the label, read the nutritional information, inspect the colour and perhaps even smell the product (Piqueras-Fiszman et al., 2012; Spence, 2016). We use these cues, together with our previous experience, to generate expectations about what we are going to taste. Expectations can then modify not only how much we like the product, but also how we perceive its taste, flavour and even mouthfeel (Cardello, 2007; Deliza et al., 1996; Deliza & MacFie, 1996; Fernqvist & Ekelund, 2014; Piqueras-Fiszman & Spence, 2015). Simply put, product-related cues and information can

generate expectations which in turn can change sensory and hedonic experience. The cues responsible for generating expectations can be related to the intrinsic properties of the product, such as aroma or appearance, or linked to external indicators of quality, such as label, packaging or other sources of information (Deliza & MacFie, 1996; Fernqvist & Ekelund, 2014; Piqueras-Fiszman & Spence, 2015; Spence et al., 2015; Velasco, Salgado-Montejo, et al., 2014).

After initial inspection of a product, we taste it. It is then that our expectations are confronted with the actual sensory properties of the food and beverage. These expectations can be either confirmed, when the sensory properties match the expectations, or disconfirmed, when the sensory properties of the product differ from expectations. What happens to consumer experience/perception in the case of disconfirmed expectations depends, among other things, on the size of the mismatch between expected and actual properties of the product. If the difference is small, the mismatch will be further minimized and the flavour or liking will be perceived as being closer to the expected flavour or liking, i.e. assimilation will occur (see Deliza & MacFie, 1996; Piqueras-Fiszman & Spence, 2015). However, if the difference between expected and actual properties is large, the perceived mismatch will be magnified, i.e. contrast will occur (Cardello, 2007; Deliza & MacFie, 1996; Zellner et al., 2004).

Liem et al.(2012) demonstrated the assimilation effect when they asked participants to taste and rate soups differing in labelled and actual salt content. Soup with reduced salt content which was also labelled as ‘reduced salt’ was not only expected to taste less salty but was also rated as significantly less salty than the same soup without the sensory label. To compare, Yeomans et al. (Yeomans et al., 2008) demonstrated contrast in their ‘smoked salmon mousse’ study. In that experiment, participants rated smoked salmon mousse which looked like a fruit ice cream. When participants expected to taste a dessert, the

mousse was rated as significantly saltier and more bitter than when the participants expected to taste a frozen savoury mousse. However, the contrast effect is rare and in the context of food and beverages has been demonstrated experimentally only a handful of times as the mismatch or the strength of expectations must be very large (Yeomans et al., 2008; Zellner et al., 2004). The difficulty in demonstrating the contrast effect experimentally would suggest that assimilation is more likely, perhaps because most product properties only deviate from our expectations by a relatively small amount. That is, we are more likely to encounter situations in which we taste a very bitter product that we expected to taste only somewhat bitter, than situations in which we taste a bitter product that we expected to taste sweet.

3.1.2 Extrinsic and Intrinsic cues

Product related cues can either be extrinsic or intrinsic to the product. Intrinsic cues are directly related to the chemosensory properties of the product, such as aroma or colour (Cardello, 2007). Given that most products in shops are packaged, consumers usually don't encounter sensory properties of the products, such as the smell, feeling in the mouth, temperature etc., before tasting it, intrinsic cues tend to modify the sensory perception directly rather than through expectations. Apart from the product colour and other aspects of appearance, consumers can rarely rely on intrinsic product cues when forming their expectations. In direct contrast, extrinsic cues are linked to information presented on or with the product (Piqueras-Fiszman & Spence, 2015). We only need to look around when shopping to observe that labelling is arguably the most common and convenient way of presenting product-relevant information to customers. Yet, even though we are frequently exposed to extrinsic and intrinsic cues simultaneously, their effect on expectations and perception is usually studied separately (Spence & Piqueras-Fiszman, 2016; Wang et al., 2019). Here we argue

that to understand how extrinsic and intrinsic cues interact and shape consumer experience, it is not only desirable but necessary to study them together.

While there are number of intrinsic product cues that could potentially elicit flavour-related expectations in beer, such as sound resulting from pouring the drink, the head and other aspects of appearance, arguably the most salient intrinsic factor is the colour of the beverage. Several studies have demonstrated the effect of colour on expectations and perception of flavour and mouthfeel of alcoholic beverages. Indeed, in the context of alcoholic beverages, colour can result in altered expectations and even perception of body, bitterness and sweetness (Carvalho et al., 2017; Reinoso-Carvalho et al., 2019; Sugrue & Dando, 2018). More specifically, dark colour has been shown to be associated with expected or perceived fuller body in beer (Carvalho et al., 2017; Reinoso-Carvalho et al., 2019), wine (Niimi et al., 2017) and even cider (Sugrue & Dando, 2018). Ivanova (Ivanova, 2018) reported that consumers normally associated dark colour in alcoholic beverages, both wine and beer with fuller body and more intense flavour. Dark beers are also expected to taste more bitter than light coloured beers (Carvalho et al., 2017; Reinoso-Carvalho et al., 2019) and the colour of cider can change expectations and perception of sweetness (Sugrue & Dando, 2018). This is in line with results of our previous study (Blackmore et al., 2020) in which expected body strongly correlated with expected beer colour, that is beer, which was expected to be dark, was also expected to have a fuller body. However, it should be noted that not all studies demonstrated the effect of beer colour on perceived taste and mouthfeel (Carvalho et al., 2017; Reinoso-Carvalho et al., 2019).

As mentioned earlier, a common way of modifying consumer expectations and perception of flavour is the use of labelling. There have been a number of studies that looked at the effect of information on expected or perceived taste

and flavour. Information about taste and sensory properties of the product (Okamoto et al., 2009; Yeomans et al., 2008), nutritional information (Liem, Miremadi, et al., 2012), brand logo (Allison & Uhl, 1964; Varela et al., 2010), packaging colour (Barnett & Spence, 2016; F. M. Carvalho & Spence, 2019; Piqueras-Fiszman & Spence, 2012a; Sousa et al., 2020; Velasco, Wan, et al., 2014), imagery (Gil-Pérez et al., 2019) and even information about production (Caporale & Monteleone, 2004; Cardello, 2003; Napolitano et al., 2007) have all been shown to have an effect on expectations. However, similarly to studies on product colour, few studies explicitly demonstrated the relationship between labelling, expectations and taste or flavour perception. It appears that short sensory descriptors, such as 'reduced salt', 'sweet' 'creamy' or 'savoury' were the most successful in not only eliciting flavour-related expectations, but also shifting participants perception of flavour and mouthfeel (Liem, Miremadi, et al., 2012; Olson & Dover, 1978; Yeomans et al., 2001, 2008). Arguably, in the case of beer, the most salient taste is bitter[4], which has previously been associated with colour of the drink (Van Doorn et al., 2019). For this reason, the present study used the descriptor "bitter" as an extrinsic cue together with beer colour (pale and dark amber) to investigate the combined effect of extrinsic and intrinsic product cues on perception of taste and mouthfeel of beer. In the UK, uniquely, "bitter" is also used as a collective name for a particular type of beer (ale), and so UK beer consumers may show especially strong expectations around this descriptor.

[4] Note that while beer has a particularly complex flavour profile, here we specifically refer to taste. Taste is one of the sensory modalities comprising of five broadly agreed on qualities: bitter, sweet, sour, salty, umami (savoury), which are represented in the gustatory system. Flavour, on the other hand is a complex multisensory percept resulting from a combination of gustatory (taste), olfactory (aroma) and somatosensory input (e.g. mouthfeel) (Buck & Bargmann, 2013)

3.1.3 Expectations mediate the effect of product cues

Notably, the effect of extrinsic and intrinsic cues on sensory and hedonic perception is thought to be mediated by expectations. Yet, the relationship between product cues, expectations and perception is rarely explicitly modelled as a causal mediation. For example, Okamoto and Dan (Okamoto & Dan, 2013) described expectations as a mediator of extrinsic cues, referring to two literature reviews (Cardello, 2007; Deliza & MacFie, 1996) [5], which themselves do not explicitly discuss mediation, let alone causal mediation analysis. Similarly, Shankar et al. (Shankar et al., 2010) in their review aimed to explain "how the expectations induced by colour–flavour associations mediate flavour perception." They referred to nine research articles (Cardello & Sawyer, 1992; Deliza & MacFie, 1996; Kähkönen & Tuorila, 1998; Lee et al., 2006; Levin & Gaeth, 1988; Schifferstein et al., 1999; Shankar et al., 2009; Wansink, 2000; Yeomans et al., 2008) to support their claim that "A wide range of research has explored the role that labelling can play in mediating people's expectations and their subsequent flavour experiences." Yet only three of the articles explicitly mentioned mediation and none reported or referred to causal mediation analysis. The literature is filled with examples such as these. Indeed, the majority of studies infer mediation without appropriate statistical modelling. While we do not dispute the role of expectations as a mediator, we argue that this needs to be reflected in the way data are analysed.

Mediation analysis is a tool used to investigate a relationship between multiple variables independent variable(s) (IV), mediator(s)(M), and dependent variable(s) (DV). Mediating variables transmit the effect of IV on the DV and

[5] Deliza and McFie (Deliza & MacFie, 1996) discussed the dual mediation model in relation to attitude formation and brand evaluation, however they did not discuss the mediating effect of expectations on sensory perception

thus act as both IV and DV. Figure 3.1A shows a simple single mediator model, while Figure 3.1B shows a mediation model specific to this paper: a model with two predictors (IV), single mediator and single outcome variable (DV). In the current study we used mediation analysis to test whether the effect of extrinsic and intrinsic cues on perception is mediated by expectations. More detailed explanation of mediation and mediation models in experimental contexts can be found in (MacKinnon et al., 2007).

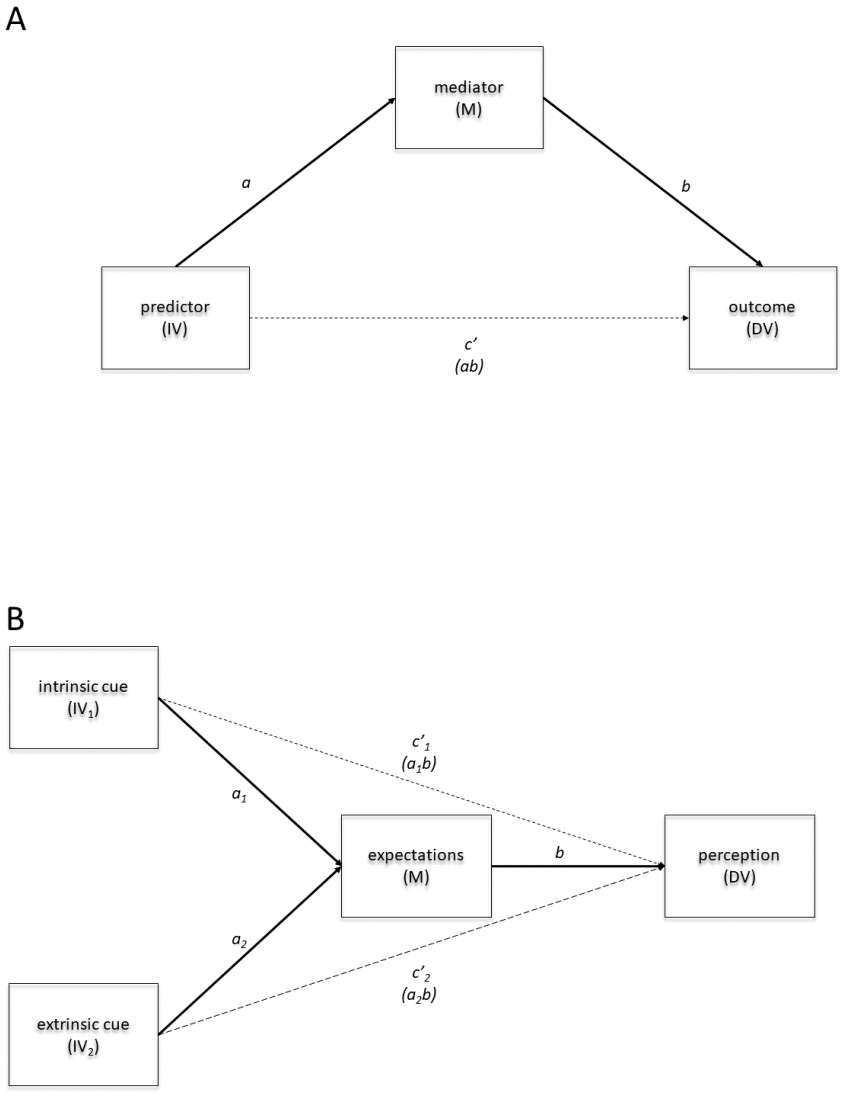


Figure 3.1. A: Single mediator model and commonly used notification. B: Proposed mediation model describing the relationship between extrinsic and intrinsic cues, expectations and perception of taste and flavour. *Total effect: c = c' + ab. Direct effect: c'. Mediated effect: me= a*b. Path a: Effect of IV on M. Path b: Effect of M on DV.*

To summarise, both extrinsic and intrinsic cues play an important role in eliciting expectations and thus have the potential to improve consumer experience. The aim of the present study was to test whether sensory descriptor and beer colour can elicit consumer expectations strong enough to change their perception of taste, flavour and mouthfeel. We also set to explicitly test and quantify the extent to which the effects of beer colour and sensory descriptor are mediated by expectations. Based on previous research, we formulated the following hypotheses. **H1**: Darker coloured beers will be expected to taste more bitter and have fuller body than lighter coloured beers. **H2**: The sensory descriptor "bitter" will affect expectations of bitterness, liking, body and refreshment. **H3**: Darker coloured beers will be rated as tasting more bitter and having fuller body than lighter coloured beers. **H4**: Beers with sensory descriptor "bitter" will be rated as significantly more bitter than unlabelled beers or beers labelled as "standard". **H5**: The effects of beer colour and sensory descriptor on perception will be mediated by expectations they generate.

3.2 METHODS

3.2.1 Design

The experiment had a 2 x 2 x 3 repeated measures design: the factors were taste (bitter/mild), beer colour (light/dark), label (no label/descriptor "standard"/ descriptor "bitter"), all factors were repeated measures. The taste was manipulated to test whether it interacted with product-related cues to modify consumers' perception. Varying the bitterness of samples contributed to the impression that participants were evaluating an array of different beer samples and thus helped to conceal the experimental manipulation, and reduce bias, such as demand characteristics. Thus, there were four different beer samples (dark bitter, dark mild, light bitter and light mild), each tasted once

during a blind session to obtain baseline taste ratings and then each sample was presented once without label, once with beer label described as “standard” and once with a label with a sensory descriptor “bitter (see Figure 3.2). Dependent variables of interest were expected and perceived bitterness, refreshment, liking and body. While expectations were first looked at as one of the outcome variables, they were later modelled as a mediator.

Figure 3.2. Beer labels presented to participants on a computer screen during the experimental session. The labels contained the same information and only differed in the design: angular typeface(A), round typeface (B)

3.2.2 Participants

One of the main aims of the experiment was to explore the effect of sensory descriptor on expectations and perception of taste. Based on previous

research (Blackmore et al., 2020) we expected a medium to large effect. G*power software was used to calculate the required sample size. To detect a medium effect, we needed to test approximately 72 participants (f=0.25, α=0.05, 1-β=0.8, *n*=72). The real aim of the study was disguised, and potential participants were recruited for an experiment investigating the effects of current mood state on perception of bitterness. All participants were informed about the real purpose of the study during debriefing at the end of the experiment.

While 76 participants were recruited, only data from 74 (25 males) participants were analysed due to several missing responses in two cases. All participants identified as regular beer drinkers, on average consuming at least one beer a month, criteria previously used by other researchers (Fukuda, 2019; Nijman et al., 2019). We relied on participants' intuitive understanding of bitterness, refreshment, liking and body, as these are commonly used when talking about beverages. Participants were young adults (M=21.3 years, SD=3.51) mostly, but not exclusively from the student population at the University of Sussex. The average BMI of participants was 23.5 kg/m^2 (SD=3.2).

Exclusion criteria included: diabetes, an alcohol use or eating disorder, colour blindness, smoking more than five cigarettes a day, pregnancy or breastfeeding, any medication (excluding contraceptive pill). Before the study, all participants read an information sheet outlining the exclusion criteria and study protocol. If they agreed to take part, they gave informed consent in accordance with the Declaration of Helsinki. The Science & Technology Cross-Schools Ethics Committee at the University of Sussex has approved the experimental protocol (application ER/HB315/5), and the study was conducted according to the ethical standards defined by the British Psychological Society.

3.2.3 Materials

3.2.3.1 Beer labels

We used four different beer labels, which are illustrated in Figure 3.2. To avoid familiarity, realistic, but fictitious beer labels were designed using an online resource (*Beerlabelizer*, 2019) and Adobe Photoshop CC 2017. Two of the labels featured the sensory descriptor "bitter", and two the descriptor "standard" (a control label)[6]. The labels also differed in terms of their design, however this was only to reduce monotony of the experiment and to disguise the experimental manipulation. Presentation of the labels was counterbalanced.

3.2.3.2 Beer samples

The bitterness and colour of the samples were manipulated specifically for this project, with the test beers produced at a pilot-plant facility at the University of Nottingham. To achieve two levels of bitterness (mild/bitter) and two different colours (light/dark, see Figure 3.3) a commercial light-coloured (EBC = 5) beer with low bitterness (IBU = 10) was used as a starting point. Food grade caramel was added to darken the colour of the beer (EBC = 25): iso-alpha acids were added to increase bitterness (IBU = 20). Both caramel and iso-alpha acids are standard ingredients used in beverages. After blending, the four resulting beers (light mild, light bitter, dark mild, dark bitter) were packed into glass bottles under CO_2 atmosphere to preserve from oxidation. The pH (4.4), carbonation (5.2 g/l) and alcohol content (3.5% ABV) of the samples were identical, only the colour and bitterness differed. The beer was stored in a fridge chilled to 4ºC, served immediately and consumed within 25 minutes. The beer

[6] Some beer samples were also presented without any label, see sections 3.2.1and 3.2.4for more detail.

was served as 75 g (± 5) samples in a standard 160 ml capacity drinking glass: each sample was labelled with a random three-digit code.

Figure 3.3. The colour difference between the light and dark beer samples

3.2.3.3 Rating scales

Participants were asked to rate expectations of bitterness, refreshment, liking and body, strength of their expectations and perception of bitterness, refreshment, liking and body. All scales were visual analogue scales ranging from 0 – 100. Scales were displayed on a computer screen and participants moved a slider to indicate their response. Anchors used were as follows: expected bitterness (not at all – extremely), perceived bitterness (not at all- extremely), expected refreshment (not at all- extremely), perceived refreshment (not at all-extremely), expected liking (dislike extremely – like extremely), perceived liking (dislike extremely – like extremely), expected body (light– full), perceived body (light - full), strength of expectations (I am just guessing – I am certain). For expected and perceived liking, the slider starting position was at 50 (middle), for all other scales the slider was positioned at 0 (far left).

3.2.4 Procedure

The experiment consisted of two sessions: a blind tasting session, followed by an experimental session. The experiment was designed and administered using Qualtrics software (*Qualtrics*, 2018) and used a black background to minimise the light in the experimental cubicle helping to conceal the colour of the samples during an initial blind tasting session. The experimental procedure is illustrated in Figure 3.4.

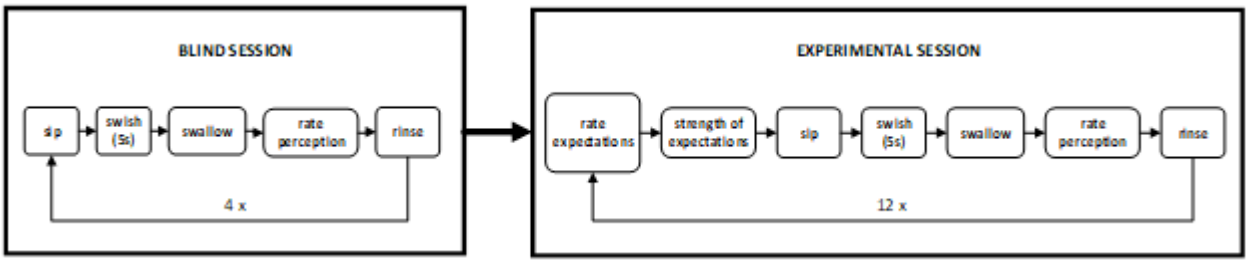


Figure 3.4. Experimental procedure*: Participants rated four different beer samples in the blind tasting session and twelve sample-label combinations in the experimental session.*

3.2.4.1 Blind tasting session

During the blind tasting session participants tasted the four beer samples, to disguise the difference in colour the experimental cubicle was lit with red light. Participants rated their perception of bitterness (not at all-extremely), refreshment (not at all-extremely), liking (dislike extremely-like extremely) and body (light –full) on a 0-100 visual analogue scale (VAS). Importantly, as all ratings were done on a computer screen with black background to minimise the amount of white light in the room. The order of the beer samples and the ratings were randomized during both the blind and experimental sessions. Participants were instructed to take one sip from each sample, swish it around their mouth for 5 s and then swallow, using mineral water between samples to rinse their mouth.

3.2.4.2 Experimental session

The blind tasting session was immediately followed by the experimental session during which participants performed ratings in a well-lit experimental cubicle. The beer samples were presented again, sometimes without a label (no label condition) and sometimes accompanied by an on-screen label with either the sensory descriptor "bitter" or descriptor "standard" (sensory descriptor condition and control descriptor condition, as shown in Figure 3.2). Altogether participants had to taste and rate 12 samples (4 beer samples x 3 label conditions), presented in a random order.

After locating the sample participants rated their expectations of bitterness, refreshment, liking and body, based on the appearance of the sample and label (if present). Participants also rated the strength of these expectations. After rating their expectations, participants proceeded to taste and rate the perceived bitterness, refreshment, body and liking of the samples, which was identical to the blind session: sip, swish for 5 s, swallow, rate perceived bitterness, refreshment, liking and body, and rinse. At the end of the experiment participants were weighed and measured and fully debriefed.

3.2.5 Data analysis

Data were analysed using R studio, R 3.6.2. To examine the effect of colour and sensory descriptor on expectations and perception of bitterness, refreshment, liking and body a multilevel model (MLM) with participants as random, and colour, taste (in the case of perceived ratings) and sensory descriptor as fixed effects, was used. Given the repeated measures design of the study, we could assume that measures from the same participants concerning sensory and hedonic ratings, especially in a short space of time would be highly correlated (Littell et al., 2000). As MLM takes into account this correlation and

models this dependency, it avoids inflating Type I and type II errors compared to repeated measures ANOVA (Field et al., 2012; Hoffman & Rovine, 2007). Using the "lmerTest" package (Kuznetsova et al., 2017) the MLM was fitted as a linear mixed model fitted by the restricted maximum likelihood (REML), with t-tests using Satterthwaite's method to estimate the degrees of freedom. The model tested all main effects and interactions. In order determine the difference between sensory descriptor and no sensory descriptor (i.e. "bitter" vs. "standard" and no label) and the difference between the two control labels ("standard" vs. no label) the main analysis was followed by pair-wise t-tests with planned non-orthogonal contrasts using Bonferroni correction.

The purpose of the blind tasting session was to obtain baseline ratings unaffected by expectations, and to carry out a manipulation check. An MLM, as described above was run to establish whether the beer colour and taste had a significant effect on perceived bitterness, refreshment, liking and body.

Finally, to establish whether the effect of product-related cues on sensory and hedonic perception was mediated by expectations, a causal mediation analysis was carried out. While there are other approaches to build and evaluate structural equation models, such as partial least square path modelling (PLS) and sequential orthogonalised partial least square path modelling (SO- PLS), these are better suited for data exploration and theory building rather than theory testing, as is the case for the current study (Menichelli et al., 2014). For this reason, we employed a causal mediation analysis. We used the "brms" (Bürkner, 2017) and "bmlm" (Vuorre & Bolger, 2018) R packages which allowed us to perform Bayesian analysis of multilevel models and Bayesian within-subjects mediation analysis.

First, the "standard" and "no label" conditions were grouped together, as there was no statistically significant difference between the two conditions,

making the descriptor a two-level variable ('bitter', control). Then the relationship between predictor and outcome variable and predictor, mediator, and outcome variable were modelled as a MLM with participants as random effect, colour and sensory descriptor as predictors, expectations as mediator and perception as outcome variable. Due to the lack of previous research we used the software default, minimally informative prior. The mediation models were then evaluated using the estimates and 95% credible intervals, which were derived from posterior distributions. There is evidence of mediation when the credible interval can rule out zero as a likely population value (Vuorre & Bolger, 2018). Because all scales ranged from 0-100, we report unstandardized coefficients. Unstandardised coefficients allow for direct estimate of the effect on the dependent variable, as the unstandardized coefficient quantifies the amount of change in a dependent variable due to a change of one unit of independent variable, which makes them more intuitive to interpret, and in the case of the present study preferable (Kim & Mueller, 1976, Baguley, 2009).

We should also comment on the use of two different beer labels (see Figure 3.2). While the effect of design or typeface was not a primary interest of the present study, a number of previous studies reported the effect of typeface on consumer expectations and experience (Velasco et al., 2015, 2018). Using an independent samples t-test we compared the effect of label (angular and round typeface) on expected and perceived bitterness, refreshment, liking and body. The difference between the two label designs was not statistically significant ($p>0.05$) and the results are visualised in Figure 3.5. The analysis scripts can be found here https://github.com/HelenaBlackmore/study2.git.

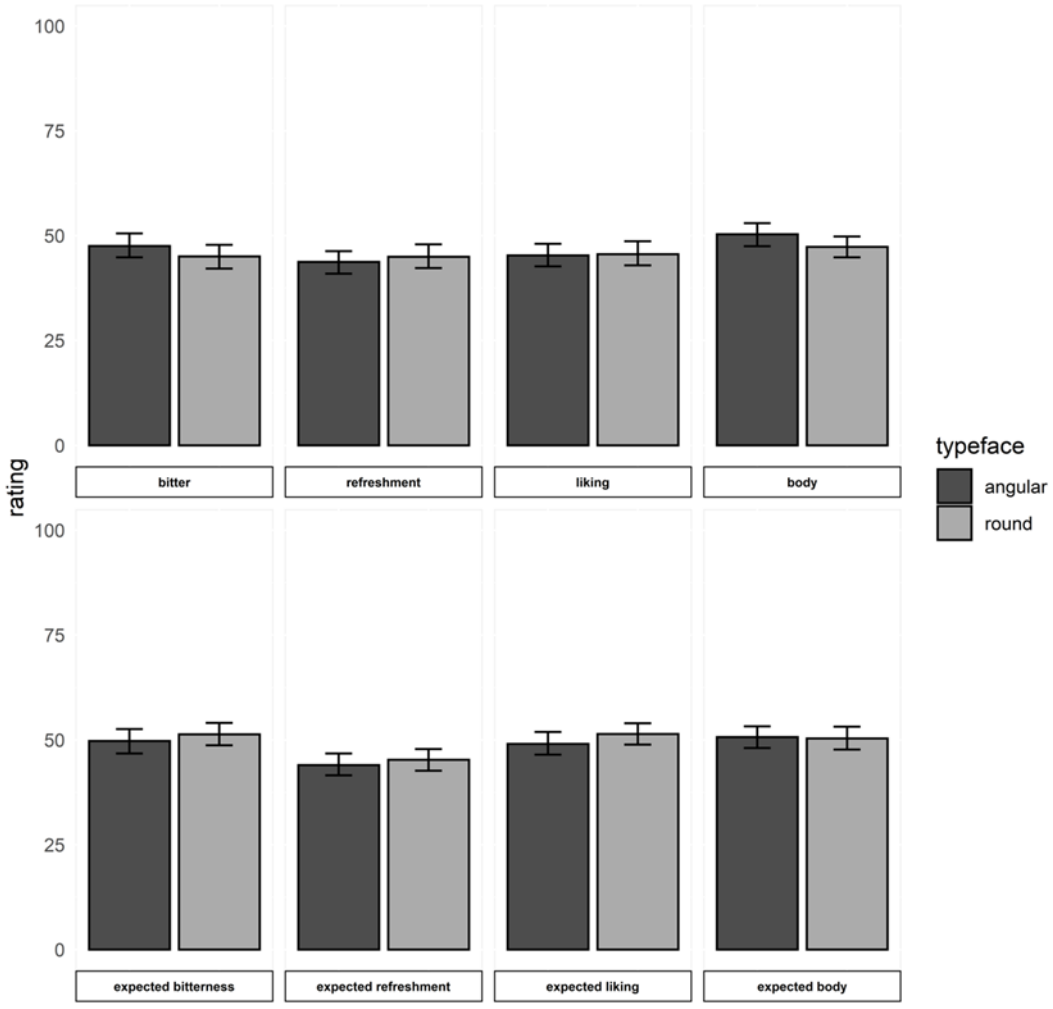


Figure 3.5. The effect of label typeface (round vs. angular) on expected and perceived bitterness, refreshment, liking and body. *All differences between the angular and round typeface label were statistically non-significant (p>0.05).*

3.3 RESULTS

3.3.1 Blind tasting session

As expected, participants' ratings of liking and refreshment were not significantly affected by either colour or taste (p > 0.05), and the ratings of bitterness were significantly affected by taste ($\chi^2(5) = 4.82$, $p = 0.028$), with bitter beers rated as tasting more bitter (b = -5.75, t(220) = -2.40, p = 0.017, r = 0.16). However, unexpectedly the dark beers were also rated as tasting slightly, but significantly, more bitter (b = 5.26, t(220) = 2.20, p = 0.029, r = 0.15). Finally,

the rated body was not significantly affected by the taste of the beer, but there was a significant effect of colour ($\chi^2(5) = 7.55$, $p = 0.006$), with the dark beers rated as having fuller body ($b = 6.33$, $t(220) = 2.76$, $p = 0.006$, $r = 0.18$). More details are in Table 3.1 and Figure 3.6.

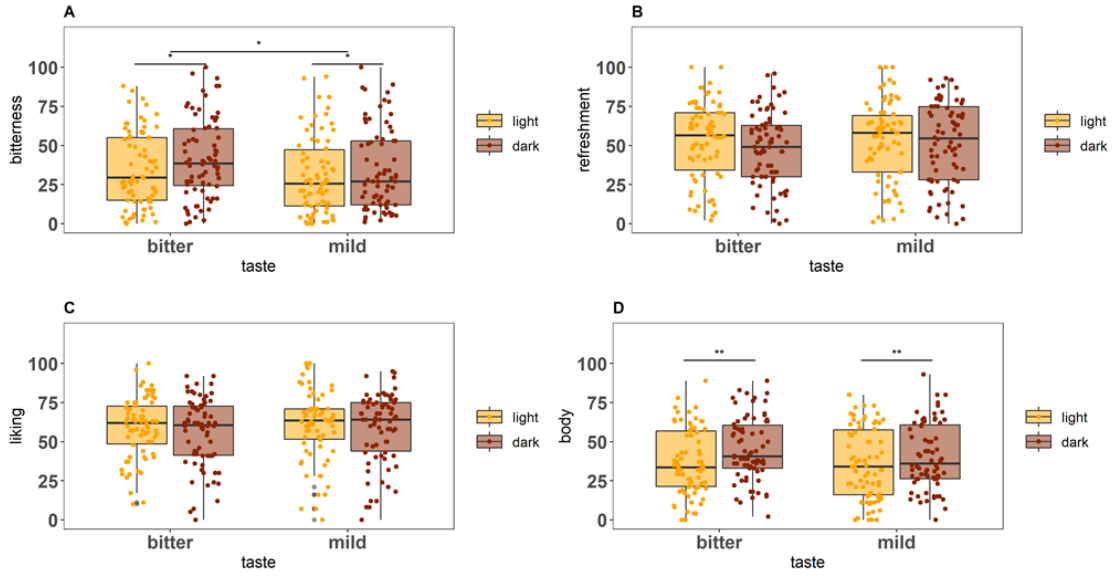


Figure 3.6. Ratings of perceived bitterness (A), refreshment (B), liking (C) and body (D) during the blind tasting session. ** p<0.05, **p<0.01, *** p<0.001*

Table 3.1.Mean (SE) perceived characteristics of the four samples of beer when tasted blind.

	Bitter		Mild	
	light	dark	light	dark
Bitter	34.6	41.5	30.5	34.1
	(2.5)	(3.0)	(2.9)	(3.1)
Refreshment	52.8	47.7	52.6	51.6
	(2.9)	(2.7)	(3.0)	(3.0)
Body	37.0	45.2	36.2	40.6
	(2.5)	(2.3)	(2.7)	(2.4)
Liking	59.0	55.9	60.1	58.7
	(2.2)	(2.5)	(2.6)	(2.6)

3.3.2 The effect of beer colour and sensory descriptor on expectations

3.3.2.1 Bitterness

Both the sensory descriptor “bitter” and the beer colour had a significant effect on expectations of bitterness ($\chi^2(6) = 148.82$, $p < 0.001$ (see Table 3.2). There were no significant interactions. More specifically, the darker coloured beers were expected to be more bitter than the lighter coloured beers (b = 20.25, t(814) = 15.63, $p < 0.001$, r = 0.48). In terms of labelling, the descriptor “bitter” generated expectations of increased bitterness compared to unlabelled beer or beer labelled "standard" (b = 5.75 , t(814) = 12.55, $p <$ 0.001, r = 0.40), and additionally, the beer labelled as “standard” was expected to be less bitter than the unlabelled beer (b = 1.92, t(814) = 2.42, p = 0.016, r = 0.08).

Table 3.2. Mean Bitterness ratings (SE)

		session	blind		expected		perceived	
		colour	light	dark	light	dark	light	dark
label	taste							
bitter	bitter		NA	NA	52.31 (3.0)	66.78 (2.4)	54.53 (2.7)	54.27 (2.6)
	mild		NA	NA	53.68 (3.0)	67.76 (2.3)	44.57 (2.7)	48.05 (3.1)
standard	bitter		NA	NA	32.27 (2.6)	48.76 (2.3)	38.84 (3.1)	51.95 (3.0)
	mild		NA	NA	32.93 (2.2)	49.93 (2.2)	35.88 (2.9)	42.23 (2.7)
No label	bitter		34.56 (2.7)	41.49 (3.0)	30.38 (2.5)	58.99 (2.3)	39.95 (3.2)	52.96 (3.0)
	mild		30.47 (2.9)	34.1 (3.1)	29.54 (2.1)	60.36 (2.2)	33.1 (2.8)	46.62 (2.9)

3.3.2.2 Refreshment

Both the beer colour and the sensory descriptor "bitter" significantly affected ratings of expected refreshment ($\chi^2(6) = 16.49$, $p < 0.001$: see Table 3.3). Overall, the descriptor "bitter" resulted in significantly lower ratings of expected refreshment than descriptor "standard" or no label ($b = 1.76$, $t(811) = 4.06$, $p < 0.001$, $r = 0.14$) and there was no difference between the beer labelled as "standard and the unlabelled beer ($b = 0.24$, $t(911)=0.32$, $p = 0.745$). Darker coloured beers were also expected to be significantly less refreshing than lighter coloured beers ($b = -19.84$, $t(811) = -16.17$, $p < 0.001$, $r = 0.49$).

Table 3.3. Mean refreshment ratings (SE)

		session	blind		expected		perceived	
		colour	light	dark	light	dark	light	dark
label	taste							
bitter	bitter		NA	NA	50.86 (2.8)	31.05 (2.0)	45.57 (3.0)	35.82 (2.6)
	mild		NA	NA	49.89 (2.6)	36.61 (2.4)	51.93 (2.8)	39.96 (2.8)
standard	bitter		NA	NA	55.38 (2.5)	36.61 (2.4)	48.28 (2.9)	36.30 (2.8)
	mild		NA	NA	54.14 (2.7)	40.46 (2.3)	51.52 (2.7)	45.30 (2.7)
No label	bitter		52.76 (2.9)	47.69 (2.7)	61.82 (2.5)	33.54 (2.5)	45.93 (2.9)	34.39 (2.8)
	mild		52.58 (3.0)	51.59 (3.0)	61.19 (2.5)	33.99 (2.3)	54.55 (3.1)	37.54 (2.7)

3.3.2.3 Liking

Both the colour of the beer and the sensory descriptor "bitter" significantly affected ratings of expected liking ($\chi^2(6) = 14.41$, $p < 0.001$: Table 3.4). Darker coloured beers and beers described as "bitter" were expected to be liked significantly less than lighter coloured or beers without a sensory descriptor ($b = -13.71$, $t(811) = -10.57$, $p < 0.001$, $r = 0.35$, and $b = 1.70$, $t(811) = 3.70$, $p < 0.001$, $r = 0.13$, respectively). The effect of label "standard" on expected liking did not significantly differ from the effect of no label ($b = 0.71$, $t(811) = 0.89$, $p = 0.373$).

Table 3.4. Mean liking ratings (SE)

		session	blind		expected		perceived	
		colour	light	dark	light	dark	light	dark
label	taste							
bitter	bitter		NA	NA	55.64 (2.5)	40.26 (2.5)	54.08 (2.8)	45.03 (2.6)
	mild		NA	NA	50.59 (2.5)	45.67 (2.5)	59.18 (2.4)	49.28 (2.9)
standard	bitter		NA	NA	57.26 (2.7)	45.30 (2.5)	58.54 (2.9)	43.81 (2.8)
	mild		NA	NA	59.18 (2.5)	47.96 (2.4)	60.05 (2.8)	53.00 (2.6)
No label	bitter		59.03 (2.2)	55.91 (2.5)	62.68 (2.2)	42.69 (2.7)	53.34 (2.8)	44.54 (3.1)
	mild		60.14 (2.6)	58.68 (2.6)	64.41 (2.1)	45.58 (2.5)	59.34 (2.7)	48.16 (2.6)

3.3.2.4 Body

Expected body was significantly affected by both the colour and the sensory descriptor ($\chi^2(6) = 53.92$, $p < 0.001$: Table 3.5. and Figure 3.7D). More

specifically, the darker coloured beers were expected to have significantly fuller body (b = 28.72, t(811) = 23.89, p < 0.001, r = 0.64) than the lighter coloured beers. In terms of the labelling, beers described as "bitter" were expected to have fuller body than beers without a sensory descriptor (b = -3.00, t(811) = -7.07, p < 0.001, r = 0.24). Moreover, the unlabelled beer was expected to have lighter body than beer labelled as "standard (b = 1.74, t(811) = 2.36, p = 0.018, r = 0.08).

Table 3.5. Mean ratings of Body (SE)

		session	blind		expected		perceived	
		colour	light	dark	light	dark	light	dark
label	taste							
bitter	bitter		NA	NA	47.82 (2.4)	70.26 (1.6)	44.39 (2.7)	61.41 (2.2)
	mild		NA	NA	40.27 (2.5)	65.18 (2.1)	34.92 (2.3)	58.77 (2.5)
standard	bitter		NA	NA	32.78 (2.4)	57.91 (2.3)	36.35 (2.5)	59.03 (2.5)
	mild		NA	NA	33.08 (2.1)	56.74 (2.4)	37.85 (2.7)	57.89 (2.3)
No label	bitter		36.97 (2.5)	45.18 (2.3)	29.58 (2.2)	68.41 (1.8)	37.30 (2.3)	62.95 (2.3)
	mild		36.16 (2.7)	40.62 (2.4)	29.54 (1.9)	66.91 (2.0)	36.92 (2.6)	56.68 (2.5)

3.3.3 The effect of beer colour, taste and sensory descriptor on perception

3.3.3.1 Bitterness

There was a significant effect of taste, colour and sensory descriptor on perceived bitterness ($\chi^2(7) = 23.02$, $p < 0.001$: see Table 3.2). The bitter, as well as the darker coloured beers were rated as more bitter ($b = -7.00$, $t(814) = -4.66$, $p < 0.001$, $r = 0.16$, and $b = 8.20$, $t(814) = 5.46$, $p < 0.001$, $r = 0.19$, respectively). The beer labelled as "bitter" was perceived as more bitter ($b = -2.55$, $t(814) = -4.81$, $p < 0.001$, $r = 0.17$), compared to beers without the sensory descriptor "bitter". There was no difference in perceived bitterness between the unlabelled beer and beer labelled as "standard" ($b = 0.47$, $t(814) = 0.51$, $p = 0.611$). There were no significant interactions between the variables.

3.3.3.2 Refreshment

Perceived refreshment was affected by taste and colour ($\chi^2(5) = 73.10$, $p < 0.001$), but not the sensory descriptor ($\chi^2(7) = 2.40$, $p = 0.301$). More specifically, the bitter beer was rated as significantly less refreshing compared to the mild beer ($b = 5.75$, $t(814) = 4.41$, $p < 0.001$, $r = 0.15$). The darker coloured beer was rated as significantly less refreshing than the lighter coloured beer ($b = -11.41$, $t(814) = -8.75$, $p < 0.001$, $r = 0.29$). See Table 3.3. None of the interactions reached statistical significance.

3.3.3.3 Liking

Again, only the taste and the beer colour had a significant effect on perceived liking ($\chi^2(5) = 49.24$, $p < 0.001$: Table 3.4) , while the sensory descriptor had no effect on perceived liking ($\chi^2(7) = 2.30$, $p = 0.317$).The bitter and the dark beers were liked significantly less than the mild and light

beer (b= 4.96, t(812) = -3.48, p < 0.001, r = 0.12, and b = -10.12, t(812) = -7.12, p < 0.001, r = 0.24, respectively). Again, no significant interaction between the taste and product cues was observed.

3.3.3.4 Body

Perceived body was significantly affected by taste and colour of the beer ($\chi^2(5) = 226.92$, $p < 0.001$), while the sensory descriptor had no effect ($\chi^2(7) = 1.72$, $p = 0.423$). Bitter beer was rated as having fuller body than the mild beer (b = -3.07, t(812) = -2.30, p = 0.022, r = 0.08).Similarly, the dark beer was perceived as having fuller body than the light beer (b = 21.50, t(812) = 16.16, p < 0.001, r = 0.49). None of the interactions reached statistical significance (p>0.05). See Table 3.5.

3.3.4 Expectations mediate the effect of product-related cues

The outcomes of the mediation analyses are visualised in Figures 5A-5D and described below.

3.3.4.1 Bitterness

Both the effect of colour and sensory descriptor on perceived bitterness were mediated via the expectations of bitterness as Figure 3.7A illustrates. Both darker beer colour and the sensory descriptor 'bitter' were associated with higher expectations of bitterness (20.25, 95% CI [16.20, 24.51] and 17.24, 95% CI [14.23, 20.29], respectively). Beer colour then directly and indirectly increased participants' perception of bitterness (4.01, 95% CI [0.23,7.84] and 4.18, 95% CI [1.76, 6.93], respectively). The sensory descriptor bitter indirectly increased perception of bitterness (4.76, 95% CI [2.91,6.86]). There was no direct effect of sensory descriptor on perceived bitterness (2.68, 95% CI [-0.74, 6.13]).

3.3.4.2 Refreshment

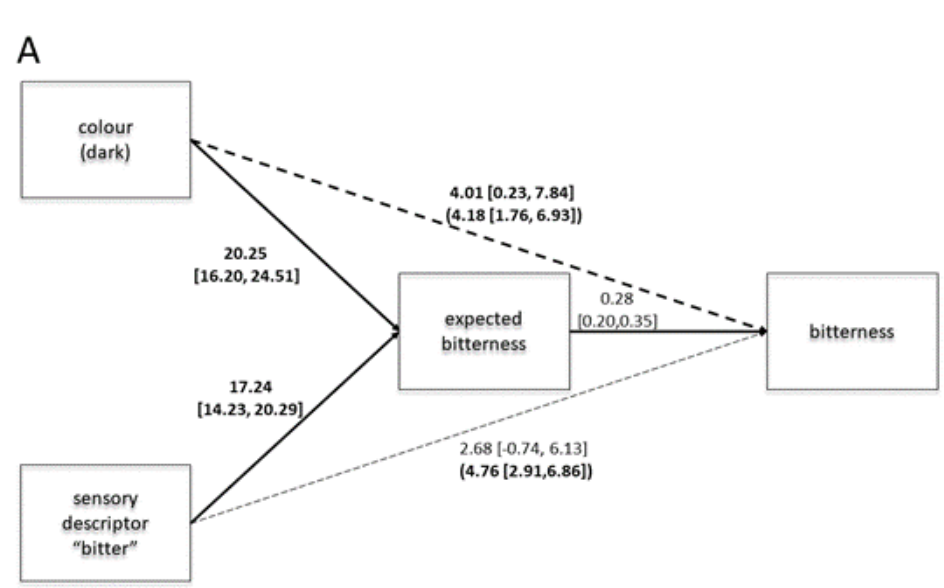
Again, both the effect of colour and sensory descriptor on perceived refreshment were mediated by expected refreshment. As Figure 3.7B shows, beer colour had an effect on expected refreshment (-19.90, 95% CI [-24.13, -15.94]) as well as direct (-7.60, 95% CI [-11.42, -3.95]) and indirect effect (-3.92, 95% CI [-6.79, -1.31]) on perceived refreshment. The effect of sensory descriptor 'bitter' lowered expectations of refreshment (-5.30, 95% CI [-8.11, -2.53] which indirectly affected perception of refreshment (-1.54, 95% CI [-2.79, -0.29]). However, there was no direct effect of sensory descriptor on perceived refreshment (0.35, 95% CI [-2.36, 3.17]).

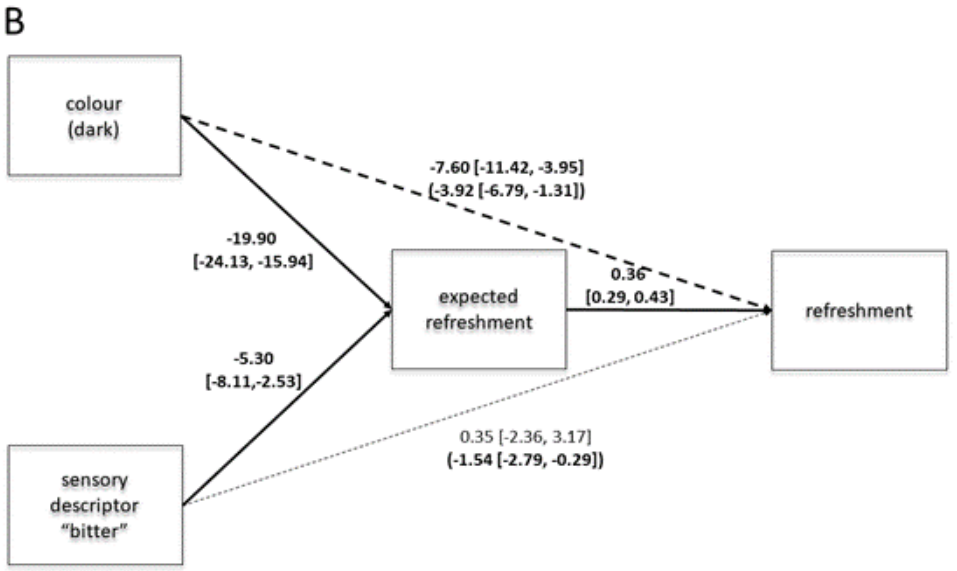
3.3.4.3 Liking

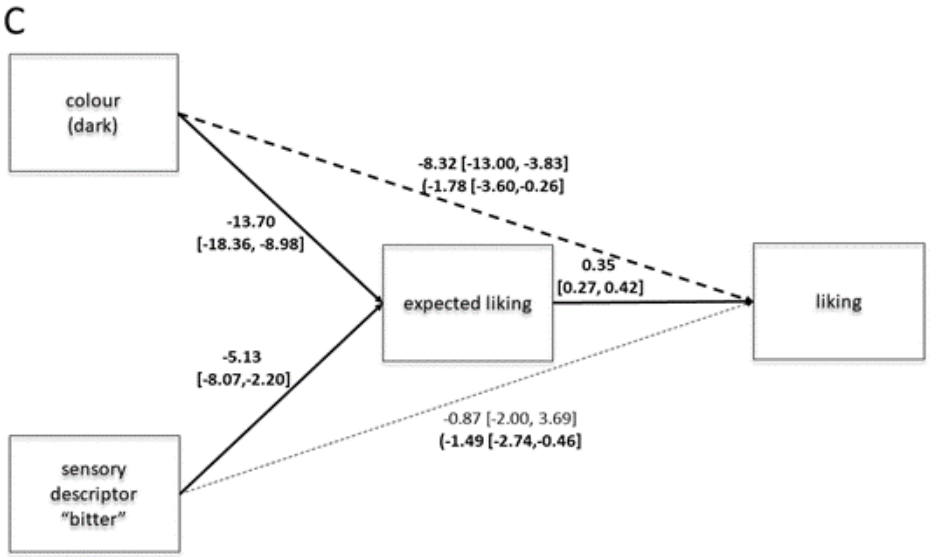
As Figure 3.7C demonstrates, the effect of beer colour and sensory descriptor on participants' liking was mediated by expectations of liking. Participants expected to like less beer samples that were dark (-13.70, 95% CI [-18.36, -8.98]) and that were described as 'bitter' (-5.13, 95% CI [-8.07, -2.20]. Beer colour had a direct (-8.32, 95% CI [-13.00, -3.83] and indirect effect [-1.78, 95% CI [-3.60, -0.26]) on perceived liking. Sensory descriptor affected liking only indirectly (-1.49, 95% CI [-2.74, -0.46]) with direct effect around 0 (-0.87, 95% CI [-3.60, -0.26]).

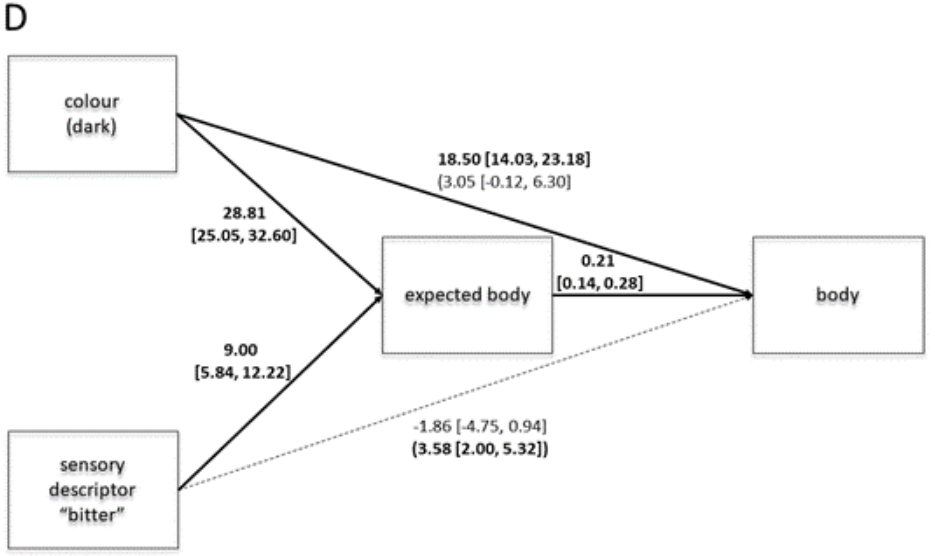
3.3.4.4 Body

In the case of perception of body, only the effect of sensory descriptor was mediated by expectations. Beer colour and sensory descriptor 'bitter' both increased expectations of body (28.81, 95% CI [25.05, 32.60] and 9.00, 95% CI [5.84, 12.22], respectively). Dark colour also seemed to directly increase perception of body (18.50, 95% CI [14.03, 23.18]), however we did not observe an indirect effect of beer colour (3.05, 95% CI [-0.12, 6.30]) on ratings of perceived body. Similarly to other percepts reported above, the sensory descriptor 'bitter' did not affect perception of body directly (-1.86, 95% CI [-4.75, 0.94]), but the effect was mediated through expectations and so as to indirectly increase ratings of body (3.58, 95% CI [2.00, 5.32]). See Figure 3.7D.


A
colour (dark)
sensory descriptor "bitter"
expected bitterness
bitterness
4.01 [0.23, 7.84]
(4.18 [1.76, 6.93])
20.25
[16.20, 24.51]
0.28
[0.20,0.35]
17.24
[14.23, 20.29]
2.68 [-0.74, 6.13]
(4.76 [2.91,6.86])


B
colour (dark)
sensory descriptor "bitter"
expected refreshment
refreshment
-7.60 [-11.42, -3.95]
(-3.92 [-6.79, -1.31])
-19.90
[-24.13, -15.94]
0.36
[0.29, 0.43]
-5.30
[-8.11,-2.53]
0.35 [-2.36, 3.17]
(-1.54 [-2.79, -0.29])


C
colour (dark)
sensory descriptor "bitter"
expected liking
liking
-8.32 [-13.00, -3.83]
(-1.78 [-3.60,-0.26]
-13.70
[-18.36, -8.98]
0.35
[0.27, 0.42]
-5.13
[-8.07,-2.20]
-0.87 [-2.00, 3.69]
(-1.49 [-2.74,-0.46]


D
colour (dark)
sensory descriptor "bitter"
expected body
body
18.50 [14.03, 23.18]
(3.05 [-0.12, 6.30)
28.81
[25.05, 32.60]
0.21
[0.14, 0.28]
9.00
[5.84, 12.22]
-1.86 [-4.75, 0.94]
(3.58 [2.00, 5.32])

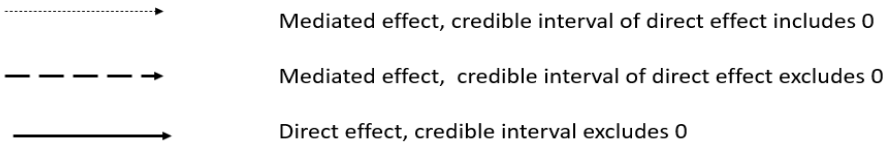


Figure 3.7. Expectations mediating the effect of extrinsic cues. *The effect of actual bitterness (taste), descriptor "bitter" and darker beer colour on expected and perceived bitterness (A), refreshment (B), liking (C) and body (D). Numeric values represent estimates of the direct effect (a, b, c') with the indirect effect (m) in brackets below. Presence of a line in the mediation model denotes a presence and a nature of a relationship between the variables.*

3.4 DISCUSSION

The present study set to investigate how beer colour (intrinsic cue) and sensory descriptor (extrinsic cue) affected consumers' expectations and perception of beer, as well as testing and quantifying the mediating effect of these expectations. Manipulating colour of the beer and the way the beer is described led to assimilation: the extrinsic and intrinsic cues affected the way participants rated the beer samples, and this effect was partially mediated by expectations. The rest of this section discusses the results of the study in more detail, highlighting the contribution of the novel findings and analytic approach, and commenting on limitations of the study.

Firstly, we observed that extrinsic and intrinsic cues clearly affected participants' expectations. Dark coloured beers were overall expected to taste more bitter, have fuller body, be less refreshing and liked less. When participants saw the descriptor "bitter" or the darker colour, they expected the beer to be more bitter, less refreshing, liked less and have fuller body. This was in line with data from our previous study (Blackmore et al., 2020).

Secondly, we demonstrated that presentation of a sensory descriptor can change consumer perception by assimilating expectations. However, as the results of the present study and the literature suggest, the effects of sensory descriptors are only limited to a specific aspect of the taste or flavour. For example, as described earlier, the descriptor "bitter" only changed perception of bitterness. A number of studies found similar pattern of results (Allison et al., 2004; Bowen et al., 1992; Grabenhorst et al., 2008a; Okamoto et al., 2009; Okamoto & Dan, 2013; Shankar et al., 2009; Skaczkowski et al., 2016; Yeomans et al., 2001). It seems that

labels related to sensory properties tend to have a specific effect on perception of taste, flavour, or mouthfeel. It is common that in instances in which there is a close link between taste intensity and liking, hedonic descriptors (e.g. “pleasant”) affect ratings of taste and flavour intensity as well as activity in the primary taste cortex (Nitschke et al., 2006). Similarly, sensory information can affect ratings of pleasantness and liking (Woods et al., 2011; Yeomans et al., 2001). However, rarely does a sensory label (e.g., salty) affect perception of other unrelated sensory percepts (e.g., bitter). Considering previous research and the results of the present study, we conclude that in order to improve consumers’ sensory perception of taste, flavour or mouthfeel we need to use a product-relevant description of the sensory aspect we are trying to modulate.

Finally, while the effect of product labels seems to be quite specific and narrow, colour of the beer, appears to be more versatile. In the present study beer colour modified perception of not only bitterness, but also liking, refreshment and body. The effects of colour on perceived intensity of flavour have been demonstrated before (Spence & Piqueras-Fiszman, 2016). Adding more colouring to a beverage usually results in ratings of more intense taste or flavour, which explains why darker beers in our experiment were rated as more bitter and having fuller body, given that body and especially bitterness are important attributes relating to intensity of overall flavour and mouthfeel.

Yet, we should point out that there are studies in the literature, which reported null results, that is, no effect of beverage colour on perceived intensity of taste or flavour (Spence & Piqueras-Fiszman, 2016). Most notably, two recent studies suggested that while beer colour can generate expectations of body and bitterness, this did not affect participants’ perception (Carvalho et al., 2017; Reinoso-Carvalho et al., 2019). In both studies, the researchers used amber and

dark beer and investigated, among other things, the effect of beer colour on sensory and hedonic expectations and perception, looking at sweetness, sourness, strength, body, bitterness and liking. Contrary to the findings of the present study they did not observe an effect of beer colour on any of the sensory properties measured. How could this be? A notable difference between the present study and the studies discussed above is the colour of the beer samples used. While our samples were pale and dark amber (see Figure 3.3), the samples used by Carvalho et al. (2017) and Reinoso-Carvalho et al. (2019) were noticeably darker: pale amber and dark. The notion of 'degree of discrepancy' offers a possible explanation. Spence and Piqureas-Fiszman (Spence & Piqueras-Fiszman, 2016) describe 'degree of discrepancy' as a mismatch between the expected flavour set by colour and the actual flavour. In simple terms, the colour of the beverage must be realistic and the mismatch between expected and actual properties relatively small. This would explain why the present study successfully demonstrated the effect of colour, while Carvalho et al. (2017) and Reinoso-Carvalho et al. (2019) did not: the samples they used were probably too dark. It would be interesting to explore the effect of beer colour on perception further using a wider range of beer colours. This would allow us to precisely pinpoint the optimal 'degree of discrepancy' and answer the question 'how dark is too dark' for assimilation of expectations to occur.

Overall, it appears that the colour of beer can be used to fine tune consumer experience. Colouring, or lack of, could thus be used to increase perceived bitterness and body or highlight perception of refreshment and liking, alternatively. To give an example, as reduced alcohol beers are often described as lacking body (Sohrabvandi et al., 2010), making non-alcoholic beer darker could potentially improve this aspect of the flavour profile. However, it should be noted that darker colour and thus increase in bitterness and body was also associated

with decreased refreshment and liking. While not desirable, these effects of colour on perceived refreshment and liking could be balanced out by a sensory descriptor.

3.4.1 Mediation

Apart from the novel findings discussed above, the present study contributes to the literature with an explicit demonstration of the mediating effect of expectations. As described in the introduction, there are several studies that claim that the effect of product-related cues on sensory perception and hedonic evaluation is mediated by expectations. As defined by MacKinnon (MacKinnon et al., 2007), a mediating variable transmits the effect of an independent variable on a dependent variable and testing mediation can explain the process by which one variable affects another. This and other expectations studies claim that expectations mediate or transmit the effect of extrinsic and intrinsic cues on perception of beer. Mediation analysis allows us to demonstrate that the relationship between product-related cues and change in perception is caused, at least in part, by expectations. While the relationship between cues/information, expectations and perception is intuitive, intuition and personal experience are not sufficient to support such a claim. In the present study, we were able to demonstrate that the effects of colour and sensory descriptor were indeed mediated by expectations.

In the case of perceived bitterness, refreshment, liking and body the sensory descriptor ‘bitter’ only affected ratings indirectly: that is the effect of sensory descriptor was clearly mediated through expectations. While we observed only direct effects of beer colour on ratings of body, with bitterness, refreshment and liking beer colour had both a direct and indirect effect. The fact that colour

affected perception both directly and indirectly suggests that its effect is only partially mediated through expectations. A partial mediation would suggest that the model may be incomplete and there may be another latent variable in the model. In our study, participants thought about and then rated their expectations, thus these expectations ratings only accounted for the conscious associations between the cues and sensory/hedonic perception. It is possible that there are associations between cues and sensory perception that are processed unconsciously, yet can still generate changes in perception of taste, flavour and liking. This needs to be directly tested and modelled in future studies.

Returning to the theory of expectations, researchers often want to determine whether product-related cues generate expectations that lead to change in perception. This change in perceived properties of a food or beverage can be either in line with (assimilation) or in contrast (contrast) to these expectations. Mediation analysis is a convenient tool to test whether assimilation or contrast effect occurred. In order to establish assimilation or contrast, we first need to test whether a given cue has an effect on perception and expectations, then we need to establish that expectations affect perception, and finally we need to test the mediating effect of expectations. Looking at a simple mediation model, like one visualized in Figure 3.1A, if mediation is established, both paths *a* and *b,* as well as the indirect effect *c´* should be significant. If both the direct and indirect effect (*c´* and *ab*) are in the same direction (i.e. both positive or both negative), we can conclude that assimilation occurred. In the case of a contrast effect, the mediator would act as a suppressor (a case of inconsistent mediation) and we would observe direct and indirect effects to be in opposite directions (-*c´, ab* or *c´, -ab).* The present data strongly support a simple assimilation effect. The circumstances and boundary conditions of these scenarios need to be investigated in future studies.

In conclusion, compared to other approaches, mediation analysis is an elegant way to develop and subsequently test models and theories.

3.4.2 Limitations

A slight concern in interpretation of the current data was the unexpected effect of beer colour on ratings of body and bitterness during the blind tasting. While we tried to minimise the lighting in the room by using black computer background and red lightbulb, it is possible that this did not mask the colour differences and participants could distinguish between the light and dark beer samples. It is also likely that participants paid close attention to the beer samples in such an unusual environment (dark, red-lit testing cubicle), noticing even minor differences between the samples. Concealing aspects of appearance is generally problematic both in a laboratory and a more realistic setting. If, like in the present study, researchers do not manage or cannot completely obscure the appearance of the samples, it can affect results and their interpretation.

The boxplots in *Figures 6* A-D show the means as well as the spread of the data from the blind tasting session, and while in the case of bitterness and body the effect of colour was statistically significant, the mean differences appear to be relatively small and inconsistent. More importantly, these small baseline differences did not prevent generation and ultimately assimilation of expectations in the experimental session. In the case of the present study, the failure to completely obscure the colour difference between the samples would result in reduced power and ultimately underestimation of the effects of beer colour on sensory and hedonic perception. However, overly conservative estimates of effect sizes are considered to be a smaller issue than their overestimation, as most

psychological studies indeed tend to overestimate effect sizes (Brand et al., 2011).

3.4.3 Summary

What are the implications of the findings discussed above? The findings of the present study suggest that in the context of beer both sensory descriptor and beer colour can change not only consumers' expectations but also their sensory and hedonic perception. This knowledge is invaluable for improving consumers' experience of beers with reduced alcohol content. The conclusions made in this study could be used to increase consumers' acceptance and enjoyment of non-alcoholic beers. We suggest using sensory descriptors on labels to strengthen consumers' expectations of the sensory properties that need to be improved. The effect of extrinsic cue, such as sensory descriptor can be furthered modulated by colour (or vice versa). Beer colour appears to be a versatile tool to modify expectations and ultimately perception of body, as well as other aspects of taste, flavour, mouthfeel and even liking, aspects that consumers may find problematic in the context of non-alcoholic beer. Of course, because the current study only used samples containing alcohol and only tested one sensory descriptor, the findings reported here need to be replicated in beers ranging in alcohol content and using other sensory descriptors.

While beer is one of the most popular alcoholic beverages in the world (Ritchie & Rosser, 2019), consumers are encouraged to moderate its intake (Department of Health, 2016; Rehm et al., 2016). As a result, the demand for alternatives with reduced alcohol content is rising (Abboud, 2019). Despite the rise of sales of beer with reduced alcohol content, consumers are often not satisfied with its flavour profile (Catarino & Mendes, 2011), especially criticizing the lack of

perceived body (Sohrabvandi et al., 2010). The findings presented above suggest that cues not directly related to the chemosensory properties of the beer can be used to further improve consumers experience of beer, particularly useful for the development of reduced alcohol beer.

4 CHAPTER 4: HOW SENSORY AND HEDONIC EXPECTATIONS SHAPE PERCEIVED PROPERTIES OF REGULAR AND NON-ALCOHOLIC BEER

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Running head: Expectations shape perceived properties of beer

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Declaration of interest:

This experiment was carried out as a part of a PhD project funded by Fund Baillet Latour. Claire Hidrio is an employee of AB InBev, and while she has provided feedback on the design and write-up, she did not contribute to the data analysis or interpretation of the results. Helena Blackmore and Prof. Martin Yeomans have no conflicts of interest to declare.

Acknowledgements

This study is a part of a PhD project funded by fonds Baillet Latour.

Author contributions

Conceptualization: H.B, and M.R.Y.; methodology: H.B., and M.R.Y.; software, H.B; formal analysis: HB; interpretation: HB; writing—original draft preparation: H.B; review and editing: H.B, M.R.Y, C.H; supervision: M.R.Y; C.H.; Y.; funding acquisition, M.R.Y.

Abstract

While the popularity of reduced alcohol beer has been increasing, consumers still sometimes complain about perceived sensory defects of these beverages. Breweries are working to improve the sensory profile of low and non-alcoholic beers by changing the product formulation, however, here we wanted to investigate the impact of psychological, rather than chemosensory determinants of flavour perception and consumer experience. As the way we experience the world around us, including gustatory perception, is shaped by our expectations, we investigated and modelled the relationships between product-related cues, expectations, and perception. We tested 87 regular beer drinkers to examine whether and how beer colour, label-based sensory descriptors and labelled alcohol content affect expected and perceived bitterness, refreshment, liking and body. Additionally, we wanted to establish, using mediation analysis, whether expectation mediate these effects. In summary, we found that both beer colour and under some circumstances sensory descriptors can shape consumers' perception of beer taste, flavour, and mouthfeel. However, liking of beer was only influenced by labelled and actual alcohol content, not by beer colour or sensory descriptors. Finally, we have demonstrated that expectations act as a mediator, transferring the effect of intrinsic (beer colour) and extrinsic (labelled alcohol content and sensory descriptor) product cues to shape consumer sensory experience.

4.1 INTRODUCTION

Beer is one of the most popular alcoholic beverages in the world: in 2020 over 182 billion litres of beer were consumed worldwide(*BarthHaas Report 2021 | BarthHaas*, n.d.; Ritchie & Rosser, 2019). However, as the WHO and medical professionals caution against overconsumption of alcohol (Burton & Sheron, 2018; WHO, 2005) increasing number of consumers limit their alcohol intake or, at least temporarily, avoid alcoholic drinks altogether (De Visser et al., 2016; Törrönen et al., 2019). Of course, there are circumstances when some wish to enjoy the health benefits of non-alcoholic beer (Chrysochou, 2014; Jackowski & Trusek, 2018; Osorio-Paz et al., 2019) or experience the flavour of beer while avoiding the effects of alcohol (Dry et al., 2012; Schulte et al., 2001). As a result, the consumption of reduced alcohol beer is on the rise (*Non-Alcoholic Beer Market Report*, 2020). Yet, consumers sometimes perceive the flavour profile of non-alcoholic beer as inferior (Catarino et al., 2007; Güzel et al., 2020; Sohrabvandi et al., 2010). Why is that? Could that be changed? And how?

Breweries are working to improve the sensory profile of low and non-alcoholic beers by changing the product formulation. However, the impact of psychological, rather than chemosensory determinants of flavour perception and consumer experience is often overlooked. In the context of eating and drinking, expectations are predictions experienced before tasting. The brain constantly generates predictions about what we are likely to experience (Clark, 2013). This is true for all sensory modalities, including taste perception (Gardner et al., 2014). There are a number of factors, such as previous experience, attitudes or product-related cues, that influence the process of expectation generation (Cardello, 2007; Deliza & MacFie, 1996; Fernqvist & Ekelund, 2014; Piqueras-Fiszman & Spence, 2015). Most of us consume food and beverages multiple times a day, yet most of

the time we have a good idea about the upcoming gustatory experience. This is the case even when we are about to taste an unfamiliar or new product. But where do our predictions come from? These expectations are based on previous experience and cues in the environment. We learn about different ingredients and their flavour with repeated exposure. We then acquire subtle associations such as between the intensity of colour of a drink and its sweetness (Spence et al., 2010) or the colour of chocolate and 'chocolatey' flavour (Shankar et al., 2009). We also pay attention to marketing: we read what the label says (e.g., low fat, delicious, lightly salted) and perhaps examine the nutritional content of the product. In other words, we rely on cues that are related to the product itself (appearance and chemosensory properties) - product intrinsic cues - and cues that are related to the packaging or other information about the product -product extrinsic cues (Cardello, 2007). In short, our predictions, the specific expectations about novel products, are shaped by intrinsic and extrinsic product-related cues. What is interesting is that expectations not only predict, but also actively shape, our experience (de Lange et al., 2018). Sensory and hedonic expectations can affect how we perceive flavour of a product, as well as how much we like it: there is abundant evidence that aspects of product labelling and product appearance can alter consumers' experience (Piqueras-Fiszman & Spence, 2015; Skaczkowski et al., 2016).

Whether the relationship between expectations and consumer experience is based on perceptual processing or due to response bias, can be answered by examining underlying neural processing (Okamoto & Dan, 2013). A number of neuroimaging studies highlighted the importance of and connection between primary and secondary gustatory cortices and how these correlate with ratings of perceived and expected taste, (Nitschke et al., 2006; Sarinopoulos et al., 2006) . The

study of expectations in the realm of taste and flavour perception, however, usually defaults to explaining expectations and their effect using the assimilation/contrast model, which is based on behavioural data (Cardello, 2007; Deliza et al., 1996). This model posits that the size of the mismatch between expectations and actual properties of the product determines the nature of perceptual change. If the properties of the product and expectations match, our perception will be unchanged (compared to what would be perceived without any expectations, i.e., tasting the product blind). If there are relatively small differences between actual properties and expectations, the perception will be shifted in the direction of expectations (assimilation). If however the mismatch is relatively large, the difference between expectations and perception will be magnified, and perception will be shifted in the opposite direction to expectations (contrast). Countless studies demonstrated the assimilation effect (Fernqvist & Ekelund, 2014; Piqueras-Fiszman & Spence, 2015) but only a few reported a contrast effect (Yeomans et al., 2008; Zellner et al., 2004). We should observe similar pattern in our daily lives: assimilation will be more the common phenomenon, as we usually have a reasonable idea about what we are going to eat or drink. This assimilation effect, and the relative ease with which it can be achieved, is important for product marketing and development (Reinoso-Carvalho et al., 2019).

4.1.1 Colour and sensory descriptor

Drinking and eating is a multisensory experience, and the appearance of a beverage can shape our expectations (Van Doorn et al., 2019). Colour is an important aspect of appearance, as it often implies sensory properties of a product, be it taste/flavour intensity or identity (Koch & Koch, 2003; Singh, 2006; Spence, 2019; Zellner & Durlach, 2003). Beer is no different. While the compounds responsible for the colour of beer are usually not associated with its taste or

flavour (Spearot, 2016), beer colour plays an important role in generating consumers expectations. For example, in some studies participants expected darker beers to taste more bitter and have fuller body (Blackmore et al., 2021; F. M. Carvalho & Spence, 2019; Reinoso-Carvalho et al., 2019) compared to light coloured beers. However, while Blackmore et al. (2021) found that the change in increased expectations of bitterness resulted in an increase of perceived bitterness, other researchers did not find any effect of beer colour on perception of either body or bitterness (Carvalho et al., 2017; Reinoso-Carvalho et al., 2019), yet others observed that lighter beers were perceived as more bitter than darker beers (Spearot, 2016). Aside from bitterness and body, beer colour was also reported to affect perceived refreshment (Guinard et al., 1998) and liking (Donadini et al., 2014). Overall, there is some evidence that beer colour can affect both expectations and perception. However, more research is needed as the relationship between beer colour, and expected and perceived properties has shown conflicting results. In addition, we need to establish the causal relationship between beer colour, expectations and perception.

While colour and appearance of the actual product are certainly important sources of information about a product, consumers cannot always see these, most obviously when products are hidden by packaging. In this case, consumers need to rely on extrinsic cues. Many studies have found that different aspects of labelling and packaging can influence consumer's expectations, decision-making and even perception (Fernqvist & Ekelund, 2014; Piqueras-Fiszman & Spence, 2015; Skaczkowski et al., 2016; Spence & Wan, 2015). Arguably, the most direct way to generate expectations of taste or mouthfeel is to use a sensory descriptor on the label/packaging. Indeed, a number of studies showed that sensory descriptors can affect the way consumers perceive a range of products (Grabenhorst et al., 2008b;

Liem, Miremadi, et al., 2012; Okamoto et al., 2009). For example, Deliza, MacFie and Hedderley (1996) examined how information about bitterness affected participants' ratings of bitter solutions, showing that expectations of bitterness were assimilated and lead to an increase in perceived bitterness. In another study Woods and colleagues (Woods et al., 2011) demonstrated that a solution cued as "sweet" resulted in an increase in ratings of perceived sweetness, as well as increased BOLD response in the primary taste cortex. Given the need to modulate perceived sensory properties of reduced-alcohol beers, it would be interesting to examine whether and how different sensory descriptors alter the gustatory experience in the context of beer, and specifically test whether these effects are mediated by expectations.

4.1.2 Labelled and actual alcohol content

Alcohol content is an important determinant of perceived properties of alcoholic beverages, including beer. Alcohol content contributes to perception of mouthfeel, specifically body (Gawel et al., 2007; Langstaff et al., 1991; Niimi et al., 2017). Beverages with higher alcohol content tend to be rated as having fuller body, sweetness, alcohol warming sensation and increased complexity, while drinks with reduced alcohol content tend to be perceived as lacking body and other aspects of mouthfeel (Clark et al., 2011; Ramsey et al., 2018; Sohrabvandi et al., 2010). Other studies have found that reducing alcohol content in beer can result in loss of body, volatile compounds and overall change in aromatic and thus overall flavour profile (Liguori et al., 2015). But what is the role of labelled alcohol content on consumer experience?

The placebo effect results from conditioned responses or more complex phenomenon of expectations (Bodnár et al., 2020) and the placebo effect of alcohol is well documented (Bodnár et al., 2020; Galindo et al., 2020; Hull & Bond, 1986). Yet, while research has addressed the effect of expected alcohol content on cognitive performance (Galindo et al., 2020) and aspects of social behaviour (Testa et al., 2006), the effect of expected alcohol content on perception of taste, flavour, and mouthfeel is largely unknown.

Most of the research concerning labelled alcohol content has focused on wine and mostly addressed concerns of consumer liking and acceptability of low or non-alcoholic products. For example, Meillon and colleagues (Meillon et al., 2010) examined consumer's expectations and perception of partially dealcoholized wines (9.5 % ABV) and found that labelling wine as "reduced alcohol" negatively impacted participants' hedonic expectations and as a result decreased their liking. In a bar-based beer study, beer labelled as non-alcoholic was consistently expected to be liked less and perceived as less pleasant than beer that was labelled as alcoholic, regardless of actual alcohol content (Silva et al., 2017). While there might be individual differences and the consumer population is segmented (Meillon et al., 2010), reduced alcoholic beverages appear to be associated with negative expectations and are liked less - at least in the context of research studies. While we have some knowledge about the effects of labelled alcohol content on expected and perceived liking, research on the impact of alcohol labelling on sensory expectations and perception is largely missing, especially in the context of beer.

4.1.3 Aims and Objectives

As expectations can shape our eating and drinking experience, there is a need to develop an in-depth understanding of how expectations are generated and their impact on gustatory experience. This knowledge can then be readily applied to improve consumer experience and decision-making, be it in the context of alcohol consumption or other health related behaviour. The present study has two main aims. Firstly, we will explore the effects of labelled and actual alcohol content, beer colour and sensory descriptor on expected and perceived sensory and hedonic properties of beer. And secondly, we will model the relationships between product-related cues, expectations and perception using causal mediation analysis to model the nature relationships between product-related cues, expectations, and perception.

4.2 METHODS

4.2.1 Design

The study used a 2x2x2x4 mixed design to contrast the effect of intrinsic and extrinsic product cues on expected and experienced liking and different components of flavour. The aspects of the beer that were manipulated were actual alcohol content (0.0% ABV, 4.5% ABV), labelled alcohol content (0.0% ABV, 4.5% ABV), colour (light, dark) and sensory descriptor (“bitter”, “refreshing”, “full body”, no descriptor).

4.2.2 Participants

All participants were recruited from the student and staff population at the University of Sussex and altogether, 87 participants (39 male, 46 female, 2 non-binary) took part in the study. Thirty participants (19 male, 10 female, 1 non-

binary) viewed labels with the sensory descriptor “bitter”, 29 (13 male, 16 female) with the descriptor “full body” and 28 (7 male, 20 female, 1 non-binary) with the sensory descriptor “refreshing”. All participants also viewed labels without a sensory descriptor. The average age of the participants was 27 years (M=27.16, SD=7.3) and average BMI was 23.67 (M=23.67, SD=3.68). Neither BMI nor age significantly differed among the “sensory descriptor” conditions ($p>0.05$). Participants’ alcohol consumption was coded as high (fortnightly and more often) vs. low (monthly or less often) and a Chi square test was performed to examine whether alcohol consumption frequency differed between the sensory descriptor conditions. There were no differences in how often participants in different conditions consumed wine, spirits, regular or non-alcoholic beer ($p>0.05$). Additionally, there were no differences in participants feelings of hunger, fullness, thirst, tiredness, happiness, being energetic, and clear-headed ($p>0.05$). The group means for BMI, age, hunger and mood, as well as distribution of alcohol use are included in tables S1 and S2 in the Supplemental materials.

Potential participants with alcohol use disorder, diagnosed eating disorder, who were pregnant or breastfeeding, who had diabetes, were colour-blind, smoked 5 or more cigarettes a day or were taking any medication excluding the contraceptive pill were not allowed to participate in the study. Additionally, those who participated in our previous study (Blackmore et al., 2021) were also excluded. Participants were recruited for a study examining the effect of current mood state on taste perception of beers. They were informed about the real purpose study during debrief and each participant was breathalysed to ensure their breath alcohol concentration was below the legal drink drive limit. The Science & Technology Cross-Schools Ethics Committee at the University of Sussex approved

the experimental protocol (application ER/HB315/5), and the study was conducted according to the ethical standards defined by the British Psychological Society.

4.2.3 Materials

4.2.3.1 Beer samples

The samples were all based on a commercially available non-alcoholic beer (<0.05% ABV). The colour of the beer was altered by adding 1.36 g/l powdered malt extract (PureMalt) to alter the beer colour. As a result, the light-coloured beer was pale (5 EBC) and the darker coloured beer was dark amber (25 EBC), both the light and dark coloured beers appearance fits within the lager category(Brewers Association Beer Style Guidelines, 2021). The alcohol content (ABV) of the beer was increased by adding 4 ml of 96% pure ethanol into half of the samples to achieve a concentration of 4.5%.

Samples were prepared immediately before serving and the same manipulations were applied whether ethanol had been added or not. To ensure the colour and alcohol manipulations did not result in confounding differences in carbonation between samples, for all stimuli, 15 ml of beer were decanted into a plastic jug from each freshly opened 330 ml can. Alcohol and/or colour was then added dependent on condition, and all samples were stirred for 10 seconds (pilot testing confirmed that this was adequate to disperse the colouring agent). The remaining 315 ml of beer was then added to each sample and was gently stirred. This resulted in four beer samples: dark 0%, light 0%, dark 4.5%, light 4.5%. For serving, approximately 80ml of each sample was gently poured into standard 200 ml capacity glasses. The samples were presented on a tray and each sample was numbered by a randomly generated three-digit code. All beer samples were prepared at 4° C and consumed within 30 minutes.

4.2.3.2 Software

The beer labels were created using an online resource (*Beerlabelizer*, 2019) and Adobe Photoshop CC 2017. The labels differed in the labelled ABV and the sensory descriptor (see ***Figure 4.1***). Presentation of the labels, as well as beer samples was randomized. The experiment was designed and administered using Qualtrics software (*Qualtrics*, 2018).

Figure 4.1. Labels used in the experiment. Each participant was exposed to labels with one of the sensory descriptors bitter, refreshing and full body, and labels without any sensory descriptor. *These labels additionally contained information about alcohol content*

4.2.4 Procedure

As participants arrived, they were screened for exclusion criteria and to ensure they had not consumed food or flavoured beverages in the 2 hours prior to the experiment. They were seated in a red-lit experimental cubicle. Red lighting was used during the blind-tasting session to disguise the colour of the beer samples and thus eliminate the effect of this cue on perception of taste and flavour. Participants first completed an informed consent form and provided some

demographic information (gender, age) then they rated their hunger, fullness, thirst, tiredness, happiness, and how energetic and clear-headed they were. Participants also answered questions about their alcohol consumption and experience with or attitudes to non-alcoholic beer. The experiment consisted of two parts, the blind tasting session and the experimental session. The blind tasting was always followed by the experimental session, and both are described in detail below (and visualized in ***Figure 4.2***). After tasting all the beer samples presented in the blind tasting and experimental session, participants completed a questionnaire about their drinking habits to record how often they drank different types of alcoholic beverages. At the end height and weight were recorded.

4.2.4.1 Blind tasting session

Four numbered beer samples were placed in front of the participant, which were tasted in a random order. Participants were instructed to pick up a sample, take one sip, swish the beer around the mouths for 5s and then swallow. They then rated the bitterness, refreshment, liking, body and perceived alcohol content of the beer they just tasted. All ratings except for perceived ABV were made on a 0-100 visual analogue scale (VAS), the anchors used are presented in ***Table 4.1***. Perceived ABV was rated on a scale ranging from 0.0% to 6.0%[7]. Before each new sample, participants used mineral water to rinse their mouth. This was repeated for all four samples, as is illustrated in ***Figure 4.2***. Once they rated all four samples, participants were asked to call the experimenter who took away the samples and changed the lighting in the room. This part of the experiment took less than 10 minutes.

[7] This range was chosen because most commercially available alcoholic and non-alcoholic beers fall between 0-6% ABV (Sohrabvandi et al., 2010)

Table 4.1. Visual analogue scale anchors used during the blind and experimental sessions.

		Anchors	
		0 (0.0%)	100 (6.0%)
Expected	Bitterness	not at all	extremely
	Refreshment	not at all	extremely
	Liking	dislike extremely	like extremely
	Body	light	full
	Confidence	just guessing	100% certain
Perceived	Bitterness	not at all	extremely
	Refreshment	not at all	extremely
	Liking	dislike extremely	like extremely
	Body	light	full
	Alcohol content	non-alcoholic/ low alcohol	strong

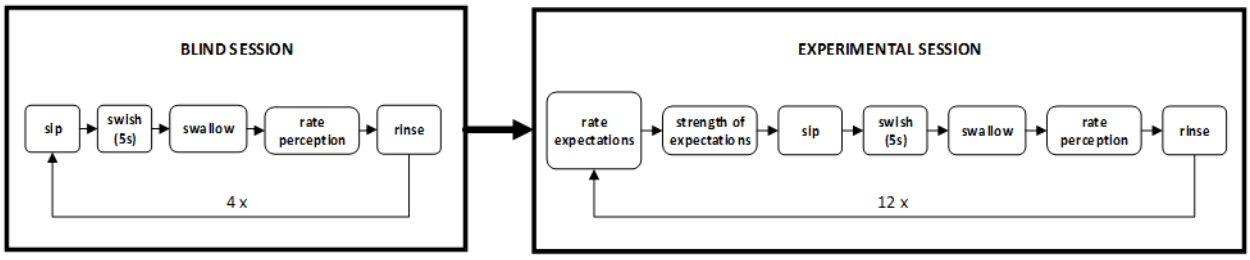


Figure 4.2.A schematic depiction of the beer tasting procedure in the blind and experimental sessions

4.2.4.2 Experimental session

The experimental session was carried out in a well-lit experimental cubicle. This time the bright lighting allowed participants to notice colour differences of the samples. During this session, participants tasted and rated 12 beer samples, this time with each sample accompanied by a beer label presented on a computer screen. All participants viewed half of the labels without a sensory descriptor and half with one of the sensory descriptors. The sensory descriptors in this study were based on findings from our previous studies (Blackmore et al., 2020). There were altogether four different beer samples, light coloured non-alcoholic, light coloured alcoholic, dark coloured non-alcoholic, and dark colour alcoholic, and eight different labels: 0.0% bitter, 0.0% refreshing, 0.0% full body, 0.0 %, 4.5% bitter, 4.5 % refreshing, 4.5% full body, 4.5% (see ***Figure 4.1***). Participants tasted six samples accompanied by a label with a sensory descriptor and six samples without a sensory descriptor, altogether 12 beer samples. In eight of the samples the labelled and actual alcohol content matched, in two samples the non-alcoholic beer was labelled as alcoholic and in two samples the alcoholic beer was labelled as non-alcoholic, making it a fractional factorial design. The use of fractional factorial design in this case enabled us to avoid issues such as carry-over effects and participant fatigue, while obtaining maximum amount of information (Gunst & Mason, 2009; Holland & Cravens, 1973).The labels contained varying information about the alcohol content and sensory properties of the sample. In this part of the experiment participants were instructed to locate a sample (these were again tasted in a random order, determined by the Qualtrics algorithm), inspect its appearance and the associated label, and rate their expectations of bitterness, liking, refreshment and body (same scales as in the blind tasting), as well as their confidence about these expectations. Once expectations were rated, participants

proceeded to taste the sample. The tasting process was virtually identical to the one in the blind tasting session: sip, swish for 5 s, swallow, rate perceived bitterness, refreshment, liking, body and alcohol content, rinse (see ***Figure 4.2***). This was repeated with all 12 samples.

4.2.5 Data Analysis

Data were analysed using R studio 1.6 and R 4.0. To check whether the beer colour affected participants' blind ratings of bitterness, refreshment, liking and body a multilevel model (MLM) with participants as random, and colour, alcohol content as fixed effects, was used (see Field et al., 2012; Hoffman & Rovine, 2007).

To examine the effects of the independent variables on expectations and perception and to examine the relationship between expectations and perception we used a causal mediation analysis. We used "bmlm" (Vuorre, 2017) R package which allowed us to perform Bayesian within-subjects mediation analysis, suitable to be used with repeated measures factors (here colour). The relationship between predictor and outcome variable and predictor, mediator, and outcome variable were modelled as a MLM with participants as random effect, colour and sensory descriptor as predictors, expectations as mediator and perception as outcome variable. The software default, minimally informative prior was used. The mediation models were then evaluated using the estimates and 95% credible intervals, which were derived from posterior distributions. There is evidence of mediation when the credible interval can rule out zero as a likely population value (Vuorre & Bolger, 2018).

4.3 RESULTS

4.3.1 Blind tasting session

The data from the blind tasting session were analysed using a multilevel model (MLM) with participants as random, and colour, alcohol content as fixed effects. This analysis was used to determine whether participants' baseline ratings of bitterness, refreshment, liking, body and perceived alcohol content differed as a function of alcohol content and colour. In a blind tasting session, we would expect the ratings, especially those of body and perceived alcohol content, to be affected by the actual alcohol content, but not by colour, as that was disguised. Alcoholic beers were perceived as more bitter (b =5.32, 95% CI [1.12, 9.51], t(343) = 2.48, p = 0.013), having fuller body (b =15.41 , 95% CI [11.39, 19.44], t(343) =7.51, p <0.001), higher alcohol content (b =0.62, 95% CI [0.43, 0.82], t(343) =6.37, p <0.001) and were liked more (b = 5.57 95% CI [2.10,9.05], t(343) = 3.15, p = 0.002) compared to the non-alcoholic samples. Unexpectedly, the colour of the sample increased ratings of perceived body (b =7.31, 95% CI [3.29, 11.33], t(343) =3.56, p <0.001). The distribution of the data and the relationships are visualised in ***Figure 4.3*** and detailed in

Table 4.2.

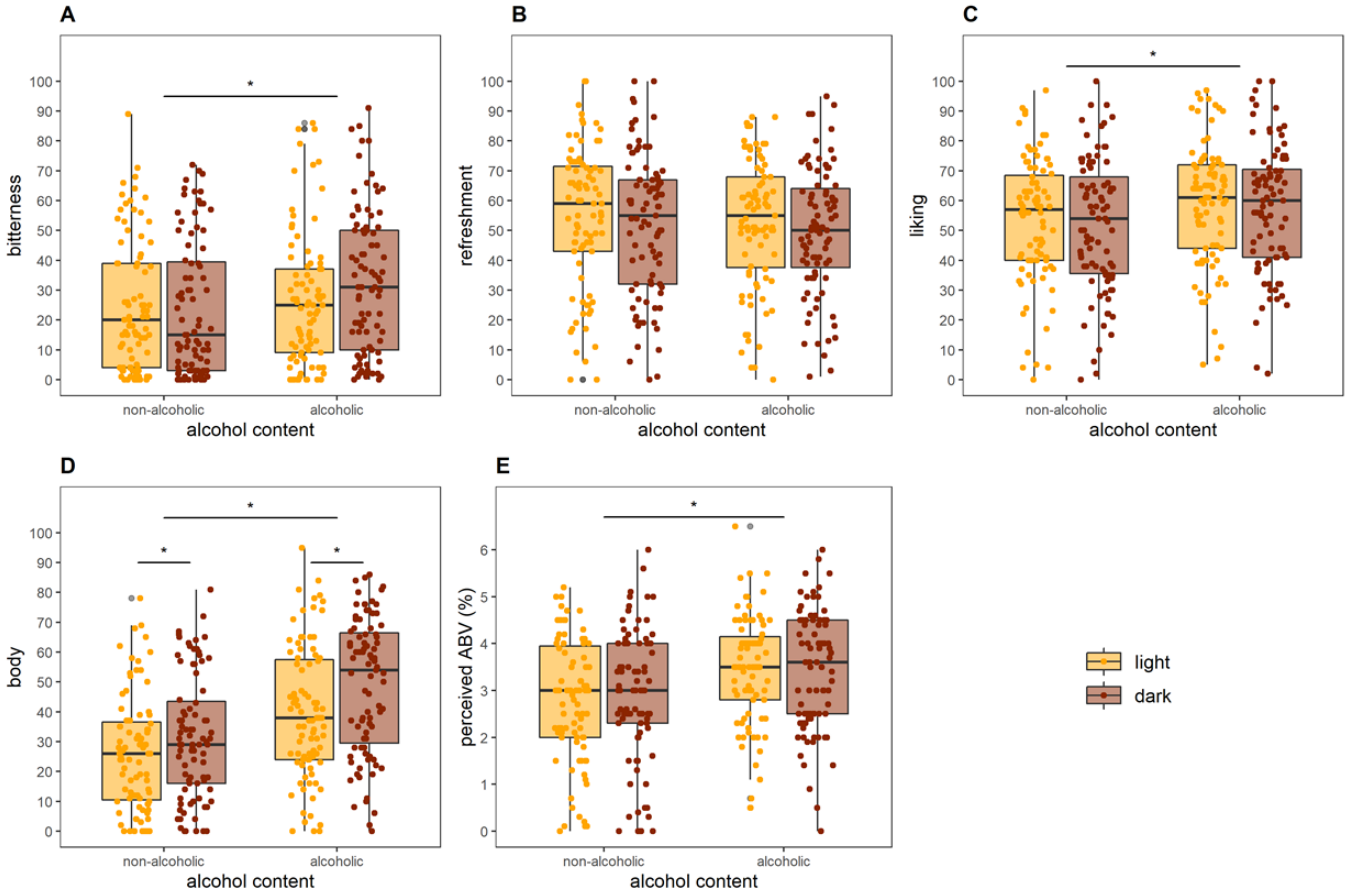


Figure 4.3. Ratings of perceived bitterness (A), refreshment (B), liking (C) body (D), and alcohol content (E) during the blind tasting session. *The perceived bitterness, refreshment, body, and liking were measured on 0-100 VAS and perceived alcohol content was was measured on a 0% - 6% ABV VAS.*

Table 4.2. Mean (SE) perceived characteristics of the four samples of beer tasted during the blind tasting session.

	0.0%		4.5%	
	light	dark	light	dark
Bitter	24.5 (2.4)	23.8 (2.4)	26.3 (2.4)	32.5 (2.6)
Refreshment	54.6 (2.6)	52.0 (2.6)	52.6 (2.3)	49.8 (2.3)
Body	26.0 (2.0)	31.5 (2.2)	39.6 (2.4)	48.8 (2.4)
Liking	53.4 (2.3)	51.7 (2.4)	58.7 (2.4)	57.6 (2.3)
Perceived alcohol content	2.8 (0.1)	2.9 (0.1)	3.5 (0.1)	3.4 (0.1)

4.3.2 Experimental session

Separate mediation analyses were conducted for each of the rated characteristics of the beers: bitterness, refreshment, liking and body. In each case the full summary of the model can be found in

Table 4.3, and models are visualized in

Figure 4.4 A, B, C and D, respectively.

4.3.2.1 Bitterness

4.3.2.1.1 Beer colour

Darker beer colour increased expectations of bitterness (*a* = 18.03, 95% CI [14.03, 22.01]), which in turn affected perceived bitterness (*c′* = 4.03, 95% CI [1.06, 7.30]). However, we did not observe an indirect, i.e. mediated effect of beer colour on perceived bitterness (*me* = 1.72, 95% CI [-0.10, 3.65]).

4.3.2.1.2 Sensory descriptors

While the sensory descriptor "full body" had no effect on expected or perceived ratings of bitterness (*a* = -4.38, 95% CI [-8.93, 0.38], *c′* = -1.45, 95% CI [-5.70, 2.78], *me* = -0.76, 95% CI [-1.96, 0.16]), the descriptor "refreshing" decreased expected bitterness (*a* = -5.97, 95% CI [-10.20, -1.62]). However, this effect was not mediated: the sensory descriptor "refreshing" did not directly (*c′* = -0.35, 95% CI [-4.22, 3.49]) or indirectly (*me* = -0.84, 95% CI [-2.12, 0.10]) affect perception of bitterness. Finally, the descriptor "bitter" increased ratings of expected (*a* = 8.87, 95% CI[4.26, 13.50]) and this in turn affected perceived bitterness, which was mediated by expectations of bitterness (*me* = 1.78, 95% CI [0.60,3.31]) as generated by the descriptor.

4.3.2.1.3 Labelled alcohol content

Beers labelled as 0.0% ABV were expected to be less bitter than beers labelled as 4.5% ABV (*a* = -7.07, 95% CI [-9.59, -4.56]), and the effect of labelled

alcohol content on bitterness was mediated by expectations of bitterness (*me* = -1.22, 95% CI [-1.90, -0.62]).

4.3.2.1.4 Actual alcohol content

Beer samples that contained alcohol (4.5% ABV) were rated as more bitter compared to non-alcoholic beer samples (4.79, 95% CI [2.39, 7.20]).

4.3.2.2 Refreshment

4.3.2.2.1 Beer colour

Compared to light-coloured beers, darker beers were expected to be less refreshing (*a* = -16.54, 95% CI [-20.36, -12.72]). Dark beer colour reduced ratings of perceived refreshment, which effect was mediated by expected refreshment (*me* = -3.22, 95% CI [-5.09, -1.77]).

4.3.2.2.2 Sensory descriptors

Expectations of refreshment were not affected either by the sensory descriptor "bitter" (*a* = 0.02, 95% CI = [-4.00, 4.14]) or descriptor "full body" (*a* = 3.04, 95% CI [-1.12, 7.26]). However, beers labelled as "refreshing" were expected to be more refreshing compared to beers with no sensory descriptor (*a* = 10.19, 95% CI [5.69, 14.67]. The effect of the "refreshing" label then indirectly affected perceived refreshment (*me* = 2.81, 95% CI [1.36, 4.95], *b*= 0.27, 95% CI [0.18, 0.37]).

4.3.2.2.3 Labelled alcohol content

Labelled alcohol had no effect on expected (*a* = -1.55, 95% CI [-3.91, 0.80]) or perceived refreshment (*c´* = -0.56, 95% CI [-2.48, 1.43], *me* = -0.45, 95% CI [-1.22, 0.30]).

4.3.2.2.4 Actual alcohol content

The alcohol content of beer samples had no effect on perceived refreshment (0.90, 95% CI [-1.27, 3.08]).

4.3.2.3 Body

4.3.2.3.1 Beer colour

Dark coloured beers were expected to have fuller body than light-coloured beers (*a* = 25.94, 95% CI [21.73,30.10]). The effect of beer colour was mediated by expectations of body (*me* = 5.84, 95% CI [2.98, 8.87]) and as a result, darker beers were perceived as having fuller body.

4.3.2.3.2 Sensory descriptors

While the descriptor "bitter" did not affect expected or perceived body of beer (*c′* = -1.40, 95% CI [-3.71, 0.56], *me* = -1.42, 95% CI [-3.71, 0.56]) the descriptors "full body" and "refreshing" did. Beers described as "refreshing" generated expectations of lighter body (*a* = -8.86, 95% CI [-13.61, -4.09]), and the descriptor "refreshing" then indirectly lowered perception of body of the beer (*me* = -2.66, 95% CI [-4.69, 1.02]). On the other hand, descriptor "full body" increased participants' expectations of body (*a* = 8.84, 95% CI [1.71, 15.76]), however we did not observe either direct or indirect effect of the descriptor "full body" on perceived body of the beer (*c′* = -3.66, 95% CI [-8.34, 0.99], *me* = 2.72, 95% CI [-0.13, 6.08).]

4.3.2.3.3 Labelled alcohol content

Labelled alcohol content (0.0% ABV) resulted in decrease of expected body (*a* = -7.82, 95% CI [-10.46, -4.98]. Labelling beers as non-alcoholic (0.0% ABV)

additionally resulted in decrease of perceived body, mediated by expected body (*me* = -2.50, 95% CI [-3.71, -1.46]).

4.3.2.3.4 Actual alcohol content

After controlling for effects of product cues (colour, descriptor and labelled alcohol content), beers that contained alcohol (4.5% ABV) were perceived as having fuller body compared to non-alcoholic beers (12.93, 95% CI [10.57, 15.36]).

4.3.2.4 Liking

4.3.2.4.1 Beer colour

Beer colour had no effect on expected (*a* = -1.99, 95% CI [-6.01, 1.83]) or perceived (*c'*= -2.51, 95% CI [-5.04, 0.03], *me* = 0.25, 95% CI [-1.08, 1.64]) liking.

4.3.2.4.2 Sensory descriptors

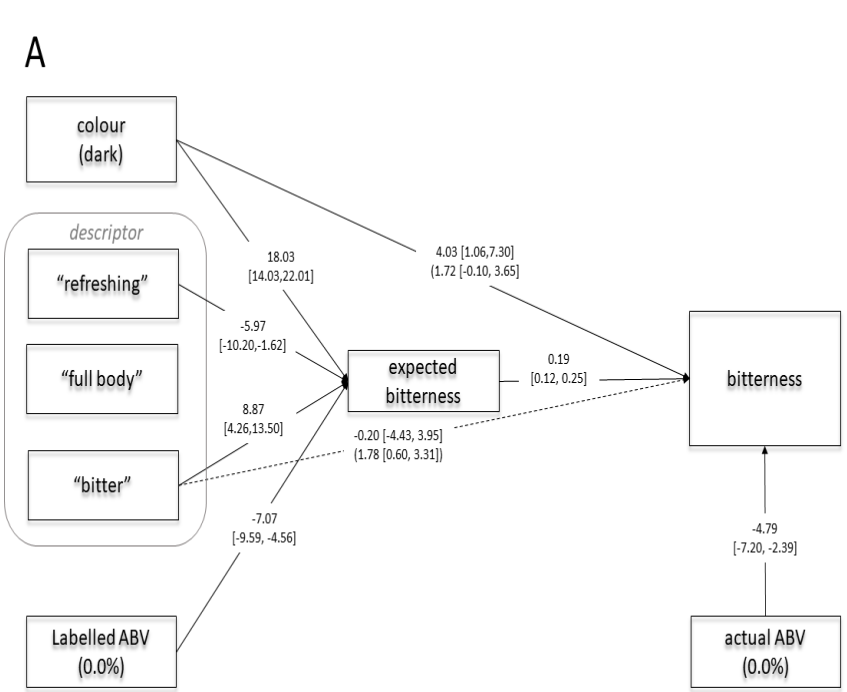
None of the sensory descriptors ("bitter", "refreshing", "full body") affected expected (a= - 3.46, 95% CI [-7.60, 0.68], a = 1.27, 95% CI [-2.47, 4.95], a = 0.94, 95% CI [-3.06, 5.07], respectively) or perceived liking (c' = 1.63, 95% CI [-1.73, 4.99], me = -0.94, 95% CI [-2.35, 0.20], c' = -2.38, 95% CI [-5.97, 1.25], *me* = 0.23 [-0.65, 1.19], *c'* = 2.76, 95% CI [-1.51, 6.93], *me* = 0.13 95% CI [-0.57, 0.93], respectively) .

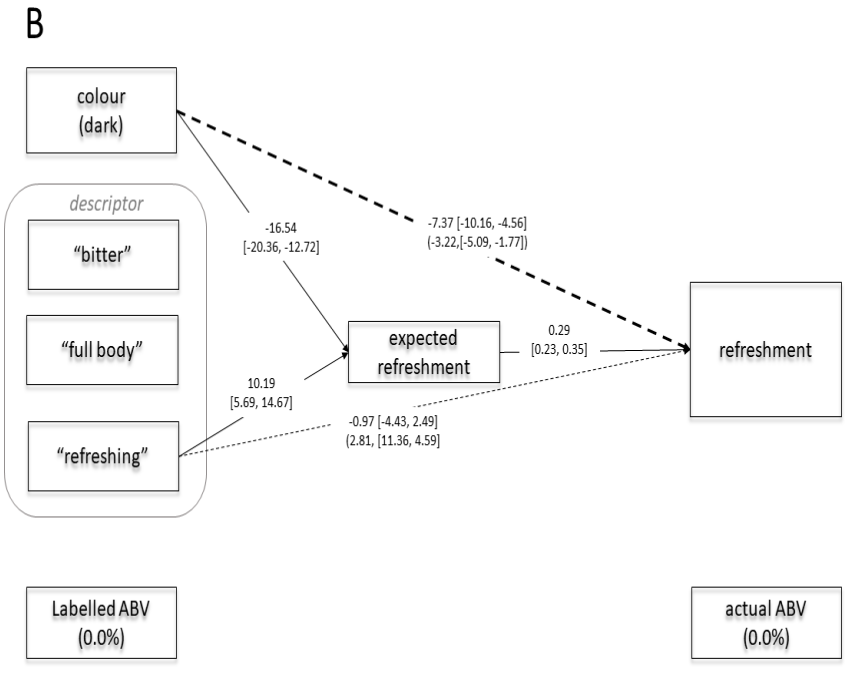
4.3.2.4.3 Labelled alcohol content

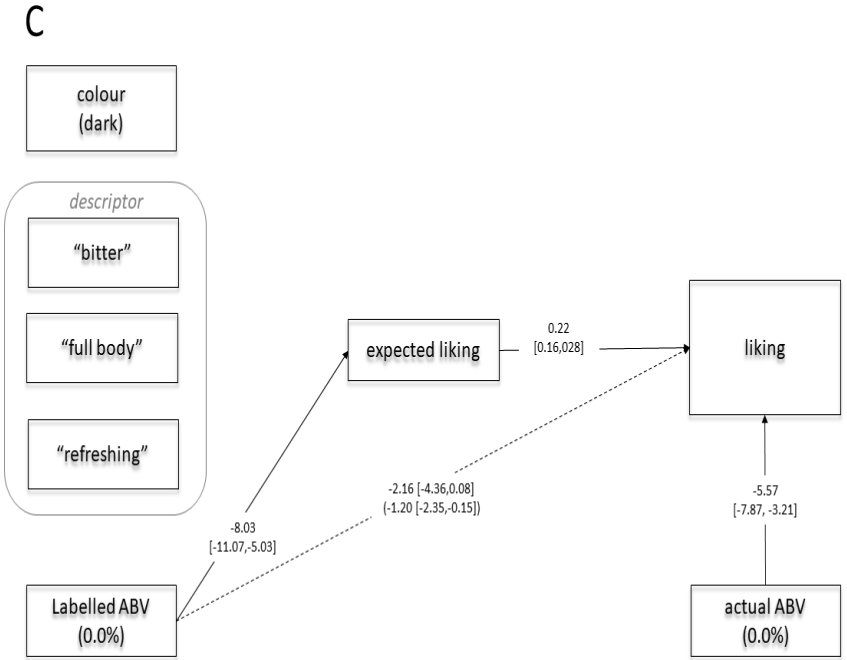
Beers labelled as 0.0% ABV lowered participants' expectations of liking (*a* = -8.03, 95% CI [-11.07, -5.03]). The effect of the "0.0% ABV" label was mediated through expectations and indirectly lowered reported perceived liking (*me* = -1.20, 95% CI [-2.35, -0.15]).

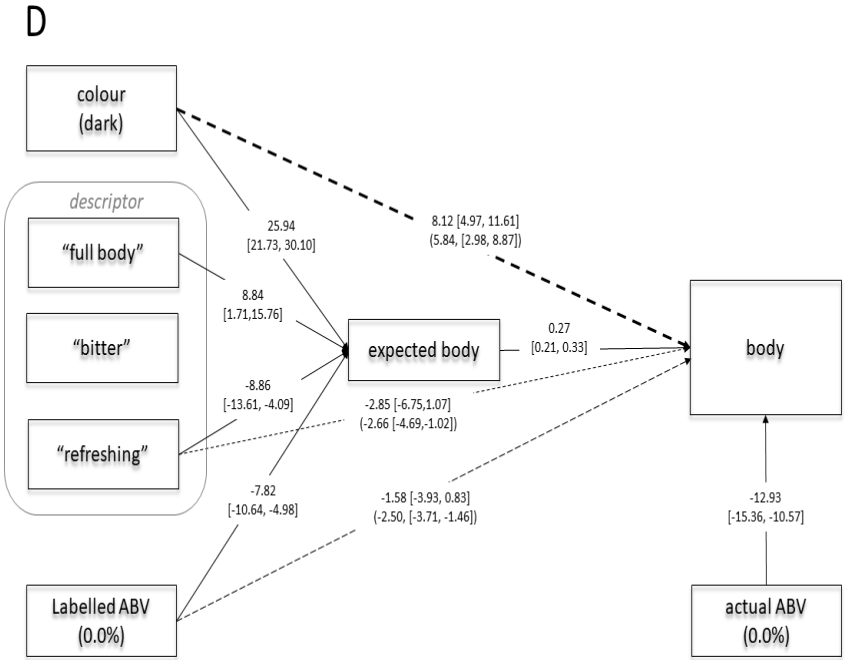
4.3.2.4.4 Actual alcohol content

After controlling for other predictors of liking, non-alcoholic beers (0.0% ABV) were liked less than regular beers (4.5% ABV) (5.57, 95% CI [3.21, 7.87]).


A
colour (dark)
descriptor
"refreshing"
"full body"
"bitter"
Labelled ABV (0.0%)
expected bitterness
bitterness
actual ABV (0.0%)
18.03 [14.03,22.01]
4.03 [1.06,7.30] (1.72 [-0.10, 3.65]
-5.97 [-10.20,-1.62]
8.87 [4.26,13.50]
-0.20 [-4.43, 3.95] (1.78 [0.60, 3.31])
0.19 [0.12, 0.25]
-7.07 [-9.59, -4.56]
-4.79 [-7.20, -2.39]


B
colour (dark)
descriptor
"bitter"
"full body"
"refreshing"
Labelled ABV (0.0%)
expected refreshment
refreshment
actual ABV (0.0%)
-16.54 [-20.36, -12.72]
-7.37 [-10.16, -4.56] (-3.22,[-5.09, -1.77])
0.29 [0.23, 0.35]
10.19 [5.69, 14.67]
-0.97 [-4.43, 2.49] (2.81, [11.36, 4.59]


C
colour (dark)
descriptor
"bitter"
"full body"
"refreshing"
Labelled ABV (0.0%)
expected liking
liking
actual ABV (0.0%)
0.22 [0.16,028]
-8.03 [-11.07,-5.03]
-2.16 [-4.36,0.08] (-1.20 [-2.35,-0.15])
-5.57 [-7.87, -3.21]


D
colour (dark)
descriptor
"full body"
"bitter"
"refreshing"
Labelled ABV (0.0%)
expected body
body
actual ABV (0.0%)
25.94 [21.73, 30.10]
8.12 [4.97, 11.61] (5.84, [2.98, 8.87])
8.84 [1.71,15.76]
0.27 [0.21, 0.33]
-8.86 [-13.61, -4.09]
-2.85 [-6.75,1.07] (-2.66 [-4.69,-1.02])
-7.82 [-10.64, -4.98]
-1.58 [-3.93, 0.83] (-2.50, [-3.71, -1.46])
-12.93 [-15.36, -10.57]

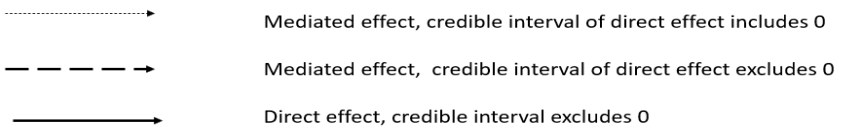


Figure 4.4.Causal mediation analysis. *Relationships between extrinsic and intrinsic cues, expectations and perception of bitterness (A), refreshment (B), liking (C) and body (D). Numeric values represent estimates of the direct effect (a, b, c') with the indirect effect (me) in brackets below. Each line in the mediation model denotes a presence and a nature of a relationship between the variables.*

Table 4.3. A numerical summery of the fixed effects of the multilevel mediation analysis. *Credible intervals are in square brackets. me is the average mediated effect, c′ is the direct effect, a represents the effect of the variable on expectations and b is the effect of expectations generated by given variable on perception. Instances where credible intervals do not contain 0 are in bold.*

	bitterness						**refreshment**						**liking**						**body**					
		descriptor						**descriptor**						**descriptor**						**descriptor**					
	Colour (dark)	"bitter"	"refreshing"	"full body"	**Labelled ABV (0.0%)**	**Colour (dark)**	"bitter"	"refreshing"	"full body"	**Labelled ABV (0.0%)**	**Colour (dark)**	"bitter"	"refreshing"	"full body"	**Labelled ABV (0.0%)**	**Colour (dark)**	"bitter"	"refreshing"	"full body"	**Labelled ABV (0.0%)**
a	**18.03 [14.03, 22.01]**	**8.87 [4.26, 13.50]**	-5.97 [-10.20, -1.62]	-4.38 [-8.93, 0.38]	**-7.07 [-9.59, -4.56]**	**-16.54 [-20.36, -12.72]**	0.02 [-4.00, 4.14]	**10.19 [5.69, 14.67]**	3.04 [-1.12, 7.26]	-1.55 [-3.91,0.80]	-1.99 [-6.01,1.83]	-3.46 [-7.60, 0.68]	1.27 [-2.47, 4.95]	0.94 [-3.06, 5.07]	**-8.03 [-11.07, -5.03]**	**25.94 [21.73, 30.10]**	-3.32 [-8.48, 1.66]	**-8.86 [-13.61, -4.09]**	**8.84 [1.71, 15.76]**	**-7.82 [-10.64, -4.98]**
b	**0.10 [0.02, 0.18]**	**0.20 [0.10, 0.31]**	0.13 [-0.01, 027]	**0.18 [0.07, 0.29]**	**0.17 [0.11, 0.24]**	**0.18 [0.11, 0.25]**	**0.26 [0.14, 0.37]**	**0.27 [0.18, 0.37]**	**0.37 [0.22, 0.51]**	**0.30 [0.24,0.37]**	**0.16 [0.08, 0.24]**	**0.26 [0.14,0.39]**	0.20 [0.07, 0.33]	0.11 [-0.02, 0.25]	**0.18 [0.11, 0.26]**	**0.20 [0.12,0.29]**	**0.37 [0.24, 0.50]**	**0.29 [0.17, 0.42]**	**0.30 [0.17, 0.44]**	**0.32 [0.24, 0.39]**
c′	**4.03 [1.06, 7.30]**	-0.20 [-4.43, 3.95]	-0.35 [-4.22, 3.49]	-1.45 [-5.70, 2.78]	-1.28 [-3.55, 0.99]	**-7.37 [-10.16, -4.56]**	3.26 [-0.05, 6.65]	-0.97 [-4.43, 2.49]	2.14 [-1.97, 6.20]	-0.56 [-2.48, 1.43]	-2.51 [-5.04, 0.03]	1.63 [-1.73, 4.99]	-2.38 [-5.97, 1.25]	2.76 [-1.51, 6.93]	-2.16 [-4.36, 0.08]	**8.12 [4.97, 11.61]**	-1.40 [-3.71, 0.56]	-2.85 [-6.75,1.07]	-3.66 [-8.34,0.99]	-1.58 [-3.93,0.83]
me	1.72 [-0.10, 3.65]	**1.78 [0.60, 3.31]**	-0.84 [-2.12,0.10]	-0.76 [-1.96, 0.16]	**-1.22 [-1.90, -0.62]**	**-3.22 [-5.09, -1.77]**	-0.03 [-1.20, 1.12]	**2.81 [1.36, 4.59]**	1.16 [-0.44, 2.98]	-0.45 [-1.22, 0.30]	0.25 [-1.08, 1.64]	-0.94 [-2.35, 0.20]	0.23 [-0.65, 1.19]	0.13 [-0.57, 0.93]	**-1.20 [-2.35, -0.15]**	**5.84 [2.98, 8.87]**	-1.42 [-3.71, 0.56]	**-2.66 [-4.69, -1.02]**	2.72 [-0.13, 6.08]	**-2.50 [-3.71, -1.46]**

4.4 DISCUSSION

There are three key findings from this study. First, we demonstrated that intrinsic cues (beer colour) and to some extent extrinsic cues (sensory descriptor) have a significant effect on expectations and the perception of taste, flavour and mouthfeel of beer. Second, using formal causal mediation analysis, we confirmed that the effects of product related cues on sensory perception were mediated by the expectations they generated. Finally, we showed that perceived liking was increased directly by actual and indirectly (i.e., mediated by expected liking) by labelled alcohol content. While the design and research questions build on previous research (Blackmore et al., 2021), the analytical approach and findings are novel. The implications and limitations of the present study are discussed in detail below.

4.4.1 Assimilation and Contrast

As defined by MacKinnon (MacKinnon et al., 2007), a mediating variable transmits the effect of an independent variable on a dependent variable and testing mediation can explain the process by which one variable affects another. Thus mediation analysis is a convenient tool to test whether assimilation or contrast effects occurred (Blackmore et al., 2021). In this study we wanted to test whether expectations mediated the effect of extrinsic and intrinsic cues on sensory and hedonic perception. We used product cues that are commonly associated with alcoholic and reduced alcohol beers: labelled alcohol content, sensory descriptors, beer colour. Mediation analysis allowed us to demonstrate that the relationship

between product-related cues and change in perception is often mediated by expectations.

When examining the effects of intrinsic cues, beer colour, presented in

Figure 4.4 A, B, C and D, we can see, that beer colour had a significant effect on expected and perceived bitterness, refreshment, and body of beer. We demonstrated that the effect of beer colour refreshment and body was mediated by expectations. Darker colour in our experiment increased both expected and in turn perceived body and bitterness and decreased expected and perceived refreshment. Considering the assimilation and contrast theory, we can conclude that manipulating the beer colour generated consumer expectations which were then assimilated and resulted in changes to participants' perception.

The results from the present study are in agreement with results from our earlier study (Blackmore et al., 2021). In both studies, we demonstrated the relationship between beer colour and both expected and perceived bitterness. Beer colour was previously associated with increased expectations of bitterness and body, however not always with change in sensory perception (Carvalho et al., 2017). The samples used in the Carvalho et al. (2017) study, however, were much darker (17.5 and 50 EBC) than samples used in the present study (5 vs 25 EBC). Considering this difference, it is possible that the relationship between beer colour and change in perception is observed only in a specific colour range. In future studies, the effects of beer colour on sensory and hedonic properties need to be studied in more detail and researchers should consider beer colour on a continuum rather than a binary dark vs. light.

We should point out that in the case of bitterness, while the effects on both expected and perceived bitterness were direct, we did not observe mediation. This

finding is in contrast to our previous findings (Blackmore et al., 2021) in a similarly designed study with fewer variables, in which we demonstrated that the effect of colour on perceived refreshment, body and bitterness was mediated through expectations. However, since the effect of other extrinsic product cues, including other sensory descriptors in this and our previous study (Blackmore et al., 2021), and considering the theoretical model of expectations (de Lange et al., 2018; Deliza & MacFie, 1996), it is unlikely that beer colour would affect perceived bitterness only directly rather than indirectly through expectations.

In the literature it is well documented that some sensory descriptors can modulate sensory experience and/or expectations (Fernqvist & Ekelund, 2014; Okamoto & Dan, 2013; Piqueras-Fiszman & Spence, 2015). Looking at the results of the present study, we can see, that some of the sensory descriptors used also generated expectations, however, not as consistently as was the case of colour. Interestingly, unlike in the case of beer colour, sensory descriptors in most cases did not change participants' perception. On a closer inspection, we notice that, at least in the case of perceived bitterness and refreshment, only relevant sensory descriptors lead to changes in perceived bitterness and refreshment, respectively. In the instance of perceived body, the descriptor "full body" while increasing expectations of body did not change participants' ratings of body, and the descriptor "refreshing" lead to decreases in both expected and perceived body. Why this was the case is not quite clear. However, refreshment and body can be in some circumstances negatively correlated (Blackmore, 2019), possibly explaining the effect of the descriptor "refreshing" on perceived body in the present study. In summary, it appears that sensory descriptors can shape perceived sensory properties of beer, particularly when they are relevant for the sensory percept,

such as bitterness being shaped by the descriptor “bitter”, but not by the descriptor “full body”.

Turning to the labelled alcohol content, our analysis showed that labelled alcohol content consistently affected consumer’s hedonic but not sensory expectations. More specifically, beers labelled as alcoholic were expected to be more bitter, have fuller body and be liked more. The labelled alcohol content however, only changed participants’ liking, an effect mediated by expected liking. This finding is in line with previous research which suggests that liking and alcohol content are closely related. For example, adding alcohol into non-alcoholic lager beers can increase consumers’ ratings of liking (Ramsey et al., 2018), and labelling non-alcoholic beers as alcoholic can increase perceived liking (Silva et al., 2017), presumably through improved expectations. Similarly, labelling wines as “partially dealcoholized” decreased both expected and perceived liking (Meillon et al., 2010).

To conclude, while a specific sensory descriptor (“bitter”) appears to be able to affect specific sensory percept (bitterness), beer colour can modulate consumer experience more generally. Therefore, we can employ both colour and sensory descriptors to improve the perceived sensory profile of beer, although more research is needed to assess the impact of a wider range of beer colours. However, as neither beer colour nor the sensory descriptors changed participants’ liking, it might not be possible to use these product cues to improve consumer experience of non-alcoholic beers. As the labelled alcohol content was a good predictor of expected and perceived liking, it should be investigated whether detracting participants’ attention from the “0.0% ABV” label might improve hedonic ratings.

4.4.2 Perception as probabilistic inference

As reported above, all cases of product cues affecting consumers' experience were cases of assimilation, that is perception changed to better match prior expectations. In other words, the difference between prediction and perception (i.e. the prediction error) was minimised. This fits well not only with the assimilation/contrast account of expectations, but also with more theoretical accounts of sensory perception. Increasingly, psychology is moving away from conceptualising perception as information processing and rather views it through the lens of probabilistic or Bayesian inference (Clark, 2013). Theories of probabilistic predictions and Bayesian inference are the cornerstone of the most current and comprehensive theory of perception (action and learning): the free energy principle framework (Clark, 2013; Friston, 2010, 2012; Friston et al., 2011; Friston & Kiebel, 2009; Hohwy, 2007; Siman-Tov et al., 2019).

The free energy principle postulates that perception optimizes predictions by minimizing free energy with respect to synaptic activity, which links to the Bayesian probabilistic view of perception (Friston, 2003). This model of perception conceives the brain as a prediction machine which, based on previous experience and cues in the environment, is constantly predicting our experience: what we are about to see, hear and taste. These predictions are then contrasted, through multiple feedback loops, against sensory input (Friston, 2003; Siman-Tov et al., 2019). The aim of any prediction is to be accurate and indeed it appears that the brain is trying to avoid errors in prediction that are mismatched between sensory input and expectations (Friston, 2003; Friston & Kiebel, 2009). One way to minimise prediction errors is to make accurate predictions: this lies at the core of learning, which results in more accurate predictions in future. However, as Friston implies, prediction errors can also result in changes in perception (Friston, 2010).

Once the properties of sensory stimuli (here aspects of taste, flavour and mouthfeel) are compared to our predictions, and the difference between the prediction and actual properties of the stimulus (mismatch, often referred to as prediction error) are evaluated, one of the following scenarios ensues: 1. The prediction was spot on and matched the properties of the stimulus/ sensory input. An ideal case in which nothing happens, as there is no need for any adjustments. 2. The prediction was way off, resulting in a surprise. This draws our attention to this mismatch between prediction and properties of the stimulus, we take notice and adjust our future predictions. 3. The prediction was relatively close to the properties of the sensory stimulus.

It is not difficult to appreciate how the assimilation/ contrast theory relates to the free energy principle model of perception, which highlights the importance of minimization of prediction errors. We can see that scenario 2 described above (the mismatch between expected and actual properties of the stimulus is relatively large) would be akin to the contrast effect: the mismatch (prediction error) between prediction and sensory input is increased, that is, the difference is highlighted, arguably to attract attention, which leads to more accurate subsequent predictions and thus minimising the size of future prediction errors. However, when the mismatch between expected and actual stimulus properties is relatively small, a way to minimise prediction error is to adjust our perception in real time. This is what happens during assimilation: perception of taste or flavour shifts closer to what we expected.

A good understanding of the relationship between product properties, product cues, expectations, and perception can guide product design that would lead to increase in consumers' enjoyment and acceptability of products, e.g. reduced-alcohol beers. However, there are several research questions to be

addressed in future. For example, what is the maximum size of mismatch (prediction error) resulting in assimilation, and what size of prediction error/mismatch is necessary for the contrast effect to occur? Indeed, there seems to be a considerable lack of understanding of the conditions necessary to induce contrast and this should be a focus of future research.

4.4.3 Limitations

Even though the results of the current study are in line with theory and consistent with our previous published and unpublished data (Blackmore et al., 2020), it is appropriate to discuss potential limitations. Apart from usual methodological issues common in psychology research, such as relatively young age and of the participants and associated WEIRD[8] bias, potential demand characteristics resulting from a repeated measures design etc., there were two specific limitations in the current study.

Firstly, the fractional factorial design of the study meant that not all combinations of factors (beer colour, labelled ABV, ABV, sensory descriptor) were presented to all participants. While a potential advantage of such a design is that participants taste fewer samples and thus minimise sensory fatigue, a phenomenon especially problematic with alcoholic beverages (Seo et al., 2015), the design employed in the current study made it statistically difficult to reliably test potential interactions between the variables. However, in our previous study (Blackmore et al., 2021), we did not observe any interactions between extrinsic and intrinsic cues as far as expectations or perceptions were concerned, thus not

[8] WEIRD refers to participants from Western, educated, industrialized, rich and democratic societies

observing any meaningful interactions in the current study ultimately does not raise a major concern.

The second issue arose during the blind tasting session. To obtain participants' baseline ratings, we asked them to rate the beer samples without any influence of extrinsic or intrinsic factors. We tried to conceal the colour of the beer by using red lighting and minimising light emitted from the PC screen. Yet, despite the measures taken, the ratings of perceived body seemed to be affected by the beer colour, with darker beers rated as having significantly fuller body than light-coloured beers. While this could be a type I error and the significant difference has arisen by chance, it remains possible that participants were able to notice some difference between the samples. Perhaps because of the unusual conditions (tasting small beer samples in a dark, red lit room) participants were more cautious and examined the samples more closely than they would normally, which might have led to them noticing the subtle difference in appearance. The baseline ratings were not used in analysis of data from the experimental session, neither it was used in the mediation analysis. We used the baseline data to quantify the change in perception, but this analysis does not relate to the research questions addressed in the current paper.

4.4.4 Conclusion

While beer is still one of the most popular beverages and the most consumed alcoholic beverage worldwide, there has been a slow decline in sales (BarthHaas Report, 2021). On the other hand, sales of non-alcoholic beer have been steadily increasing (Non-Alcoholic Beer Market Report, 2020.). Despite these trends, consumers often complain about perceived flavour profile of beer with reduced alcohol content. As expectations have been shown to affect consumers' perception

and acceptance of number of products, we wanted to explore the effect of extrinsic and intrinsic cues on perceived properties of both alcoholic and non-alcoholic beer and to explore the relationship between these cues, expectations and perception.

We have demonstrated that product-related cues, especially beer colour, can significantly influence consumer's perception of taste, flavour and mouthfeel and that these effects are mediated by expectations. Additionally, we have discussed how these findings fit in with the assimilation/contrast theory and more broadly with the free energy principle. Based on the results of the study and underlying theoretical underpinnings, we conclude that altered expectations may, indeed be a good way to improve consumers' experience and a better understanding of expectations, especially in the context of taste and flavour perception is necessary. However, we cannot conclude that product cues such as beer colour or sensory descriptors can be used to improve consumer experience of non-alcoholic beers.

Supplementary material

Supplementary Table S1. Group means and standard deviations (in brackets) of participants BMI, age, mood and fullness

Condition	BMI (sd)	Age (sd)	Hunger (sd)	Fullness (sd)	Thirst (sd)	Tiredness (sd)	Happy (sd)	Energy (sd)	Alertness (sd)	Anxiety (sd)	Clarity (sd)
'Bitter'	23.10 (3.64)	26.9 (7.6)	36.3 (28.2)	47.8 (24.7)	59.9 (25.5)	40.3 (25.7)	63.1 (14.9)	56.0 (16.5)	58.6 (21.2)	28.4 (26.2)	70.2 (19.6)
'Refreshing'	24.30 (4.28)	26.7 (6.2)	36.5 (28.2)	46.3 (25.4)	50.1 (21.9)	43.0 (23.1)	66.5 (13.5)	63.4 (19.8)	56.8 (28.0)	23.7 (22.2)	69.9 (24.5)
'Full Body'	23.60 (2.68)	27.9 (8.1)	40.0 (31.2)	51.6 (25.8)	62.2 (19.3)	43.3 (23.2)	67.2 (15.4)	54.6 (21.3)	67.0 (17.9)	25.7 (21.5)	79.2 (17.5)

Supplementary Table S2. Participants' drinks consumption. The table reports participant counts in each condition. *High consumption was defined as consuming the beverage fortnightly or more often, while low consumption was considered less often than fortnightly.*

	Beer Consumption		Non-Alcoholic Beer Consumption		Wine Consumption		Spirits Consumption		
	High	Low	High	Low	High	Low	High	Low	Total
'Bitter'	26	4	1	29	19	11	14	16	30
'Refreshing'	24	4	1	27	18	10	15	13	28
'Full Body'	21	8	0	29	18	11	12	17	29
Total	71	16	2	85	55	32	41	46	87

5 CHAPTER 5: CAN SHIFTING CONSUMERS' FOCUS IN THE CONTEXT OF NON-ALCOHOLIC BEVERAGES CHANGE POST-INGESTIVE EXPERIENCE?

Abstract

Consumer choices, as well as evaluation of most products, are based on hedonic and utilitarian considerations. In the case of beer, hedonic attributes refer to ratings of flavour and liking, whereas utilitarian attributes refer to the effects of the drink. It has been shown that consumer focus can affect consumers liking and behaviour. To understand whether and how labelling can be used to improve consumer experience, it is necessary to explore the relationship between consumer focus, expectations and post-ingestive experience. The primary goal of the current study was to test whether consumer focus together with alcohol content can change consumers' liking and satisfaction with non-alcoholic beers. We also wanted to explore the effects of these variables on expectations, sensory perception and several aspects of post-ingestive experience. In a 2x3 between participant design 189 participants tasted either alcoholic or non-alcoholic beer accompanied by a labelling designed to manipulate their focus. Participants rated expected and sensory properties of the beer as well as their liking, satisfaction, and mood. Participants' cognitive performance was assessed using Inspection time task (ITT). The results showed no effect of consumer focus or alcohol content on expected or perceived liking, taste, flavour or mouthfeel. The observed effects of focus and alcohol content on post-ingestive experience were mixed, suggesting need for further research.

5.1 INTRODUCTION

We live in a society where the majority of the things we buy, including food and drink, are either packaged and labelled or at the very least come with some product information (e.g. price, ripeness, country of origin etc.). Access to extensive information on food items is highly valued by most customers, since it can boost both expected and perceived enjoyment (Cardello, 2003; Tuorila et al., 1994). Information on food and drink packaging informs our beliefs and expectations about the products nutritional value, healthiness, sensory and hedonic properties and can thus shape our sensory perception, choices and eating behaviour (Wegman et al., 2018).

5.1.1 Consumer focus and post-ingestive experience

Consumer choices, as well as evaluation of most products, are based on hedonic and utilitarian considerations (Dhar & Wertenbroch, 2000). In the case of foods and drinks, hedonic features relate to the consumers' short-term experience during consumption, whereas utilitarian features relate to the product's more long-term effects, such as health benefits or feelings of guilt. Hedonic and utilitarian motivations are rarely mutually exclusive (Batra & Ahtola, 1990). Indeed, most products are consumed for both utilitarian and hedonic reasons. Beer and non-alcoholic beer are good examples of this, as they are consumed both because of their sensory properties (taste, flavour mouthfeel) and because of their medium- and long-term effects (e.g., health, mood, cognitive performance).

Muñoz-Vilches et al. demonstrated that participants' choice and wanting can be to some extend manipulated using mental simulation (Muñoz-Vilches et al., 2019). They asked participants to focus on either eating a product or thinking about how they will feel after consumption, essentially shifting their focus to

hedonic or utilitarian properties of the product. They found that focusing on the outcome of consumption increased participants wanting for "healthy" and decreased their wanting for "unhealthy" products. The relationships between wanting, liking and choice are nuanced and complex (Berridge & Robinson, 2016), there is a well-established association between them. Generally, liking/preference and wanting, are good predictors of choice (Recio-Román et al., 2020). While consumer satisfaction is related to factors during consumption such as liking of sensory attributes, as well as factors post-ingestion such as fulfilment of expectations (Andersen & Hyldig, 2015). As a result, if modifying attentional focus can influence want and preference, it could have consequences for consumer decision-making and purchasing behaviour.

However, the use of priming in the context of consumption has had mixed results. For example, researchers showed that health priming did not affect consumer's choices, while hedonic priming did, albeit only when hedonic cues were presented without the presence of other cues (Bauer et al., 2022). Likewise, in a recent metanalysis Buckland and colleagues (Buckland et al., 2018) systematically reviewed 26 studies investigating the effect of weight-loss priming on food intake, and while they found an effect of goal priming on food consumption, this effect was small if not negligible. Overall, it appears that the use of priming to shift consumer focus and thus manipulate either their behaviour or modulate their preferences is possible, but further research to explore the context is needed.

As reduced alcohol beer is consumed both because of its "taste" and health benefits (Chrysochou, 2014) and regular beer is consumed both because of its "taste" and effects of alcohol, they are excellent examples of products which require consumers to evaluate both their hedonic and utilitarian value. It is

possible that paying attention to either hedonic or utilitarian/functional aspects of beer may interact with the drink's alcohol content and affect consumers' hedonic, sensory, and post-ingestive experience. Since labels are primarily used to communicate information to customers, they are an ideal medium for directing consumer's attention to desired aspects of a product.

5.1.2 Alcohol and post-ingestive experience

Research on post-ingestive experience is especially relevant and interesting in the context of psychoactive substances such as alcohol or caffeine, as these neuromodulators directly affect how we feel (Cappelletti et al., 2015) and some, such as alcohol (ethanol) are intrinsically rewarding (Shizgal & Hyman, 2014) . Alcohol acts as a primary reinforcer, as it induces opioid release in the reward areas of the brain, such as the nucleus accumbens and orbitofrontal cortex (Mitchell et al., 2012). While alcohol itself is rewarding, it also over time leads to an association between the taste of the alcoholic beverage and reward. Thus, it is likely that flavour of an alcoholic beverage, beer for example, becomes a conditioned cue for this reward (Smeets & de Graaf, 2019).

Reward aside, ethanol also affects consumers mood and cognitive performance. However, this effect is far from straightforward, as some effects are closely related to context and expectancy. It has been shown that, for example, in the case of mood and aggression, alcohol only affects behaviour in those who believe this will be the case (Lindman et al., 2015; Lindman & Lang, 1994). To some extent, the effects of alcohol are shaped by prior beliefs and expectations. In an extreme case, participants can experience effects of alcohol if they simply believe they consumed some. The alcohol placebo effect has been well-documented.

Simply put, if participants believe they are consuming alcohol their behaviour and reported mood will reflect that (Bodnár et al., 2020).

Cognitive performance is known to suffer after alcohol consumption (Tzambazis & Stough, 2000). This effect is also modulated by consumers believes and expectancy about the effects of alcohol. In a small study Fillmore and colleagues (Fillmore et al., 1998) demonstrated that the level of impairment caused by a drink believed to contain alcohol (both for alcoholic drink and placebo drink) was related to participants' believes about the effect. While Fillmore et al. only investigated participants information processing, other studies found similar effects of alcohol expectancy on aspects of cognitive performance, such as attentional processing (Gilbertson et al., 2010) and reaction time. When assessing the effects of low doses of alcohol on cognitive performance, it's critical to select a task that is unaffected by motor function, as well as one that is sensitive to low doses of alcohol. Simple information processing tasks, such as the Inspection time task (ITT) are ideal. Performance on the ITT has been shown to be a sensitive and dose-related measure of decline in cognitive impairment resulting from acute alcohol consumption even at low breath concentration (BrAc) (Cash et al., 2015; Dry et al., 2012).

5.1.3 Aims and Objectives

Beer is consumed for its flavour but also for the effects of alcohol. While alcohol can improve mood (Curtin & Lang, 2007; McCollam et al., 1980), alcohol consumption is also associated with undesirable effects such as tiredness, inability to drive, negative effects on health and so on (Burton & Sheron, 2018; Dunaway et al., 2011; Roehrs & Roth, 2001; Tzambazis & Stough, 2000). To avoid these undesirable effects, consumers might turn to non-alcoholic beer. Similarly, non-

alcoholic beer is consumed for its flavour as well as absence of alcohol. And while non-alcoholic beer does not cause cognitive impairment and has number of health benefits (Osorio-Paz et al., 2019), consumers may complain about sensory aspects of the drink (Sohrabvandi et al., 2010). Thus, when making a choice between alcoholic and non-alcoholic beer, consumers must consider the hedonic and utilitarian features of the beverage. Here we consider the taste, flavour, mouthfeel and liking during consumption as hedonic aspects, while the utilitarian features are the effects of alcoholic or non-alcoholic beer such as effects of alcohol or lack thereof on mood, cognitive performance, and satisfaction.

In conclusion, past research, both empirical and theoretical, showed that products are consumed for hedonic and utilitarian reasons. In the case of beer, hedonic attributes refer to the hedonic and sensory qualities, such as ratings of flavour and liking, whereas utilitarian attributes refer to the effects. We also know that we can use cues to modulate or prime consumers' focus and with it influence, at least in the short term, their choices, preference, and behaviour and as an extension liking and satisfaction. Taking together the context and expectancy-dependent effects of alcohol, as well as evidence of label-based cues on consumers behaviour, it would be interesting to explore these two effects in the context of alcoholic and non-alcoholic beer.

Considering the research discussed above we have designed a study in which we served participants alcoholic or non-alcoholic beer and used labelling to manipulated consumer focus (hedonic, utilitarian, control) and measured sensory evaluations, liking, satisfaction, mood and cognitive performance on an ITT. We tested the following hypotheses. See Figure 5.1 for labels used in different conditions.

H1: In the non-alcoholic beer condition, participants exposed to the hedonic labelling will like the non-alcoholic beer less and will have lower consumer satisfaction ratings compared to those exposed to the control and utilitarian labelling.

H2: In the beer condition, participants exposed to hedonic labelling will have higher ratings of liking and consumer satisfaction.

H3: In the beer condition, participants exposed to utilitarian labelling will perform worse, on the inspection time task compared to those in the hedonic and control condition.

5.2 METHODS

5.2.1 Design

The study employed a 2 x 3 between participant design. Both independent variables (drink type, label information) were between participant factors. Each participant received either an alcoholic (4.5 % ABV) or non-alcoholic (0.0% ABV) beer with a sample bottle with one of three labels ("hedonic", "utilitarian" or control label). The labels are presented in Figure 5.1 and the beer sample and sample bottle appearance is shown in Figure 5.2. The data design, collection plan and the analytical strategy were preregistered on the Open Science Framework https://osf.io/47uwx.

Figure 5.1. Front and back labels used in the study.

Figure 5.2. Sample bottle and 300 ml beer sample as presented to the participants.

5.2.2 Participants

Participants were recruited through psychology participant database, social media and flyers distributed around the University of Sussex campus. Potential participants with alcohol use disorder, history of eating disorder, smokers (>5 cigarettes a day), those on medication (excluding the contraceptive pill), participants who were pregnant or breastfeeding, and those with diabetes were not allowed to participate in the study. The exclusion criteria were made clear during recruitment and in the consent form. The Science & Technology Cross-Schools Ethics Committee at the University of Sussex approved the experimental protocol (application ER/HB315/6), and the study was conducted according to the ethical standards defined by the British Psychological Society.

We recruited 189 participants (145 self-identified as female, 41 as male and 5 as non-binary). All participants were over the age of 18, all self-identified as regular beer drinkers, consuming on average at least 1 beer a month. Participants' age ranged between 18 and 57, however most participants were young adults, and the mean age was 20.3 years (sd= 4.7). The age did not significantly differ across the six conditions F(1, 181) = 0.26,p= 0.608. The participants' BMI ranged between 16.7 - 36.1 kg/m^2. The average BMI was 23.1 kg/m^2 (sd=3.7) and again, this did not differ across conditions F(1, 186) = 1.62,p= 0.205. We also asked participants about their weekly alcohol and beer consumption. Neither the overall alcohol consumption nor beer consumption differed significantly across the conditions, F(2, 189) = 3.19, p = 0.069 and F(2, 189) = 0.06, p = 0.804, respectively.

5.2.3 Materials

Both alcoholic and non-alcoholic samples were commercially available beers containing 4.5% and 0.0% abv, respectively. The experiment was designed and administered using Qualtrics software (*Qualtrics*, 2018) and Inquisit 5 (*Inquisit 5 [Computer Software]*, 2016) Participants self-reported their mood on a Bond-Lader mood questionnaire (Bond & Lader, 1974) , and their cognitive performance was assessed using Inspection Time Task (ITT) (Deary et al., 2004). These tasks as well as the stimuli used are described in more detail below.

5.2.3.1 Beer labels

The beer labels were created using an online resource (*Beerlabelizer*, 2020) and Adobe Photoshop CC 2017. The labels differed in the labelled alcohol content and the information (see Figure 5.1). We used fictitious labels to avoid effects of familiarity with any brand. However, the beer labels were designed in a way to look as realistic as possible, hence the positive consumer centred labelling: 'Feel good'

and ‘Great taste’ on the front label. The label at the back of the bottle prompted participants to either think about the sensory aspects of the drink (alcoholic or non-alcoholic beer) to invoke hedonic focus, or to think about the effects of the drink (alcoholic or non-alcoholic beer) to invoke utilitarian focus. The control labels had generic information such as volume, brand name and alcohol content, but no information to prime participants’ focus. All front and back labels used in the study are presented in Figure 5.1. Front and back labels used in the study.

5.2.3.2 Inspection time task

In this task, participants were presented with stimuli that had one long and one short arm. The stimuli were presented for variable durations (between 19 and 200 ms) before they were covered by a mask. Participants had to indicate whether the short arm was on the left or right and press the corresponding response keys. Inspection time task assesses early information processing (Deary & Stough, 1996). Performance on the ITT has been shown to be a sensitive and dose-related measure of decline in cognitive impairment resulting from acute alcohol consumption even at low breath concentration (BrAc) (Cash et al., 2015; Dry et al., 2012). The ITT used in this study was presented using Inquisit software (*Inquisit 5 [Computer Software]*, 2016), and was adapted from a version on the Millisecond library (Borchert, 2014), which in turn was based on a published design (Deary et al., 2004). Compared to the Deary et al. (2004) version of the task, we presented stimuli for 19 ms or longer to accommodate for the refresh rate of available computer screens (60 Hz)[9].

[9] A monitor with a vertical refresh rate of 60 Hz will not display correctly any stimuli with duration below approximately 17 ms

5.2.3.3 Bond-Lader Questionnaire

The Bond-Lader mood questionnaire (Bond & Lader, 1974) asks participants to rate 16 feelings on a visual analogue scale (VAS). These feelings are categorised into three independent factors: alert, content, calm. The ratings and the factors are shown in Table 5.1. Bond-Lader questionnaire is commonly used to assess effects of psychoactive substances (Hull & Bond, 1986; Yeomans et al., 2002).

Table 5.1.Feelings and associated factors in Bond-Lader questionnaire

Factor	Feeling
Alert	alert
	strong
	clear-headed
	well-coordinated
	energetic
	quick-witted
	attentive
	proficient
	interested
Content	tranquil
	content
	happy
	amicable
	gregarious
Calm	calm
	relaxed

5.2.3.4 Drinking habits questionnaire

The drinking habits questionnaire was adapted from the National Health and Nutrition Examination Survey (NHANES) food frequency questionnaire (NHANES, 2021). In this questionnaire we asked participants how often they drink different types of alcoholic beverages and how many units of alcohol and beer they consumed each week.

5.2.4 Procedure

Once they formally consented to take part in the study, participants were randomly allocated to one of the six conditions. And seated in an experimental cubicle. They completed a demographic questionnaire and a questionnaire about their drinking habits. They were then invited to carefully inspect the front and back of the sample beer bottle and the researcher then poured 300 ml of either the alcoholic or non-alcoholic beer into a glass. Participants then rated their expectations about the sensory properties of the sample (bitterness, refreshment, body and liking) and expectations about their post-ingestive experience (mood, satisfaction and cognitive performance). Participants were made to believe that they were drinking the same beer as in the bottle they just inspected. Each participant had 10 minutes to consume the beer and rate perceived bitterness, body, refreshment and liking. They were asked to make the ratings at the beginning of the tasting, but this was not enforced or checked.

Upon completion of consumption, participants were seated in the participant waiting area. They were then brought back 30 and again 60 minutes after they finished the beer to rate their mood and to complete the ITT to assess their

cognitive performance. At the 60-minute mark, participants were also asked how satisfied they were with the beer they tasted earlier. Finally, the researcher measured their height and weight and debriefed the participants. Participants who consumed alcoholic beer were additionally breathalysed to ensure they were not over the legal driving limit[10]. The procedure is depicted below in Figure 5.3.

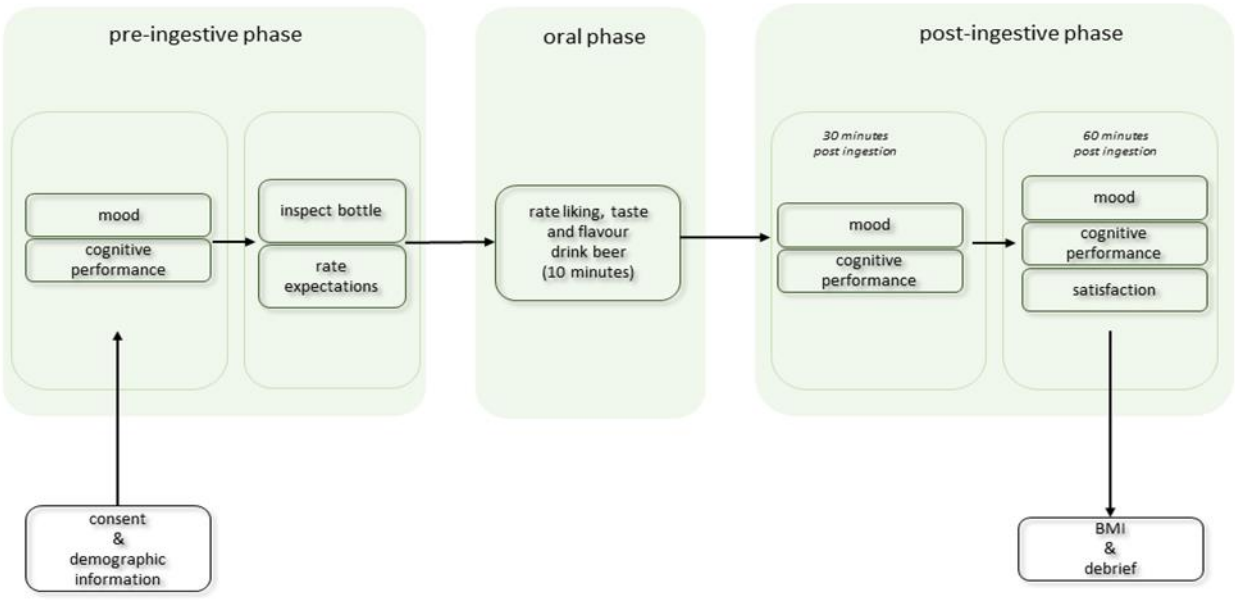


Figure 5.3. Schematic depiction of experimental procedure

5.2.5 Data Analysis

To test H1 and H2 we built two linear models with focus and alcohol content as predictors and perceived liking and satisfaction as outcomes. Because of violated assumption of homoscedasticity and bias in the non-robust linear model of satisfaction, the models reported here are robust models with HC4 heteroscedasticity consistent standard errors (Cribari-Neto & Lima, 2014; Hayes &

[10] The maximum breath alcohol concentration (BrAC) in England and Wales is 35 µg of alcohol per 100 ml of breath

Cai, 2007). To test H3 we modelled the outcome of cognitive performance (% correct for a given stimulus length) as predicted by duration of stimulus (19-200 ms), focus (hedonic, utilitarian and control), alcohol content (alcoholic, non-alcoholic) and time (baseline, 30 minutes after consumption, 60 minutes after consumption). We applied Greenhouse-Geisser correction where necessary.

We further explored the effect of consumer focus and beer alcohol content on expected and perceived bitterness, refreshment, body and liking as well as satisfaction and willingness to pay. All parameters reported are robust parameters with HC4 heteroscedasticity consistent errors where possible. To explore the effect of consumer focus on mood and cognitive performance we used afex package (Singmann et al., 2021) to build and report main effects followed by simple effect analysis using the emmeans package (Lenth, 2021). Simple effects are reported using planned contrasts with Holm corrected p-values. Both confirmatory and exploratory analyses were planned as stated in the pre-registration. Data were analysed using R 4.0.4 (2021).

5.3 RESULTS

5.3.1 Confirmatory analyses

Hypothesis 1: *"In the non-alcoholic beer condition, participants exposed to the hedonic labelling will like the non-alcoholic beer less and will have lower consumer satisfaction ratings compared to those exposed to the control and utilitarian labelling."*

Hypothesis 2: *"In the beer condition, participants exposed to hedonic labelling will have higher ratings of liking and consumer satisfaction."*

Hypothesis 3: *"In the beer condition, participants exposed to utilitarian labelling will perform worse, on the inspection time task compared to those in the hedonic and control condition."*

The results showed that hedonic labelling, regardless of alcohol content, did not increase participants' liking compared to samples with utilitarian (b = 3.07, SE = 5.03, 95% CI [-6.85, 12.98], p = 0.542) or control labels (b = 3.91, SE = 5.05, 95% CI [-6.05, 13.87], p = 0.440). Just as with liking, labelling did not increase reported satisfaction, there was no difference in satisfaction reported by participants who were presented with bottles with hedonic labelling compared to those who saw utilitarian (b = 9.38, SE = 5.25, 95% CI [-0.98, 19.74], p = 0.076) or control (b = 7.88, SE = 5.76, 95% CI [-3.48, 19.24], p = 0.440) labels, regardless of alcohol content. These results are contrary to the hypothesized effects. In the hedonic condition, participants liked the non-alcoholic samples less (b = -2.48, 95% CI [-18.09, 13.13], p = 0.754) and were less satisfied with them (b = -10.06, 95% CI [- 27.07, 6.95,], p = 0.245) compared to alcoholic beer samples, this difference, however, was not statistically significant. In terms of cognitive performance, an effect predicted by hypothesis 3 was not observed: there was no effect of focus on participants' cognitive performance F(2,178) = 1.41, p = 0.248 and neither the time*alcohol, time*focus, or time*alcohol*focus interactions were significant (F(2,356) = 0.25, p = 0.703, F(4,356) = 1.07 , p = 0.362, F(4,356) = 0.09, p = 0.962 , respectively). Results of exploratory analyses are reported in section 5.3.2.2.2 below.

5.3.2 Exploratory analyses

5.3.2.1 Pre-ingestive and Oral phase

There was a consistent association between expected and perceived bitterness (*b* = 0.27, 95% CI [0.06, 0.48], *p* =0.012), refreshment (*b* = 0.26, 95% CI [0.10, 0.41], p < 0.001), body (*b* = 0.20, 95% CI [0.00, 0.40], *p* = 0.055) and liking (*b* = 0.16, 95% CI [0.00, 0.31], *p* = 0.045). However, on closer examination we did not find an effect of either consumer focus or alcohol content and expected and perceived bitterness, refreshment and liking. There was an effect of alcohol content on perceived body, however. More specifically, as expected, non-alcoholic beers were rated as having lighter body than alcoholic samples (*b* = -6.27, 95% CI [-11.97, -0.57], *p* = 0.031). See Table 5.2**Error! Reference source not found.** for more detail.

Table 5.2. The effects of alcohol and focus on expected and perceived bitterness, refreshment, body and liking

	Bitterness		Refreshment		Body		Liking	
	expected	perceived	expected	perceived	expected	perceived	expected	perceived
expectations	NA	**0.27, 95% CI [0.06, 0.48], *p* =0.012**	NA	**0.26, 95% CI [0.10, 0.41], p < 0.001**	NA	**0.20, 95% CI [0.00, 0.40], *p* = 0.055**	NA	**0.16, 95% CI [0.00, 0.31], *p* = 0.045**
alcohol (non-alcoholic vs. alcoholic)	-0.96, 95% CI [-5.59, 3.66], *p* = 0.682	-0.25 95% CI [-6.53, 6.03], *p*=0.938	-1.62, 95% CI [-6.61, 3.37], *p* = 0.522	-1.50, 95% CI [-5.91, 2.92], *p* = 0.505	-4.23, 95% CI [-9.31, 0.85], *p* = 0.102	**-6.27, 95% CI [-11.97, -0.57], *p* = 0.031**	-4.50, 95% CI [-10.11, 1.12], *p* = 0.116	-3.35, 95% CI [-8.62, 1.92], *p* = 0.212
focus (hedonic vs. control)	9.07, 95% CI [-0.55, 18.69], *p* = 0.065	2.73, [-10.19, 15.64], *p* = 0.678	-3.68, 95% CI [-12.08, 4.72], *p* = 0.388	-3.61, 95% CI [-12.48, 5.26], *p* = 0.423	0.08, 95% CI [-9.43, 9.59], *p* = 0.986	3.95, 95% CI [-6.92, 14.82], *p* = 0.474	-7.36, 95% CI [-18.32, 3.59], *p* = 0.186	-3.51, 95% CI [-15.22, 8.20], *p* = 0.555
focus (utilitarian vs. control)	-7.62, 95% CI [-16.72, 1.48], *p* = 0.100	1.54, 95% CI [-10.10, 13.19], *p* = 0.794	8.31, 95% CI [-1.14, 17.76], *p* = 0.084	2.26, 95% CI [-5.79, 10.32], *p* = 0.580	3.20, 95% CI [-6.65, 13.05], *p* = 0.523	-5.47, 95% CI [-16.72, 5.79], *p* = 0.339	2.23, 95% CI [-8.52, 12.97], *p* = 0.683	1.14, 95% CI [-9.07, 11.35], *p* = 0.826

5.3.2.2 Post-ingestive phase

5.3.2.2.1 Mood

Looking at mood we have observed a main effect of time. The analysis showed that participants felt calmer at the beginning of the experiment compared to the later stages ($F(2,358) = 5.94$, $p = 0.004$). More specifically, participants reported feeling calmer at baseline compared to 30 minutes ($b = 3.47$, 95% CI [1.27, 5.67], $p = 0.007$) and 60 minutes after ($b = 3.1$, 95% CI [0.74, 5.55], $p = 0.023$) consumption of the drink (see Figure 5.5A). We should note that this was not affected by alcohol content of the drink they had consumed.

Participants' feeling of contentment was also affected by the time of the mood rating ($F(2,358) = 3.39$, $p = 0.039$). Participants felt significantly more content at the end of the experiment, 60 minutes after consumption compared to 30 minutes after consumption ($b = 1.84$, 95% CI [0.58, 3.10], $p = 0.014$), see Figure 5.5B). More interestingly, there was a significant interaction between alcohol content and consumer focus on content ratings $F(2, 179) = 4.12$, $p = 0.018$). Participants who focused on the hedonic aspects of the drink reported feeling significantly calmer if they drank alcoholic samples, compared to those who drank non-alcoholic samples ($b = 12.89$, 95% CI [3.23, 22.55], $p = 0.020$), but this difference disappeared in the utilitarian condition (Figure 5.4A).

When looking at self-reported alertness, the results showed a significant effect of time ($F(2, 358) = 64.60$, $p < 0.001$), a significant interaction between time and alcohol content ($F(2, 358) = 9.76$, $p < 0.001$), and a significant interaction between focus and alcohol content ($F(2, 179) = 3.96$, $p = 0.021$). Planned contrasts

revealed that participants felt significantly more alert at the end of the experiment than they did at the beginning (b = 8.45, 95% CI [6.67, 10.23], p < 0.001) see Figure 5.5C, and the difference in alertness was magnified for those who had consumed alcoholic beer Figure 5.4C). Additionally, the effect of alcohol content * focus showed that similarly, as in the case of contentment, when participants were asked to focus on the taste of the product (hedonic condition) their alertness was higher when they consumed alcoholic beer than those who consumed non-alcoholic beer, this difference, however, was not present in the utilitarian or control condition (Figure 5.4B).

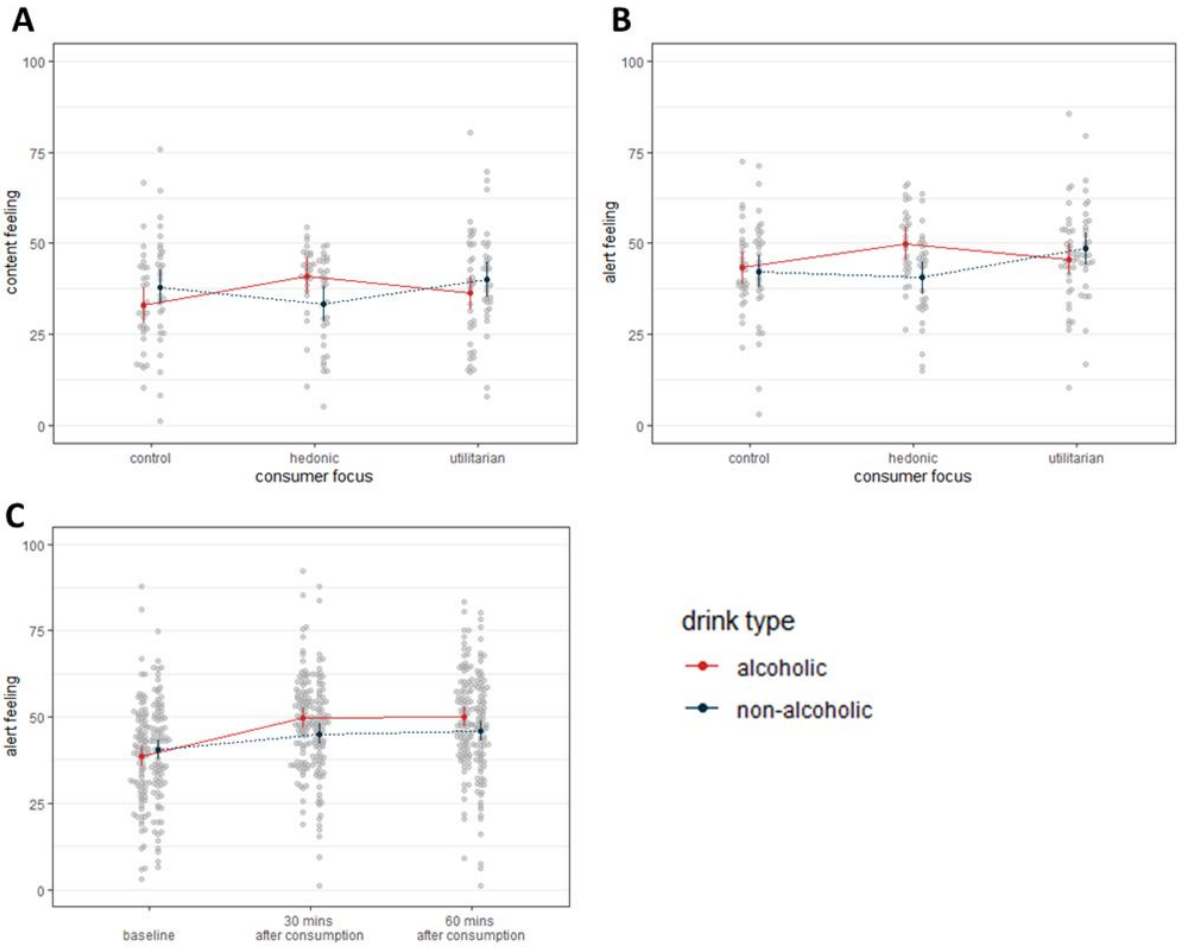


Figure 5.4. Interaction plot depicting interaction between alcohol content and consumer focus for content, calm and alert feeling. *Error bars represent 95% confidence intervals*

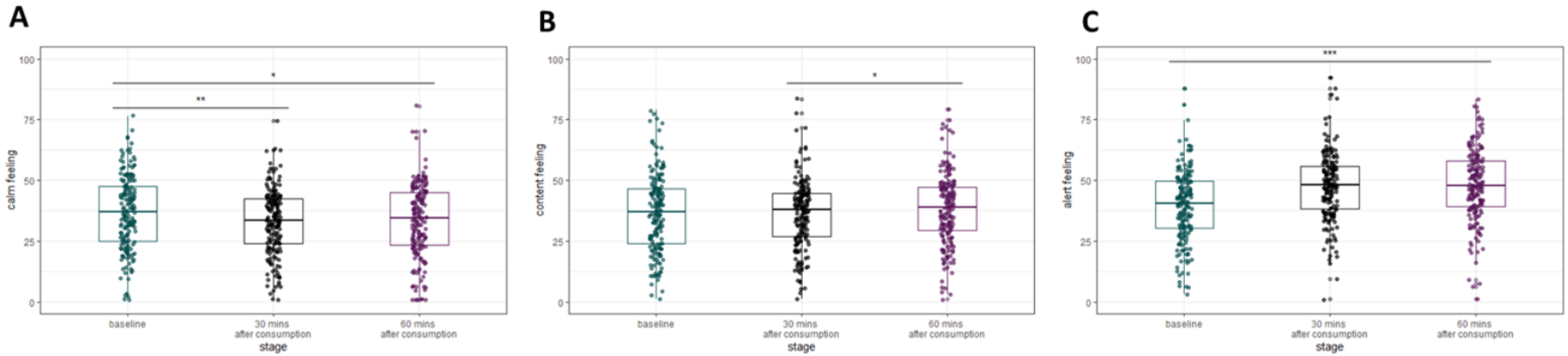


Figure 5.5 participants' feelings of calm, contentment, and alertness before, 30 minutes and 60 minutes after consumption of the drink.

** p<0.05, ** p<0.01, *** p<0.00*

5.3.2.2.2 Cognitive performance

Participants cognitive performance was measured as the percentage of correct responses per duration of a stimulus (19- 200 *ms*). The results of exploratory analysis showed there was an effect of alcohol content ($F(1, 178) = 8.12$, $p = 0.005$) on cognitive performance. More specifically, as shown in

Figure 5.6 participants who consumed alcoholic drinks tended to perform worse than those who consumed non-alcoholic drinks ($b = 0.03$, 95% CI [0.01, 0.05], $p = 0.005$). As expected, we also observed a significant effect of stimulus duration ($F(12, 2136) = 397.83$, $p < 0.001$) and time ($F(2, 356) = 9.77$, $p < 0.001$). The percentage of correct responses increased as the duration of the stimulus increased ($b = 2.76$, 95% CI [2.58, 2.94], $p < 0.001$) and participants' performance, perhaps due to tiredness, decreased throughout the experiment ($b = - 0.02$, 95% CI [-0.03, -0.01], $p = 0.003$). Finally, there was a significant interaction between stimulus duration and time ($F(24, 4272)= 4.82$, $p < 0.001$), as clear from

Figure 5.7, the decline in performance throughout the experiment was only noticeable for stimuli with short duration.

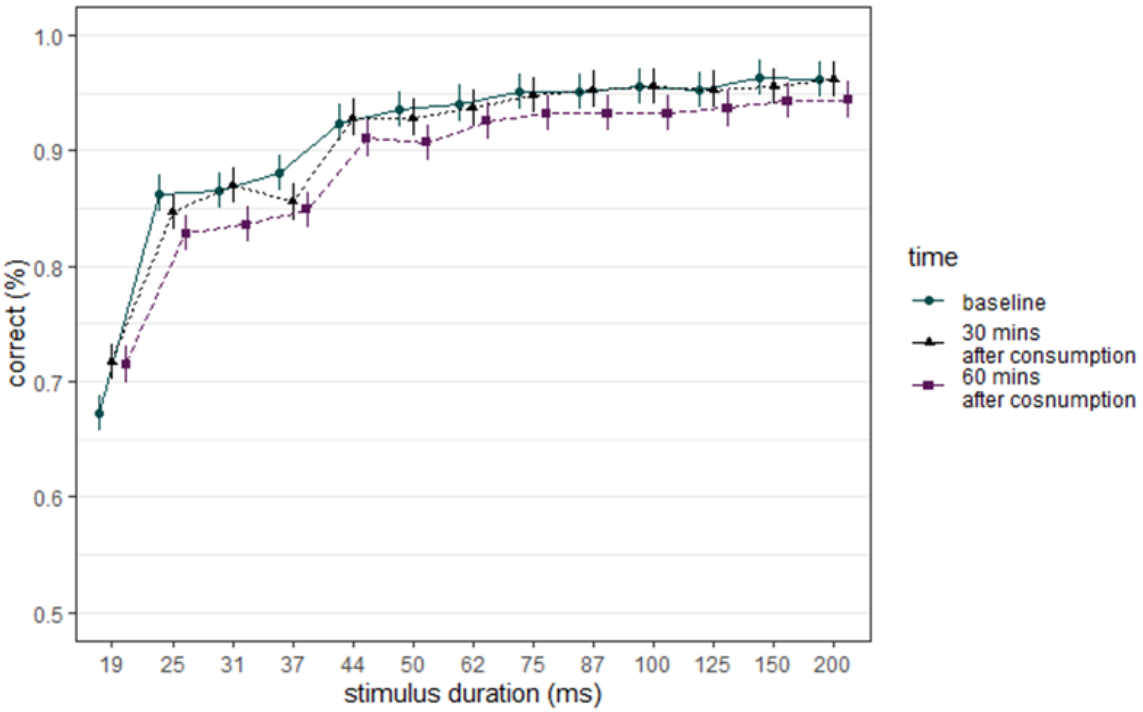


Figure 5.6. Participants cognitive performance as a percentage of correct responses foreach stimulus duration. *This figure shows an interaction between time and stimulus duration, error bars represent 95% confidence interval*

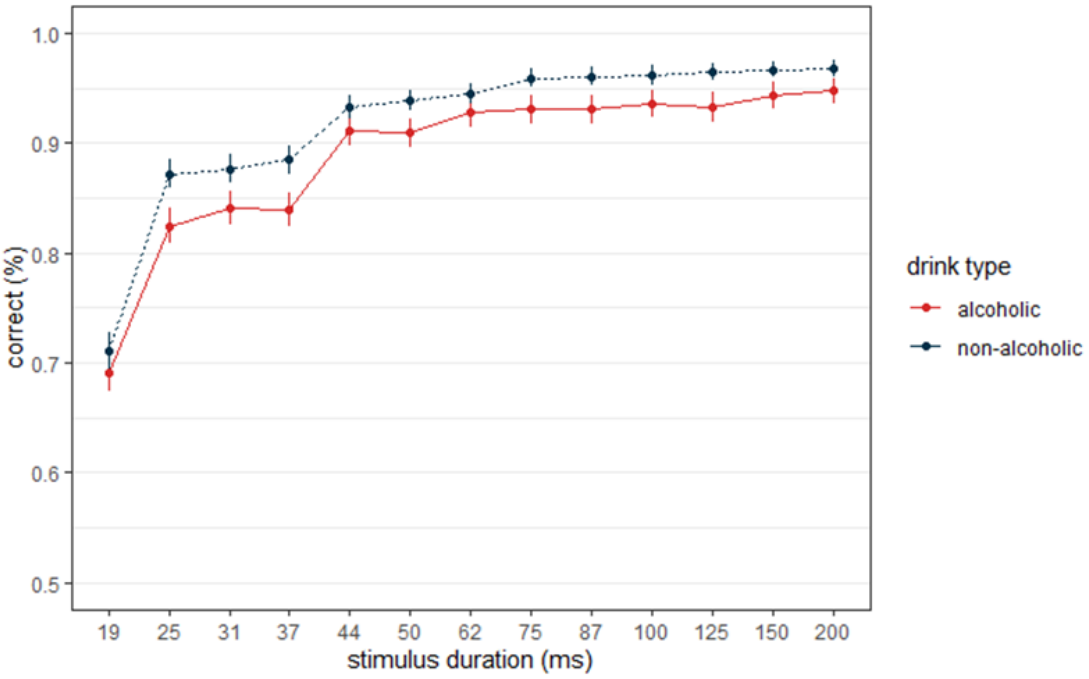


Figure 5.7. Participants' cognitive performance by drink type and stimulus duration*. Error bars represent 95% confidence interval.*

5.3.2.2.3 Satisfaction and willingness to pay

The results are reported in detail in Table 5.3. The effect of alcohol content and consumer focus on expected and perceived satisfaction and willingness to pay.. These results showed that participants' expected satisfaction was not affected by the drinks alcohol content or consumer focus, but perceived satisfaction was improved by alcohol content. Participants reported being more satisfied with alcoholic than non-alcoholic beers (b = 6.91, 95% CI [1.15, 12.66], p = 0.019). There was also a significant association between expected and perceived satisfaction (b = 0.19, 95% CI [0.01, 0.37], p = 0.040). We also examined the effect of alcohol content, consumer focus and satisfaction on participants' willingness to pay (wtp). There was no difference between wtp in alcoholic and non-alcoholic beer samples. However, participants asked to focus on the effects of the drink were willing to pay less than those in the control condition (b = -0.38, 95% CI [-0.77, 0.01], p = 0.053), regardless of the alcohol content of the drink. Not surprisingly, there was a statistically significant association between participants' satisfaction and wtp (b = 0.02, 95% CI [0.02, 0.03], p < 0.001).

Table 5.3. The effect of alcohol content and consumer focus on expected and perceived satisfaction and willingness to pay.

	satisfaction		willingness to pay
	expected	perceived	
satisfaction	NA	NA	**0.02** 95% CI [**0.02, 0.03],** **< 0.001**
expected satisfaction	NA	**0.19,** **95% CI [0.01, 0.37],** ***p* = 0.040**	-0.01, 95% CI [-0.01, 0.00], 0.072
alcohol (non-alcoholic vs. alcoholic)	- 3.91, 95% CI [-8.90, 1.08], *p* = 0.123	**-6.91,** **95% CI [-12.66, -1.15],** ***p* =0.019**	-0.12, 95% CI [-0.36, 0.12], 0.316
focus (hedonic vs. control)	-2.39, 95% CI [-11.79, 7.01], *p* =0.617	-11.06, 95% CI [-24.02, 1.90], *p* = 0.094	0.11, 95% CI [-0.34, 0.55], 0.640
focus (utilitarian vs. control)	0.99, 95% CI [-7.40, 9.38], *p* = 0.816	7.07, 95% CI [-3.68, 17.82], *p* = 0.196	-0.38, 95% CI [-0.77, 0.01], 0.053

5.4 DISCUSSION

The primary goal of the current study was to test whether consumer focus together with alcohol content can change consumers' liking and satisfaction. We also wanted to explore the effects of these variables on expectations and sensory perception, as well as several aspects of post-ingestive experience. The discussion will address and critically discuss our findings focusing on hypothesis testing, pre-ingestive and oral phase, and post-ingestive phase.

5.4.1 Hypotheses testing

Regardless of alcohol content, consumer focus did not increase participants' liking or satisfaction for the beer we tested. Alcohol content in the hedonic condition did not affect satisfaction or liking. As a result, we cannot reject the null hypotheses. A possible explanation is that the effect was too small to detect in our study. As Buckland et al. (2018) suggests priming effects have relatively small effect sizes, at least in the context of food intake/ eating behaviour. While some studies (Muñoz-Vilches et al., 2019) previously demonstrated that liking and preference can be modified by changing consumer focus, other studies failed to find consistent effects of priming using cues, on consumer choice (Bauer et al., 2022; Manippa et al., 2019). It is, however, unclear whether the lack of observed effect in the present study was a result of absence of an effect, small sample size or perhaps the laboratory environment and tasks lacking in ecological validity.

There are inherent problems with studying alcohol consumption in a laboratory. A number of studies found that the environment in which foods and beverages are consumed can influence consumers' liking or acceptance (Delarue & Boutrolle, 2010; King et al., 2007; Lichters et al., 2021; Meiselman et al., 2000). An

especially relevant study is a wine study conducted by Meillon et al. (2010). The researchers obtained hedonic ratings of partially dealcoholized wines in both home and laboratory settings and demonstrated, among other things, that while the direction of the effects in question did not differ in the two environments, the wines were consistently rated higher when tasted at home.

Furthermore, the effects of alcohol (ethanol) are context dependent. During the debrief, some participants admitted that, despite the labels clearly indicating the alcohol content and them drinking the samples, they did not believe they were served alcoholic beer! The specific effects of alcohol are influenced in part by the consumer's expectations and beliefs (Lindman et al., 2015; Lindman & Lang, 1994). Bodnár and colleagues even suggested that expectations based on previous experiences and social cues are responsible for the majority of the behavioural changes that occur after consuming alcohol (Bodnár et al., 2020). As a result, any effects that alcohol would have had in a more ecologically valid environment, such as a bar or a social gathering, may be attenuated in a laboratory setting.

Of course, it is also possible that the effect of focus on consumer liking, and satisfaction simply does not exist or is too small to be meaningfully used to improve consumer experience in the context of non-alcoholic beers. However, it is unclear why we found no effect of alcohol on perceived liking. A number of studies in beers have shown an association between alcohol content and liking (Blackmore et al., 2022; Ramsey et al., 2018; Silva et al., 2017). We propose that future studies test a bigger participant sample and investigate whether individual differences and consumer segmentation are to blame for the absence of observed effects in the present study.

5.4.2 Pre-ingestive and oral phase

We have demonstrated a consistent relationship between expectations and perception. Bitterness, refreshment, body, liking, and satisfaction were predicted by expected bitterness, refreshment, body, liking, and satisfaction. This finding is not surprising, and it is consistent with the findings of our previous studies (Blackmore et al., 2021, 2022). However, neither the alcohol content nor the consumer focus altered participants' expectations in the present study. This is especially surprising when it comes to alcohol content. In our previous research, we found that labelled alcohol content increased expected bitterness, body, and liking. As previously suggested, it is possible that participants simply did not believe the alcohol content label was informative. Indeed, the majority of our participants came from the University of Sussex's participant pool and were likely familiar with psychological experiments and the use of deception. Finally, the finding that the presence of alcohol in beer resulted in higher ratings of perceived body is consistent with previous research, as ethanol is a key determinant of mouthfeel, particularly ratings of body (Gawel et al., 2007; Langstaff et al., 1991; Niimi et al., 2017).

5.4.3 Post-ingestive phase

5.4.3.1 Mood

Aside from the relatively mundane observation that participants self-reported mood changed as the experiment progressed, we found that the participants' mood also changed as a result of alcohol content and consumer focus. Participants who focused on the hedonic aspects of the drink reported feeling significantly calmer and more alert when they drank alcoholic beer. This difference, however, was not present in the utilitarian or control conditions. There

has been little work on the effects of alcohol and priming cues, such as the ones used in the present study on mood or feelings. If either of the cues generated expectations and thus had an effect on mood, we would expect it to be the utilitarian cue, which emphasized, however vaguely, the effects of the drinks.

Alcohol induces feeling of calm and relaxation and is reported to reduce anxiety, which is often a strong motivation for drinking (Curtin & Lang, 2007; Robinson et al., 2009). The calming effects of alcohol may result from disruption of functional connectivity between the dorsal anterior cingulate cortex and anterior insula, which in turn may impair detection and appraisal of emotionally salient information and thus inducing relaxation (Gorka et al., 2018). While this explains participants reporting feeling calmer after consumption of alcoholic beer, why we observed the calming effect of alcohol only in the hedonic condition, however, is not clear. It might have been either due to low power and thus we failed to observe this effect in all conditions, or on the contrary, there was no effect present, and this finding was a false positive. Given our analysis, it is impossible to tell which of these reasons is more likely.

Participants also reported feeling more alert at the end of the experiment than they did at the start, a difference that was especially obvious in those who drank alcoholic beer. On the surface, the rise in self-reported alertness appears perplexing, considering alcohol use is frequently associated with drowsiness due to the sedative effects of alcohol (Harrison et al., 2017). However, deeper examination reveals that alcohol has biphasic effects, and thus it works as both a depressant and a stimulant (Pohorecky, 1977). Excitatory effects are present at low alcohol doses and when blood alcohol concentrations ascend to a peak (Pohorecky, 1977; Roehrs & Roth, 2001). This would be in line with our findings. Participants in this study only drank one alcoholic beverage, a 4.5 % abv lager that contained total of

10.7 g (13.5 ml) of ethanol. Participants rated their alertness at baseline, 30 minutes after consumption, and 60 minutes after consumption, with the two latter both during the climbing BAC, with the peak alcohol blood concentration for beer occurring about 60 minutes after consumption (Mitchell et al., 2014).

5.4.3.2 Cognitive performance

Unsurprisingly, when individuals drank alcoholic beer samples, their cognitive function was lower than when they drank non-alcoholic beer. Alcohol has been demonstrated to disturb both the early and late stages of information processing (Tzambazis & Stough, 2000) and the ITT has previously been shown to be a sensitive measure of cognitive performance while under the influence of alcohol (Cash et al., 2015; Dry et al., 2012). Prompting participants to focus on the hedonic or utilitarian features of the drink, on the other hand, had no effect on their performance. However, while we used an objective measure of performance, it might be interesting to also measure subjective/perceived cognitive performance in future studies, as this attribute may be more prone to change in response to signals.

5.4.3.3 Satisfaction and willingness to pay

As with aspects of sensory and hedonic perception discussed above, we have observed an association between expected and perceived satisfaction, which in turn predicted participants' willingness to pay. Willingness to pay and satisfaction can be good indicator of future purchase behaviour. For this reason, it is interesting that those who were prompted to focused on hedonic aspects of the drink, that is the taste and the enjoyment it brings were willing to pay more for the product than those in the control condition. Even more interesting is that this was the case for both alcoholic and non-alcoholic samples. This might indicate that

mindfulness and process of savouring can improve participants' perception/ willingness to pay, which is a good indicator of future purchase. Therefore, adding a hedonic cue or prompting consumers to savour and focus on the taste can improve their experience and can be used in marketing.

5.4.4 Limitations

To make our labels as realistic as possible, both the hedonic and utilitarian front label highlighted the positives of the drink, that is either positive aspects of sensory experience: 'Great Taste', or positive effects: 'Feel Good'. The back of the bottle labels then expanded on this simple message and drew consumers attention to more generic or neutral aspects of taste and flavour or effects/consequences of the drink (see Figure 5.1). The advantage of this approach is that the labels looked realistic – beer or indeed any product is marketed using positive information. Positive labelling on both hedonic and utilitarian condition also prevents confounding variables that could be introduced by differences in the design of the two labels. The issue, however, might be that participants focused on the positive aspects of labelling rather than the sensory/effect aspects which we wanted them to think about and thus did not generate the intended focus and thus reduced the size of the effect observed. In future studies researchers should find a way to check that the hedonic and utilitarian labels generated desired focus in participants. This could be done after consumption or during debrief, relying on participants' self-reports or perhaps by integrating an attentional task that would objectively measure participants' attention.

The second major issue results from the laboratory environment in which the study was carried out. Researching alcoholic beverages in a lab is problematic as social environment is very important in the context of alcohol consumption as well

as the effects alcohol may have (Sher, 1985). For example, Corbin and colleagues argued that more naturalistic environments might be better suited when trying to detect expectancy-related effects (Corbin et al., 2015). Given this, the findings of the study, as well as most laboratory studies on alcohol consumption, should be interpreted with caution, as most people do not consume alcohol in a laboratory-like setting. Future research should consider studying alcohol consumption, especially in the context of post-ingestive experience in a more ecologically valid environment such as a bar or social gathering.

Finally, number of participants in the present study in the alcoholic beer condition admitted during debrief that they did not believe they had consumed alcoholic beverage. Because many of our participants were undergraduate psychology students familiar with the use of (however minor) deception in psychology studies, it is understandable that they were quite sceptical when presented with an alcoholic beverage. This is problematic, because, as Bodnár et al. (2020) demonstrated that if people believe they are not consuming alcohol, they will compensate to counter the effects of alcohol on their behaviour. A study like this, where expectations play a key role, can suffer from highly sceptical participants. While we would ideally recommend using truly naïve participants in future studies and thus exclude psychology students and those who had previously participated in a number of psychological studies, finding a sufficiently large sample of such naïve participants may be difficult if not impossible.

5.4.5 Conclusion

Overall, we found no effect of focus or alcohol on expected or perceived liking, taste, flavour or mouthfeel. The observed effects of focus and alcohol content on post-ingestive experience are somewhat unclear. While we can

conclude that alcoholic beers produce higher satisfaction and willingness to pay, these findings are hardly surprising. Similarly, alcohol acting as a stimulant and an anxiolytic substance is also supported by previous research. It is the lack of effects that is somewhat surprising. This of course can be a result of small sample size, given the effect size, low quality of data, unsuitable testing environment or simply a lack of effect in the context of alcoholic and non-alcoholic beers. More research is needed, and future researchers should consider not only cues, but also the environment in which the study is carried out and participants individual differences.

6 CHAPTER 6: GENERAL DISCUSSION

Our experience is shaped in part by sensory input and in part by predictions made on the basis of contextual cues and previous experience. In the context of food and drink the cues associated with the product appearance and packaging are key factors that can give raise to consumer expectations and ultimately influence to the overall experience. Understanding how product-related cues affect the oral and post-ingestive experience may aid in improving perceptions and attitudes about low-alcohol beers. In the context of non-alcoholic lager style beer, the primary goal of the research reported in this thesis was to explore and, more crucially, quantify the relationships between contextual product-related signals, consumer expectations, and oral and post-ingestive experience.

To answer this question, I designed and conducted four studies consisting of seven experiments, spanning the pre-ingestive, oral, and post-ingestive phases of ingestion and consumer experience. The findings of the research presented in the thesis will be summarised in this final chapter. I will also highlight the theoretical context of these findings, discuss practical implications for consumers and product development, acknowledge the research limitations and shortcomings, and suggest future research directions in the area of expectations and taste and flavour perception.

6.1 SUMMARY OF FINDINGS

6.1.1 Pre-ingestive phase

6.1.1.1 Study 1

The pre-ingestive phase is the time of expectation generation. It is when we use contextual information, usually product-related cues to make a prediction about the upcoming sensory experience. The past research has shown that expectations can alter consumers' sensory and hedonic perception. However, as discussed in the introduction, the process of expectation generation and the way these expectations influence experience is often product specific. To gain a better understanding of the process of expectation generation the research summarised in Chapter 2 aimed to determine which factors influenced consumer expectations in the context of beer. Study 1, as described in detail in chapter 2, was a series of four online experiments examining the association between extrinsic and intrinsic product cues and perceived sensory and hedonic properties of beer. The experiments in Study 1 examined the effects of label design, label colour, labelled alcohol content, and sensory descriptor on expectations of liking, bitterness, smoothness, sweetness, refreshment, body and colour of beer.

The results of Study 1 provided clear evidence that label colour, labelled alcohol content and sensory descriptors all had the potential to generate expectations of sensory properties as well as liking. The important take-away from this study was that:

1. Expectations of fuller body were associated with the beer's labelled alcohol content.
2. Labelled alcohol content did not predict expected liking.
3. Expectation generation was product specific.

4. The effect size product cues had on expectations was context dependent.

In terms of labelled alcohol content, which in the study ranged between 0% abv and 6% abv, the association between bitterness and body, and labelled alcohol content is not surprising. Previous studies demonstrated that higher alcohol content and the warming sensation it causes is associated with perception of full body, among other things (Ivanova et al., 2022; Ramsey et al., 2018), and lack of body is often reported as a defect of low- and non-alcoholic beers (Blanco et al., 2016; Sohrabvandi et al., 2010). What was more surprising was that no effect of labelled alcohol content on expected liking was observed, as past research consistently pointed to consumers' negative attitudes towards and low hedonic expectations of non-alcoholic and reduced alcohol products (Bellut & Arendt, 2019; Meillon et al., 2010; Silva et al., 2017). However, it is possible that as attitudes towards alcohol consumption are not uniform among different consumer segments. For example, as younger people consume less alcohol (Törrönen et al., 2019), it is possible that the consumer segmented we tested, that is mostly young participants, did not associate alcohol content with higher liking. This can be supported by Meillon and colleagues' (2010) observation that older participants (> 50) were more likely to have negative expectations of partially dealcoholized wine compared to younger (<39) participants. It is of course also possible that we did not observe a relationship between expected liking and alcohol content simply because the participants did not have to consume or purchase the product they were asked to rate.

Previous literature seems to suggest that the association between product cues and expectations/perception of taste and flavour can differ between products. This seems to be especially the case with more implicit or ambiguous cues, such as

label colour. The association between red labels and increased expected bitterness, observed in study 1, can be used as an example. This was an effect specific to beer, as red colour has been previously associated with expected and perceived sweetness (Spence et al., 2015). Following from this observation, care should be taken when generalising findings presented in this thesis and other expectation research.

Additionally, the results showed that the effect size of different cues on expectations was not stable and differed depending on which other cues were present. For example, when participants were presented with relatively vague cues such as label colour and design, label colour had a relatively large effect on expectations. When it was, however, considered alongside more informative cues such as labelled alcohol content or sensory descriptor, the effect of label colour decreased or disappeared altogether. The implication of this, which will be discussed in more detail in section 6.3, is that we need to study product cues in combination with other cues and avoid over-generalisation, as the association between many product cues and expectations is often context dependent and product specific.

6.1.2 Oral Phase

6.1.2.1 Study 2

Study 1 provided valuable information about which cues generate expectation in the context of beer and expectations of which sensory characteristics of beer can be altered. This information was then used to design Study 2. The primary aim of this experiment was to investigate the effect of sensory descriptor, taste and beer colour on expected and perceived bitterness, body, refreshment and liking of beer. The goal was to model and quantify the

strength of the relationships between product cues, expectations, and sensory and hedonic perception.

The results showed that product related cues not only generated expectations, but that they could, indirectly, affect sensory and hedonic perception of beer. The results are reported and discussed in detail in Chapter 3: here I provide the key highlights:

1. Beer colour affected a range of expected and perceived properties of beer.
2. The effect of sensory descriptor on perceived taste and flavour was very specific.
3. The effect of product-related cues on perception was mediated by expectations.

It should be noted that while beer colour changed expected and perceived ratings of bitterness, body refreshment and liking, the sensory descriptor 'bitter' only affected perceived bitterness. This is not uncommon; on a closer examination we notice a similar pattern in past research, which suggests that the effect of sensory descriptor is quite narrow (Allison et al., 2004; Grabenhorst et al., 2008b; Okamoto et al., 2009; Shankar et al., 2009; Skaczkowski et al., 2016; Yeomans et al., 2001), while the effects of drink colour are more varied (Spence et al., 2015; Sugrue & Dando, 2018; Zellner & Durlach, 2003).

However it is not sufficient to analyse the effects of product cues on expectations and perception separately, especially because of the claim that expectations act as a mediator between product cues and taste and flavour perception (Okamoto & Dan, 2013). For this reason, a mediation analysis was used to determine whether expectations do indeed act as a mediator and what is the

direct and indirect effect of extrinsic and intrinsic product cues on perceived properties of beer. I demonstrated that the presence of a sensory descriptor or change in beer colour could change consumer perception by assimilating their expectations. The findings and statistical analysis showed that mediation analysis is a powerful tool in expectations research. Mediation analysis can determine the direct and indirect effect of cues on sensory and hedonic experience and thus determine whether assimilation or contrast occurred. The implications of using mediation analysis to research the effect of expectations on experience will be further discussed in section 6.2.2 of this chapter.

6.1.2.2 Study 3

With the knowledge that simple product cues, such as beer colour and a descriptor of taste could alter how participant perceive alcoholic beer, it was necessary to also test this in beers that varied in both labelled as well as actual alcohol content. Study 3 examined whether and how beer colour, range of sensory descriptors and labelled alcohol content affect expected and perceived taste, flavour and mouthfeel in the context of alcoholic and non-alcoholic beers. Overall, the results suggested that expectation indeed act as a mediator between product cues and sensory and hedonic perception, providing support for findings from Study 2. A detailed report and discussion of findings from this study is covered in Chapter 4. Below are the key findings from this study:

1. Consistent with study 2 intrinsic cues (beer colour) and to some extent extrinsic cues (sensory descriptor) had a significant effect on expectations and the perception of taste, flavour, and mouthfeel of beer.
2. The effects of product related cues on sensory perception were mediated by the expectations they generated.

3. Perceived liking was increased directly by actual and indirectly by labelled alcohol content.

The findings in Study 2 were broadly consistent with findings in study 1. The study 2 findings confirmed that the effect of extrinsic and intrinsic product cues was mediated by expectations and that the effect of label-based sensory descriptors was very specific, while the effect of beer colour was relatively broad. The contribution of Study 3 was that it not only replicated findings from Study 2 but extended these to include a number of sensory descriptors and in the context of both alcoholic and non-alcoholic beer. This extension was essential if the findings were to be applied and used to improve acceptability of reduced alcohol beers.

In contradiction to Study 1 (summarised above), we observed an association between labelled alcohol content, expected and perceived liking. The main difference between Study 1 and Study 3 was that Study 1 was implemented online and participants thus did not get to consume any beer samples. It is possible that the predictions participants made about the qualities of the beer were inaccurate as a result. In Study 3 participants knew that rating their expectations would be followed by tasting, so the predictions were perhaps more consequential and accurate. Additionally, in Study 3 participants tasted multiple alcoholic and non-alcoholic beer samples, so it is possible that even if they initially did not have any negative expectations, after tasting a sample they suspected to be non-alcoholic if they did not like it, it then affected formation of expectations. In other words, it is possible that the observed association between 0.0% abv alcohol label and low expected liking was, to some extent, a result of learning. That said, the order of the samples was randomised, and the labelled alcohol content sometimes did and sometimes did not match the actual alcohol content. While it is impossible to

conclude the reason for the discrepancy in findings between these two studies, previous research supports the finding of a positive relationship between liking and alcohol content (Meillon et al., 2010; Silva et al., 2017).

6.1.3 Post-ingestive phase

6.1.3.1 Study 4

Another question to be addressed is whether product cues can be used to improve the post-ingestive experience of consumers Given the context-dependent effects of alcohol and the potential of using brief mental simulation to change aspects of consumer preference/liking, the question addressed in Study 4 was whether product cues could be used to improve consumers' post-ingestive experience. The primary goal was to test whether consumer focus on utilitarian or hedonic attributes of beer can together with alcohol content change consumers' liking and satisfaction. The secondary goal was to explore the effect of focus and alcohol content on other aspects of post-ingestive experience such as mood and cognitive performance. The findings are reported and discussed in Chapter 5, below is the summary and brief discussion of the highlights from study 4:

1. Alcohol increased feelings of alertness throughout the experiment.
2. Participants who focused on the hedonic aspects of the drink reported feeling significantly calmer and more alert when they consumed alcoholic beer.
3. Consumer focus did not change liking or satisfaction.

The effect of alcohol on mood is well known (see review: Sayette, 2017). In study 4, the changes in mood included increase of alertness and feeling of calm as a result of alcohol consumption while focusing on hedonic aspects (that is experience during consumption) of the drink. This is difficult to explain. The

anxiolytic properties of alcohol (Curtin & Lang, 2007; Robinson et al., 2009) can explain the increase in calmness and stimulant properties of alcohol (especially in low doses on the ascend to the peak BAC) can account for the increase in alertness, it is not clear why this was only observed in the hedonic condition, that is when participants focused on the sensory properties of the drink during consumption. It is possible that effect of focus was not present, and the observed effect arose as a false positive, not uncommon in exploratory research. The need for further research into the effects of label-generated consumer focus on post-ingestive experience and post-ingestive experience in general is clear.

Looking at hedonic aspects of consumer experience, there was no effect of consumer focus on perceived liking or satisfaction. As focus was elicited by using mental stimulation, it is possible that the effect size was too small to be detected in this study. As Buckland and colleagues in their meta-analysis concluded, the effects of priming in the context of food tend to be small (Buckland et al., 2018). Given the potential small effect of label-generated consumer focus, it is questionable how meaningful the effect is even if it exists. In terms of application of the findings, manipulating consumer focus on either sensory properties or the effects of beer does not seem to be an effective way to improve consumers' post-ingestive experience and satisfaction with non-alcoholic beers. However more research is needed to confirm this.

6.2 Broader Research context

In conclusion, study 1 contributed to the literature by shedding more light on expectation generation in the context of beer, namely it provided a better understanding of factors that contribute to expectation generation in the context of beer and reduced alcohol beers. Studies 2 and 3 demonstrated that both

extrinsic and intrinsic product cues can generate expectations which then may mediate both sensory and hedonic perception. Finally study 4 demonstrated the difficulties with studying motivational expectations in the context of alcohol content and post-ingestive experience. Drawbacks and limitations aside, below I will discuss the theoretical context of the research, its methodological implications, and implications for product development. To summarise, the main contribution of the research presented in this thesis is that product-related cues, especially beer colour, can significantly influence consumer's perception of taste, flavour, and mouthfeel of alcoholic and non-alcoholic beer and that these effects are mediated by expectations. The implications of these findings as well as the methods used are discussed below.

6.2.1 Theoretical context

The relationship between expectations and perception during consumption is often described by the assimilation-contrast theory. As explained in the general introduction in section 1.1.4.2, the change in an individual's ratings of a product depends on the size and direction of mismatch between expected and actual sensory properties of a product. This mismatch, also referred to as disconfirmation, can lead to a change in sensory and hedonic perception and either assimilation or contrast effect occur. Assimilation refers to the change of perception in the direction of expectations, while contrast is a change in the opposite direction.

Whether assimilation or contrast effect is observed is determined by the size of mismatch. While the size of the mismatch between expected and actual product properties required for contrast to occur is unknown, the mismatch was very large or expected and actual product properties were qualitatively different in cases where the contrast effect was demonstrated. (Yeomans et al., 2008). Most of the research on the effect of expectations on perception of sensory and hedonic

perception in the context of food and drink consumption, including the studies in this thesis, have demonstrated and described assimilation effect. Indeed, this should be what we tend to observe in everyday life as well. Usually, our predictions about upcoming sensory experience are relatively accurate. When they are not accurate and the mismatch between expected and actual properties of a product is large, akin to a surprise, the difference is highlighted, perhaps so our experience results in updating of our internal models which will ensure more accurate predictions in the future. Given the stimuli used in the studies presented in this thesis, the mismatch generated was only small, and thus only assimilation was observed. While this is hardly surprising, it contributes to current consensus and provides support for the current theoretical account of expectations.

6.2.2 Methodological implications

Another key contribution of the thesis is the explicit demonstration of the mediating effect of expectations and the explanation how it can be used as an elegant and effective tool when studying expectations. The notion that expectations act as a mediating variable, responsible for the indirect effect of product-related cues on sensory and hedonic perception is not new. Indeed, number of researchers made the claim in the past (Okamoto & Dan, 2013; Piqueras-Fiszman & Spence, 2015; Shankar et al., 2010). And while most researchers agree that expectations act as a mediator in the cue- expectation-experience relationship, so far researchers would usually determine whether assimilation or contrast occurred relying on results of ANOVA and comparing blind and informed ratings (Woods et al., 2010; Yeomans et al., 2008). However, these methods, as currently employed, cannot quantify or even confirm the causal relationship between product cues, expectations and sensory and hedonic ratings.

To do this, we need to use appropriate statistical modelling, namely causal mediation analysis.

Mediation analysis is a convenient and more rigorous tool which enables us to quantify the strength of relationship between product cues and expectations, product cues and perception and expectation and perception (see Figure 8), as well as helping us to determine assimilation or contrast occurred, at the same time as. The detailed explanation of how mediation analysis can be used to evaluate the nature of the cue-expectations-perception relationship is outlined and demonstrated in Chapter 3.

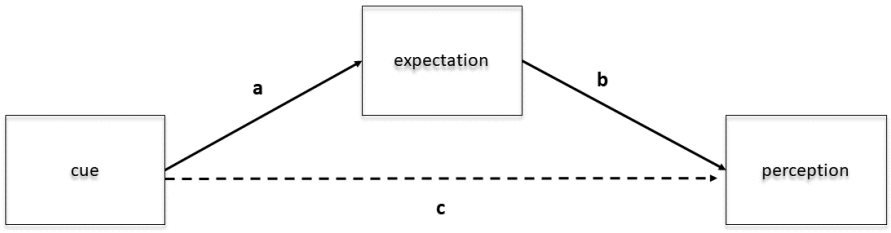


Figure 8. Simple mediation. A relationship between product cue, expectations and perception.

Note that the measure of expectations in the studies presented here was based on participants' self-report, thus their conscious evaluations, thus the expectations ratings only accounted for the conscious association between the cues and sensory experience. It is possible that there are unconscious associations between cues and sensory perception which can still generate changes in perception of taste, flavour and liking. Research on multisensory and multimodal correspondence is, however beyond the scope of this thesis (Piqueras-Fiszman et al., 2012; Spence et al., 2015; Velasco et al., 2016).

6.2.3 Implications for consumers and product development

Aside from theoretical and methodological contributions, the studies included in this thesis, contribute a number of empirical findings. While these are specific to lager beer and might not be generalisable to other products, the findings can be, with some caution, used to make general recommendations both for consumers who are perhaps interested in non-alcoholic beers and to product development teams who develop and market reduced alcohol beers.

6.2.3.1 Consumers

While consumers cannot control the extrinsic and intrinsic cues associated with a product they consume, they should be aware that keeping an open mind and avoiding negative expectations may benefit them and improve their experience. The studies presented here suggest that there is a strong and consistent relationship between expected and perceived liking as well as expected and perceived sensory properties. While it is not quite clear what the relationship between labelled alcohol content and expected and perceived liking is, as the findings were contradictory, the focus on benefits and advantages of consuming non-alcoholic beers may improve liking and post-ingestive experience. However, while there is a theoretical basis for this recommendation, the data currently show no support for this. Additionally, given the importance of context during consumption, it is possible that pleasant and social environments may be conducive to improved post-ingestive experience. Clearly, generalising findings from a simple laboratory experiment to real life is proving to be difficult and this difficulty should be taken into account in future research, but more on this in section 6.4.1.

6.2.3.2 Product development

In terms of product development, several points should be noted. First, it was clear that colour of beer, at least in the lager category[11], had an important impact on consumers' sensory and hedonic expectations and perception. It appears that consumers prefer light coloured lagers, which is associated with both expected and perceived refreshment and reduced bitterness. However, interestingly, darker coloured beers were expected and perceived as having fuller body, which is an often-cited deficit of beers with reduced alcohol content (Blanco et al., 2016; Sohrabvandi et al., 2010). However, data from the research presented here cannot determine what hue or intensity of colour is optimal. More research is needed to determine the colour which will optimise perceived body without negative effect on liking, refreshment and bitterness.

The role of sensory descriptors in generating expectations and shaping experience was also important, but the effect was quite narrow. Perhaps sensory descriptors can be used strategically with beer colour to optimise expected and perceived properties of a non-alcoholic beverage. This will, however, be highly product specific and will depend on the specific sensory profile of a product.

In terms of labelling alcohol context, few recommendations can be made. First of all, the relationship between labelled alcohol content and hedonic evaluations is mixed and may differ for different consumer segments. Secondly, given the regulations in the EU and most other countries alcoholic beverages must be labelled as such and because non-alcoholic beer is often consumed specifically to avoid alcohol, there is a benefit of labelling the alcohol content of non-alcoholic

[11]Findings for ale type beers may differ, see:Carvalho et al., 2017; Reinoso-Carvalho et al., 2019

beers as well. However, what needs to be further explored in future studies is the role of choice and motivation on consumers' liking and satisfaction.

Overall, the research presented in this thesis offers some insight into the role of product-related cues in modifying sensory and hedonic perception through expectations. While more research is needed before these findings are used and applied to specific products, the knowledge that the change of perception and hedonic evaluations is driven by expectations can guide future research and perhaps only those cues that generate strong expectations in consumers can be then studied in more detail to stablish any potential changes in perceived attributes. This can potentially reduce research costs and save time.

6.3 LIMITATIONS OF THE CURRENT WORK

The research presented here has made an important contribution to the research of expectations in the context of eating and drinking. As with any research, the research presented in this thesis has limitations. Specific limitations of each study are discussed in detail in relevant chapters. Here I will provide a broad overview of some of the key limitations, especially limitations pertaining to methodology and validity of results.

6.3.1 Design and methodology

Online studies are common, especially when researching associations between cues and sensory percepts (Dong & Gleim, 2018; Velasco et al., 2015). Compared to lab based research the data collection is faster, cheaper and the researchers can reach a more diverse sample of participants (McGraw et al., 2000; Reips, 2002). Online experiments, however have issues with data quality, often because of careless responding (Brühlmann et al., 2020). Additionally, in online experiments participants do not taste samples or make purchases, which can lead

to inaccurate ratings. Results from online studies should be interpreted with caution, as some findings, such as the lack of association between liking and alcohol content may be difficult to replicate, as was the case in the present research.

Another issue is that while effort was made to create and present participants with realistic samples, only a selection of cues was used in each experiment. As findings from Study 1 suggest, the effect size can vary depending on the combination of product cues being studied. Consumers are usually confronted with countless extrinsic cues, including appearance, labelled alcohol content, but also product packaging and intrinsic product cues apparent at point of consumption, like aroma and even sound of pouring the drink. Given the countless product-related cues that might influence expectations and perception of taste, flavour and mouthfeel, and the reduction of effect size as cues are added, it should be questioned which product-related cues have a meaningful effect in a realistic, i.e., outside of the lab, environment.

6.3.2 Participant sample

As is common in psychology and other research areas, the majority of participants, especially in the lab-based studies 2, 3 and 4 were recruited from the participant database and opportunistic recruitment (via leaflets and social media posts) at University of Sussex. As a result, most of the participants were University of Sussex students. Thus, our participant sample lacked diversity, as the participants were generally young and relatively educated people. The age may be especially important to note here, as it was previously shown that there are differences between different age segments in terms of beer consumption and

preference (Capitello & Todirica, 2021). Younger consumers are more interested in craft beer compared to older consumers (Carvalho et al., 2018), while older consumers associate alcohol content with liking more strongly (Meillon et al., 2010). Thus, it is important to acknowledge that while many findings, particularly those associated with sensory ratings should generalise well, effects on hedonic ratings might differ across consumer segments.

While each of the studies was preceded by a power analysis, the studies were powered to detects effects of medium effect size. It is likely that more subtle effects were not detected. This is not necessarily an issue, as in applied research we should focus on determining whether an effect is meaningful rather than whether it is statistically significant.

6.3.3 The relationship between sensory perception and liking

The aim of this thesis was to investigate the role of expectancy and to quantify the relationship between expectancy and consumer experience. To do so, models of contextual cues, expectations and perception have been created. These models helped to test as well as quantify the strength of these relationships. It must be noted, however, that these models are somewhat simplistic, especially when considering higher level attributes such as liking or aspects of post-ingestive experience.

While it is well established that contextual information in the form of product cues can alter expected and perceived liking, expectancy and cues are not the sole predictors of liking. On the contrary, sensory properties of products (e.g. bitterness), which are reflected in consumers' sensory ratings, are at least just as important. In summary, the models presented in this thesis are not complete, instead they have been developed to test the mediating effect of expectations and

to establish the relationship between expectations and experience, be it liking or perception of taste and flavour.

6.3.4 Validity of results

Last but not least is the issue of ecological validity. Ecological validity refers to a measure of how test performance predicts behaviour in real-world, and lack of ecological validity is a common issue in experimental research. Laboratory research enables researchers to study effects in isolation and allows control of potential confounding factors. Laboratory research however can become problematic when it comes to applying these findings or transferring knowledge out of the lab. In sensory and consumer research, it is especially important to scrutinize the ecological validity.

Given the complex multisensory experience that food and drink consumption entails and considering how contextual information impacts both oral and post-ingestive experience, even more so in the context of alcoholic/non-alcoholic beverages. One way to ensure high ecological validity is psychological realism, that is attempt to design experiments in a way that the study procedure reflects everyday life. While it is not always possible to mirror everyday life situations in the lab, steps were taken to improve psychological realism as much as possible in given circumstances. For example, in study 4, the labelled alcohol content always matched the actual alcohol content of a drink served and realistic, chilled sample bottles were presented to participants. All labels were designed to look as realistic as possible, although in Studies 1, 2 and 3 these were presented to participants on-screen. Moreover, viewing and examining samples in a laboratory in the context of experimental procedure, it is possible that participants paid more attention to both the product cues and the sensory attributes they were asked to rate, which could potentially lead to overestimation of effect sizes.

However, the biggest issue with laboratory testing appears in Study 4 which assessed the effect of focus and alcohol content on post-ingestive experience. It is documented that the effects of alcohol are highly context-dependent and that alcohol effects can vary in different environment (Bodnár et al., 2020; Corbin et al., 2015; Lindman et al., 2015). Consequently, studying drinking behaviour and experiences out of usual drinking context might be problematic, especially in relation to post-ingestive experience. It is thus questionable how well these findings would transfer or indeed whether it is this unusual drinking environment and participants' scepticism that resulted lack of observed effect. While drinking alcohol in real life we, most of the time do not closely and carefully examine the product labelling, we do not spend time contemplating the consequences of consuming the beverage or consciously reflect on the upcoming sensory experience. Additionally, alcohol is usually consumed in social setting, which can shape the way alcohol acts or the way we feel even if we consume a beverage that does not contain alcohol in a social setting. All these factors: carefully inspecting bottles, uncertainty about the drinks' content and lack of social context can affect the overall post-ingestive experience.

Finally, as mentioned in section 6.3.2, most our participants were associated with the University of Sussex, and out of these, most were undergraduate psychology students. Psychology students tend to be familiar with the use of deception in psychological research. Consequently, a number of participants mentioned that they did not believe they were served alcoholic beverage, despite the label and them actually drinking the alcoholic sample. This can have a profound effect on the way alcohol affects mood and behaviour as participants who do not believe they consumed alcohol may compensate for the effects the alcohol had on them (Bodnár et al., 2020). This scepticism is of course problematic,

especially in research on effects of motivational expectations, alcohol on post-ingestive experience, which can be highly subjective and context dependent.

Some of these limitations are inherent to psychological research, some are a result of trade-off with other potential drawbacks. For example, given the source of research funding and the geographical location of the University, it is inevitable that most of the participant sample will be from a western democratic country and relatively well educated. Similarly, while online studies can be problematic in terms of data quality and ability for a researcher to control experimental environment, it has number of benefits and can in some cases be a more ecologically valid environment (i.e. participants responding in their own home environment) than a laboratory. Some limitations, however, could be addressed or followed up in future studies. The following, and final section of the thesis will provide suggestions for future research, some of which will follow from the discussion presented in the limitations section 6.3 and some will expand on the theoretical and methodological considerations presented in section 6.2.

6.4 Future research Directions

Research presented in this thesis answered, at least in part, some questions that were set out in the introduction. However, research is a journey rather than a final destinations and based on the findings presented in this thesis I will outline considerations for future research in terms of experimental design (section 6.4.1), as well as a more general future direction for research of expectancy in the area of taste and flavour perception (section 6.4.2).

6.4.1 Context and ecological validity

Considering findings presented in this thesis we can conclude that the effects of product-related cues, expectancy and sensory perception can be highly

product-specific. Based on this, sensory research needs to be carried out in a product-specific context before it is applied or generalised. We cannot assume that specific research findings from one study will be directly applicable to another product. That is, unless more work is done to better understand the theoretical underpinnings of these relationships, which will be discussed in more detail in the following section (section 6.4.2).

An issue that should be addressed in future research is the issue of context. Firstly, product-related cues, such as beer colour and label-based information are never considered in a vacuum, these cues are almost always evaluated alongside other cues and contextual information. Some of the cues and contextual information will be more relevant than others, and it is thus necessary to quantify the relative effect of different cues on expectations and consumer experience. To achieve this quantification, product cues should be evaluated in conjunction with each other rather than in isolation. As was shown in Study 1 if a cue is the sole or primary source of information it can significantly affect consumers' expectations, however this effect is reduced or will complete disappear if more explicit and informative cues are added.

While the issue of context applies to all sensory research, it is especially important in relation to alcoholic beverages. As discussed earlier, the effect of alcohol is highly context dependent. It has been shown that the effects alcohol has on behaviour are affected by social context (Christiansen et al., 2017.; Sher, 1985), cultural beliefs (Lindman et al., 2015; Lindman & Lang, 1994) and expectations (Bodnár et al., 2020; Hull & Bond, 1986). Alcohol research, especially when looking at consumption of alcoholic and reduced alcohol beverages should be studied outside a lab to improve ecological validity of the studies. This would make the research more valid and applicable.

Finally, when studying expectancy and the effects on oral and post-ingestive experience, we need to carefully consider the use of deception and the type of participants we recruit. Firstly, number of studies addressed expectancy using deception when examining the effects of alcohol content labelling on perceived liking and sensory evaluation (Meillon et al., 2010; Silva et al., 2017). This research demonstrated that beers, or generally beverages, labelled as low or non-alcoholic are expected to be liked less and perceived to be liked less. And while useful as an initial examination, once we establish that low alcohol labelling generates negative expectations, mislabelling alcohol content is not very useful, as consumers do not ever encounter mislabelled potentially alcoholic beverages in everyday life. We do not purchase alcoholic beer only to discover that it did not contain alcohol, or vice versa. Related to point made earlier, researchers should focus on designing studies with high psychological realism, studies that mirror consumers' daily experiences.

Given how context-dependent expectation generation and the effects of product-related cues and alcohol are, it is not surprising that beliefs will affect the already complex relationships between product cues, alcohol, expectancy and post-ingestive experience. While recruiting participants from psychology undergraduates is relatively easy, we should consider whether and how that might affect our findings. Participants who have experience with psychological research may be familiar with the use of deception in studies. This knowledge might then make the participants overly sceptical and distrustful to any labelling or contextual information presented in the context of research. This will be especially true for research carried out in laboratory conditions. Therefore, more research using naïve participants and in realistic environment (e.g. bar or social gathering) should be considered when researching expectations in the context of alcoholic and non-alcoholic beverages.

Finally, it seems to be the case that the effects of expectancy on consumers' post-ingestive experience in general is under-researched. There is a number of studies that focus on consumer satisfaction and emotions elicited during and post-ingestion (Andersen et al., 2017; Andersen & Hyldig, 2015; Benton, 2002; Hammersley & Reid, 2009; Macht et al., 2003; Parker et al., 2006) this however is rarely done in relation to expectations. It is important to understand whether and how product-related cues, together with expectations can change post-ingestive experience. This understanding can help product developers create products, such as non-alcoholic beer which consumers enjoy and thus help consumers make better and healthier choices without sacrificing enjoyment.

6.4.2 Perception as probabilistic inference

The need for research to be product-specific is only present for empirical research or research that is carried out with the intention to be applied or used in marketing and product development. In psychological research, on the other hand is a need to collate the numerous product-specific studies, review these, ideally using meta-analyses and start building explanatory models of the relationship between cues, expectancy and perception in the area of taste and flavour perception. Similar research in other sensory modalities, such as vision or hearing has focused on modelling sensory expectations and perception as probabilistic inference.

Even though the idea of perception as a probabilistic inference is not new, it has gained popularity in last 20 years or so (Shams & Beierholm, 2022). This view suggests that perception is shaped by our knowledge about the probabilistic structure of our environment (de Lange et al., 2018). The brain must represent and use information about uncertainty in its computations for perception. Bayesian methods have proven successful in building computational theories for perception

(Knill & Pouget, 2004). This means that contextual cues and prior knowledge/experience shape our sensory experience. This approach to modelling sensory perception as probabilistic inference is relatively common and well researched in the area of visual and auditory perception (Kok et al., 2014). It has been, for example shown that expectations can evoke stimulus templates in the primary visual cortex and thus affect subsequent visual perception (Kok et al., 2014).

When sensory input is weak, noisy, or ambiguous, expectation can bias perception and ultimately change what is perceived (de Lange et al., 2018). This is in line with the empirical findings in the area of gustatory perception: when stimuli are very complex (such as tasting a beverage with complex sensory profile, beer, for example), and cues are likely to accurately predict the outcome, expectations are generated and can affect perception of taste or flavour. As eating and drinking is a complex multisensory experience that seems to be difficult to describe relying on empirical findings alone, researchers should try to map and further develop current theoretical understanding of perceptual processing.

While modelling of auditory, visual and even multi-sensory (auditory and visual) perception is common (Shams & Beierholm, 2022), this approach is almost unheard of in the area concerning expectations and gustatory perception. Future research in this area is thus needed. While this is no small feat, as chemical senses such as taste and olfaction are more complex and inherently more difficult to study than vision and hearing, the theoretical research is clearly needed. The taste and flavour research would benefit from more modelling and focus on theoretical underpinnings. There is a clear need to link empirical findings to theoretical models, as having a good theoretical understanding of expectancy is what will help researchers to generalise and apply research which initially appears highly product

specific. More specifically, computer modelling and taste/flavour perception as Bayesian inference should be used to model the relationship between contextual cues, expectations, and taste and flavour perception.

Overall, the focus on empirical research is invaluable. It enabled researchers to gather data and develop initial understanding. However, majority of studies, including the ones presented in this thesis, are lab-based empirical studies with a very narrow focus. While, as explained earlier there is a need for some product-specific research, especially when gathering data in product development and marketing, it is also necessary to turn attention to testing and replicating past findings outside of lab. Studying consumer drinking experience in a social setting is especially pertinent in the area of alcoholic beverages. Researchers should also focus on building, testing and expanding theoretical models, such as Bayesian causal inference model of perception, that is currently being used to account for similar findings in the area of auditory and visual research.

Bibliography

Abboud, L. (2019). Brewers acquire a taste for non-alcoholic beer. *Financial Times. [Online]*. https://www.ft.com/content/639d6864-5ac9-11e9-9dde-7aedca0a081a

Adams, F. M., & Osgood, C. E. (1973). A Cross-Cultural Study of the Affective Meanings of Color. *Journal of Cross-Cultural Psychology*, *4*(2), 135–156. https://doi.org/10.1177/002202217300400201

Allison, A. M. A., Gualtieri, T., & Craig-Petsinger, D. (2004). Are young teens influenced by increased product description detail and branding during consumer testing? *Food Quality and Preference*, *15*(7-8 SPEC.ISS.), 819–829. https://doi.org/10.1016/j.foodqual.2004.05.011

Allison, R. I., & Uhl, K. P. (1964). Influence of beer brand indentification on taste perception. *Journal of Marketing Research*, *1*(3), 36–39. https://doi.org/10.2307/3150054

Andersen, B. V., & Hyldig, G. (2015). Food satisfaction: Integrating feelings before, during and after food intake. *Food Quality and Preference*, *43*, 126–134. https://doi.org/10.1016/j.foodqual.2015.03.004

Andersen, B. V., Mielby, L. H., Viemose, I., Bredie, W. L. P., & Hyldig, G. (2017). Integration of the sensory experience and post-ingestive measures for

understanding food satisfaction. A case study on sucrose replacement by Stevia rebaudiana and addition of beta glucan in fruit drinks. *Food Quality and Preference*, *58*, 76–84. https://doi.org/10.1016/j.foodqual.2017.01.005

Andrews, I. R., & Valenzi, R. E. (1971). Combining price, brand, and store cues to form an impression of product quality. *Proceedings of the Annual Convention of the American Psychological Association*, 649–650.

Ares, G., Piqueras-Fiszman, B., Varela, P., Marco, R. M., López, A. M., & Fiszman, S. (2011). Food labels: Do consumers perceive what semiotics want to convey? *Food Quality and Preference*, *22*(7), 689–698. https://doi.org/10.1016/j.foodqual.2011.05.006

Ares, G., & Varela, P. (2017). Trained vs. consumer panels for analytical testing: Fueling a long lasting debate in the field. *Food Quality and Preference*, *61*, 79–86. https://doi.org/10.1016/j.foodqual.2016.10.006

Baguley, T. (2009). Standardized or simple effect size: What should be reported? *British Journal of Psychology*, *100*(3), 603–617. https://doi.org/10.1348/000712608X377117

Barnett, A., & Spence, C. (2016). Assessing the Effect of Changing a Bottled Beer Label on Taste Ratings. *Nutrition and Food Technology*, *2*(4), 1–4. https://doi.org/10.16966/2470-6086.132

BarthHaas Report 2021 | BarthHaas. (n.d.). Retrieved 10 November 2021, from https://www.barthhaas.com/en/campaign/barthhaas-report-2021#download

Batra, R., & Ahtola, O. T. (1990). Measuring the Hedonic and Utilitarian Sources of Consumer Attitudes. *Marketing Letters*, *2*(2), 159–170.

Bauer, J. M., van der Laan, L. N., Bruijn, G.-J. de, & Reisch, L. A. (2022). Battle of the primes – The effect and interplay of health and hedonic primes on food choice. *Appetite*, *172*, 105956. https://doi.org/10.1016/j.appet.2022.105956

Beerlabelizer. (2019). https://www.beerlabelizer.com/

Beerlabelizer. (2020). https://www.beerlabelizer.com/

Bellut, K., & Arendt, E. K. (2019). Chance and Challenge: Non-Saccharomyces Yeasts in Nonalcoholic and Low Alcohol Beer Brewing–A Review. *Journal of the American Society of Brewing Chemists*, *77*(2), 77–91. https://doi.org/10.1080/03610470.2019.1569452

Benton, D. (2002). Carbohydrate ingestion, blood glucose and mood. *Neuroscience & Biobehavioral Reviews*, *26*(3), 293–308. https://doi.org/10.1016/S0149-7634(02)00004-0

Berridge, K. C. (1996). Food reward: Brain substrates of wanting and liking. *Neuroscience & Biobehavioral Reviews*, *20*(1), 1–25. https://doi.org/10.1016/0149-7634(95)00033-B

Berridge, K. C., & Robinson, T. E. (2016). Liking, Wanting, and the Incentive-Sensitization Theory of Addiction. *American Psychologist*, *71*(8), 670–679. https://doi.org/10.1037/amp0000059

Betancur, M. I., Motoki, K., Spence, C., & Velasco, C. (2020). Factors influencing the choice of beer: A review. In *Food Research International* (Vol. 137, p. 109367). Elsevier Ltd. https://doi.org/10.1016/j.foodres.2020.109367

beveragedaily.com. (2018). *'Low alcohol' and 'alcohol free': What do these terms actually mean?* Beveragedaily.Com. https://www.beveragedaily.com/Article/2020/01/31/Low-alcohol-and-alcohol-free-EU-and-UK-regulations

Bing, J., Han, P.-J., Liu, W.-Q., Wang, Q.-M., & Bai, F.-Y. (2014). Evidence for a Far East Asian origin of lager beer yeast. *Current Biology*, *24*(10), R380–R381. https://doi.org/10.1016/j.cub.2014.04.031

Bjork, J. M., & Gilman, J. M. (2014). The effects of acute alcohol administration on the human brain: Insights from neuroimaging. *Neuropharmacology*, *84*, 101–110. https://doi.org/10.1016/j.neuropharm.2013.07.039

Blackmore, H. (2019). The effect of explicit and implicit extrinsiccues on sensory and hedonic expectations in the context of beer. *The Effect of Explicit and Implicit Extrinsiccues on Sensory and Hedonic Expectations in the Context of Beer*. PANGBORN, Edinburgh, UK.

Blackmore, H., Hidrio, C., Godineau, P., & Yeomans, M. R. (2020). The effect of implicit and explicit extrinsic cues on hedonic and sensory expectations in the context of beer. *Food Quality and Preference*, *81*(July 2019), 103855. https://doi.org/10.1016/j.foodqual.2019.103855

Blackmore, H., Hidrio, C., & Yeomans, M. R. (2021). A taste of things to come: The effect of extrinsic and intrinsic cues on perceived properties of beer mediated by expectations. *Food Quality and Preference*, 104326. https://doi.org/10.1016/j.foodqual.2021.104326

Blackmore, H., Hidrio, C., & Yeomans, M. R. (2022). How sensory and hedonic expectations shape perceived properties of regular and non-alcoholic beer. *Food Quality and Preference*, *99*, 104562. https://doi.org/10.1016/j.foodqual.2022.104562

Blanco, C. A., Andrés-Iglesias, C., & Montero, O. (2016). Low-alcohol Beers: Flavor Compounds, Defects, and Improvement Strategies. *Critical Reviews in Food*

Science and Nutrition, *56*(8), 1379–1388. https://doi.org/10.1080/10408398.2012.733979

Bodnár, V., Nagy, K., Cziboly, Á., & Bárdos, G. (2020). Alcohol and Placebo: The Role of Expectations and Social Influence. *International Journal of Mental Health and Addiction*. https://doi.org/10.1007/s11469-020-00321-0

Bond, A., & Lader, M. (1974). The use of Analogue Scales in rating subjective feelings. *British Journal Medical Psychology*, *47*, 211–218.

Bowen, D. J., Tomoyasu, N., Anderson, M., Carney, M., & Kristal, A. (1992). Effects of Expectancies and Personalized Feedback on Fat Consumption, Taste, and Preference. *Journal of Applied Social Psychology*, *22*(13), 1061–1079. https://doi.org/10.1111/j.1559-1816.1992.tb00942.x

Brand, A., Bradley, M. T., Best, L. A., & George, S. (2011). Accuracy of effect size estimates from published psychological experiments involving multiple trials. *Journal of General Psychology*, *138*(4), 281–291. https://doi.org/10.1080/00221309.2011.604365

Brewers Association Beer Style Guidelines. (2021). Brewers Association. https://www.brewersassociation.org/edu/brewers-association-beer-style-guidelines/

Brühlmann, F., Petralito, S., Aeschbach, L. F., & Opwis, K. (2020). The quality of data collected online: An investigation of careless responding in a crowdsourced sample. *Methods in Psychology*, *2*, 100022. https://doi.org/10.1016/j.metip.2020.100022

Buck, L., & Bargmann, C. (2013). Smell and Taste: The chemical senses. In *Principles of Neural Science* (2nd ed.). McGraw Hill Education. http://archive.org/details/Buck.2013-Smell.and.Taste-Chemical.Senses

Buckland, N. J., Er, V., Redpath, I., & Beaulieu, K. (2018). Priming food intake with weight control cues: Systematic review with a meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity*, *15*(1), 66. https://doi.org/10.1186/s12966-018-0698-9

Bürkner, P. C. (2017). Advanced Bayesian Multilevel Modeling with the R Package brms. *ArXiv*, *1*.

Burton, R., & Sheron, N. (2018). No level of alcohol consumption improves health. *The Lancet*, *392*(10152), 987–988. https://doi.org/10.1016/S0140-6736(18)31571-X

Cabras, I., & Higgins, D. M. (2016). Beer, brewing, and business history. *Business History*, *58*(5), 609–624. https://doi.org/10.1080/00076791.2015.1122713

Cao, J., & Zhang, S. (2014). Multiple comparison procedures. In *JAMA - Journal of the American Medical Association* (Vol. 312, Issue 5, pp. 543–544). American Medical Association. https://doi.org/10.1001/jama.2014.9440

Capitello, R., & Todirica, I. C. (2021). 2—Understanding the behavior of beer consumers. In R. Capitello & N. Maehle (Eds.), *Case Studies in the Beer Sector* (pp. 15–36). Woodhead Publishing. https://doi.org/10.1016/B978-0-12-817734-1.00002-1

Caporale, G., & Monteleone, E. (2004). Influence of information about manufacturing process on beer acceptability. *Food Quality and Preference*, *15*(3), 271–278. https://doi.org/10.1016/S0950-3293(03)00067-3

Cappelletti, S., Daria, P., Sani, G., & Aromatario, M. (2015). Caffeine: Cognitive and Physical Performance Enhancer or Psychoactive Drug? *Current Neuropharmacology*, *13*(1), 71–88.

Cardello. (2003). Consumer concerns and expectations about novel food processing technologies: Effects on product liking☆. *Appetite*, *40*(3), 217–233. https://doi.org/10.1016/S0195-6663(03)00008-4

Cardello. (2007). *Measuring consumer expectations to improve food product development*. https://doi.org/10.1533/9781845693381.2.223

Cardello, A. V., Schutz, H., Snow, C., & Lesher, L. (2000). Predictors of food acceptance, consumption and satisfaction in speci®c eating situations. *Food Quality and Preference*, 16.

Cardello, & Sawyer. (1992). Effects of disconfirmed consumer expectations on food acceptability. *Journal of Sensory Studies*, *7*(4), 253–277. https://doi.org/10.1111/j.1745-459X.1992.tb00194.x

Carlsmith, J. M., & Aronson, E. (1963). Some hedonic consequences of the confirmation and disconfirmation of expectancies. *Journal of Abnormal and Social Psychology*, *66*(2), 151–156. https://doi.org/10.1037/h0042692

Carrillo, E., Varela, P., & Fiszman, S. (2012). Effects of food package information and sensory characteristics on the perception of healthiness and the acceptability of enriched biscuits. *Food Research International*, *48*(1), 209–216. https://doi.org/10.1016/j.foodres.2012.03.016

Carvalho, F. M., & Spence, C. (2019). Cup colour influences consumers' expectations and experience on tasting specialty coffee. *Food Quality and Preference*, *75*(February), 157–169. https://doi.org/10.1016/j.foodqual.2019.03.001

Carvalho, Moors, P., Wagemans, J., & Spence, C. (2017). The influence of color on the consumer's experience of beer. *Frontiers in Psychology*, *8*(DEC), 2205. https://doi.org/10.3389/fpsyg.2017.02205

Carvalho, N. B., Minim, L. A., Nascimento, M., Ferreira, G. H. de C., & Minim, V. P. R. (2018). Characterization of the consumer market and motivations for the consumption of craft beer. *British Food Journal*, *120*(2), 378–391. https://doi.org/10.1108/BFJ-04-2017-0205

Cash, C., Peacock, A., Barrington, H., Sinnett, N., & Bruno, R. (2015). Detecting impairment: Sensitive cognitive measures of dose-related acute alcohol intoxication. *Journal of Psychopharmacology*, *29*(4), 436–446. https://doi.org/10.1177/0269881115570080

Catarino, M., & Mendes, A. (2011). Non-alcoholic beer—A new industrial process. *Separation and Purification Technology*, *79*(3), 342–351. https://doi.org/10.1016/j.seppur.2011.03.020

Catarino, M., Mendes, A., Madeira, L. M., & Ferreira, A. (2007). Alcohol Removal From Beer by Reverse Osmosis. *Separation Science and Technology*, *42*(13), 3011–3027. https://doi.org/10.1080/01496390701560223

Chambers, L., McCrickerd, K., & Yeomans, M. R. (2015). Optimising foods for satiety. *Trends in Food Science and Technology*. https://doi.org/10.1016/j.tifs.2014.10.007

Christiansen, P., Townsend, G., Knibb, G., & Field, M. (n.d.). *Bibi ergo sum: The effects of a placebo and contextual alcohol cues on motivation to drink alcohol*. https://doi.org/10.1007/s00213-016-4518-0

Chrysochou, P. (2014). Drink to get drunk or stay healthy? Exploring consumers' perceptions, motives and preferences for light beer. *Food Quality and Preference*, *31*(1), 156–163. https://doi.org/10.1016/j.foodqual.2013.08.006

Clark, A. (2013). Whatever next? Predictive brains, situated agents, and the future of cognitive science. *Behavioral and Brain Sciences*, *36*(3), 181–204. https://doi.org/10.1017/S0140525X12000477

Clark, R. A., Hewson, L., Bealin-Kelly, F., & Hort, J. (2011). The Interactions of CO2, Ethanol, Hop Acids and Sweetener on Flavour Perception in a Model Beer. *Chemosensory Perception*, *4*(1–2), 42–54. https://doi.org/10.1007/s12078-011-9087-3

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). Routledge. https://doi.org/10.4324/9780203771587

Corbin, W. R., Scott, C., Boyd, S. J., Menary, K. R., & Enders, C. K. (2015). Contextual influences on subjective and behavioral responses to alcohol. *Experimental and Clinical Psychopharmacology*, *23*(1), 59–70. https://doi.org/10.1037/a0038760

Cramer, A. O. J., van Ravenzwaaij, D., Matzke, D., Steingroever, H., Wetzels, R., Grasman, R. P. P. P., Waldorp, L. J., & Wagenmakers, E.-J. (2016). Hidden multiplicity in exploratory multiway ANOVA: Prevalence and remedies. *Psychonomic Bulletin & Review*, *23*(2), 640–647. https://doi.org/10.3758/s13423-015-0913-5

Cribari-Neto, F., & Lima, M. da G. A. (2014). New heteroskedasticity-robust standard errors for the linear regression model. *Brazilian Journal of Probability and Statistics*, *28*(1), 83–95. https://doi.org/10.1214/12-BJPS196

Curtin, J. J., & Lang, A. R. (2007). Alcohol and Emotion: Insights and Directives From Affective Science. In *Emotion and psychopathology: Bridging affective and clinical science* (pp. 191–213). American Psychological Association. https://doi.org/10.1037/11562-009

de Lange, F. P., Heilbron, M., & Kok, P. (2018). How Do Expectations Shape Perception? *Trends in Cognitive Sciences*, *22*(9), 764–779. https://doi.org/10.1016/j.tics.2018.06.002

De Visser, R. O., Robinson, E., & Bond, R. (2016). Voluntary temporary abstinence from alcohol during 'dry january' and subsequent alcohol use. *Health Psychology*, *35*(3), 281–289. https://doi.org/10.1037/hea0000297

Deary, I. J., Simonotto, E., Meyer, M., Marshall, A., Marshall, I., Goddard, N., & Wardlaw, J. M. (2004). The functional anatomy of inspection time: An event-related fMRI study. *NeuroImage*, *22*(4), 1466–1479. https://doi.org/10.1016/j.neuroimage.2004.03.047

Deary, I. J., & Stough, C. (1996). Intelligence and inspection time: Achievements, prospects, and problems. *American Psychologist*, *51*(6), 599. https://doi.org/10.1037/0003-066X.51.6.599

Delarue, J., & Boutrolle, I. (2010). 8 - The effects of context on liking: Implications for hedonic measurements in new product development. In S. R. Jaeger & H. MacFie (Eds.), *Consumer-Driven Innovation in Food and Personal Care Products* (pp. 175–218). Woodhead Publishing. https://doi.org/10.1533/9781845699970.2.175

Deliza, R., & MacFie, H. J. H. (1996). the Generation of Sensory Expectation By External Cues and Its Effect on Sensory Perception and Hedonic Ratings: A Review. *Journal of Sensory Studies*, *11*(2), 103–128. https://doi.org/10.1111/j.1745-459X.1996.tb00036.x

Deliza, R., MacFie, H. J. H., & Hedderley, D. (1996). Information Affects Consumer Assessment of Sweet and Bitter Solutions. *Journal of Food Science*, *61*(5), 1080–1084. https://doi.org/10.1111/j.1365-2621.1996.tb10936.x

Department of Health, D. of H. (2016). UK Chief Medical Officers' Low Risk Drinking Guidelines. *Department of Health, England*, *August*, 1–11. https://doi.org/10.1517/17425247.2013.808185

Dhar, R., & Wertenbroch, K. (2000). Consumer choice between hedonic and utilitarian goods. *Journal of Marketing Research*, *37*(1), 60–71. https://doi.org/10.1509/jmkr.37.1.60.18718

Djekic, I., Lorenzo, J. M., Munekata, P. E. S., Gagaoua, M., & Tomasevic, I. (2021). Review on characteristics of trained sensory panels in food science. *Journal of Texture Studies*, *52*(4), 501–509. https://doi.org/10.1111/jtxs.12616

Donadini, G., Fumi, M. D., & Newby-Clark, I. R. (2014). Consumers' preference and sensory profile of bottom fermented red beers of the Italian market. *Food Research International*, *58*, 69–80. https://doi.org/10.1016/j.foodres.2014.01.048

Dong, R., & Gleim, M. R. (2018). High or low: The impact of brand logo location on consumers product perceptions. *Food Quality and Preference*, *69*(April), 28–35. https://doi.org/10.1016/j.foodqual.2018.05.003

Dry, M. J., Burns, N. R., Nettelbeck, T., Farquharson, A. L., & White, J. M. (2012). Dose-Related Effects of Alcohol on Cognitive Functioning. *PLoS ONE*, *7*(11), e50977. https://doi.org/10.1371/journal.pone.0050977

Dunaway, K., Will, K. E., & Sabo, C. S. (2011). Alcohol-Impaired Driving. *Handbook of Traffic Psychology*, 231–248. https://doi.org/10.1016/B978-0-12-381984-0.10017-7

Escalas, J. E., & Luce, M. F. (2004). Understanding the Effects of Process-Focused versus Outcome-Focused Thought in Response to Advertising. *Journal of Consumer Research*, *31*(2), 274–285. https://doi.org/10.1086/422107

Feldman, H. (1930). *Prohibition: Its Economic and Industrial Aspects*. Appleton and Company. https://www.abebooks.co.uk/9780666772275/Prohibition-Economic-Industrial-Aspects-Classic-0666772274/plp

Fernqvist, F., & Ekelund, L. (2014). Credence and the effect on consumer liking of food—A review. *Food Quality and Preference*, *32*(PC), 340–353. https://doi.org/10.1016/j.foodqual.2013.10.005

Field, J. R., Bergiel, B. J., Giesen, J. M., & Fields, C. L. (2012). Branding: Perceptual effects on consumer evaluations. *Competitiveness Review*, *22*(3), 251–260. https://doi.org/10.1108/10595421211229664

Fillmore, M. T., Carscadden, J. L., & Vogel-Sprott, M. (1998). Alcohol, cognitive impairment and expectancies. *Journal of Studies on Alcohol*, *59*(2), 174–179. https://doi.org/10.15288/jsa.1998.59.174

Forde, C. G. (2018). From perception to ingestion; the role of sensory properties in energy selection, eating behaviour and food intake. *Food Quality and Preference*, *66*, 171–177. https://doi.org/10.1016/j.foodqual.2018.01.010

Friston, K. (2003). Functional Integration in the Brain. *Human Brain Function: Second Edition*, *68*(August), 971–997. https://doi.org/10.1016/B978-012264841-0/50050-0

Friston, K. (2010). The free-energy principle: A unified brain theory? *Nature Reviews Neuroscience*, *11*(2), 127–138. https://doi.org/10.1038/nrn2787

Friston, K. (2012). The history of the future of the Bayesian brain. *NeuroImage*, *62*(2), 1230–1233. https://doi.org/10.1016/j.neuroimage.2011.10.004

Friston, K., & Kiebel, S. (2009). Predictive coding under the free-energy principle. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1521), 1211–1221. https://doi.org/10.1098/rstb.2008.0300

Friston, K., Mattout, J., & Kilner, J. (2011). Action understanding and active inference. *Biological Cybernetics*, *104*(1–2), 137–160. https://doi.org/10.1007/s00422-011-0424-z

Fukuda, M. (2019). The effects of non-alcoholic beer on response inhibition: An open-label study. *Learning and Motivation*, *66*, 46–54. https://doi.org/10.1016/j.lmot.2019.04.002

Galindo, M. N., Navarro, J. F., & Cavas, M. (2020). The Influence of Placebo Effect on Craving and Cognitive Performance in Alcohol, Caffeine, or Nicotine Consumers: A Systematic Review. *Frontiers in Psychiatry*, *11*, 849. https://doi.org/10.3389/fpsyt.2020.00849

Gamero, A., Ferreira, V., Pretorius, I. S., & Querol, A. (2014). Wine, beer and cider: Unravelling the aroma profile. In *Molecular Mechanisms in Yeast Carbon Metabolism* (pp. 261–297). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-55013-3_10

Garber, L. L., Hyatt, E. M., & Starr, R. G. (2000). The Effects of Food Color on Perceived Flavor. *Journal of Marketing Theory and Practice*, *8*(4), 59–72. https://doi.org/10.1080/10696679.2000.11501880

Garcia-Burgos, D., & Zamora, M. C. (2015). Exploring the hedonic and incentive properties in preferences for bitter foods via self-reports, facial expressions and instrumental behaviours. *Food Quality and Preference*, *39*, 73–81. https://doi.org/10.1016/j.foodqual.2014.07.003

Gardner, M. P. H., Fontanini, A., Gardner, M. P. H., & Fontanini, A. (2014). Encoding and tracking of outcome-specific expectancy in the gustatory cortex of alert rats. *Journal of Neuroscience*, *34*(39), 13000–13017. https://doi.org/10.1523/JNEUROSCI.1820-14.2014

Gawel, R., Sluyter, S. V., & Waters, E. J. (2007). The effects of ethanol and glycerol on the body and other sensory characteristics of Riesling wines. *Australian Journal of Grape and Wine Research*, *13*(1), 38–45. https://doi.org/10.1111/j.1755-0238.2007.tb00070.x

Gilbertson, R., Prather, R., & Jo Nixon, S. (2010). Acute Alcohol Administration and Placebo Effectiveness in Older Moderate Drinkers: Influences on Cognitive Performance. *Journal of Studies on Alcohol and Drugs*, *71*(3), 345–350. https://doi.org/10.15288/jsad.2010.71.345

Gil-Pérez, I., Rebollar, R., Lidón, I., Martín, J., van Trijp, H. C. M., & Piqueras-Fiszman, B. (2019). Hot or not? Conveying sensory information on food packaging through the spiciness-shape correspondence. *Food Quality and Preference*, *71*, 197–208. https://doi.org/10.1016/j.foodqual.2018.07.009

Glade, M. J. (2010). Caffeine—Not just a stimulant. *Nutrition*, *26*(10), 932–938. https://doi.org/10.1016/j.nut.2010.08.004

Gorka, S. M., Phan, K. L., & Childs, E. (2018). Acute calming effects of alcohol are associated with disruption of the salience network. *Addiction Biology*, *23*(3), 921–930. https://doi.org/10.1111/adb.12537

Grabenhorst, F. (2014). Brain Systems for the Pleasure of Food and Other Primary Rewards | SpringerLink. In *Anhedonia: A Comprehensive Handbook Volume I*. 10.1007/978-94-017-8591-4_8

Grabenhorst, F., Rolls, E. T., & Bilderbeck, A. (2008a). How cognition modulates affective responses to taste and flavor: Top-down influences on the orbitofrontal and pregenual cingulate cortices. *Cerebral Cortex*, *18*(7), 1549–1559. https://doi.org/10.1093/cercor/bhm185

Grabenhorst, F., Rolls, E. T., & Bilderbeck, A. (2008b). How cognition modulates affective responses to taste and flavor: Top-down influences on the orbitofrontal and pregenual cingulate cortices. *Cerebral Cortex*, *18*(7), 1549–1559. https://doi.org/10.1093/cercor/bhm185

Guéguen, N. (2003). The effect of glass color on the evaluation of a beverage's thirst-quenching quality. *Curr Psychol Lett Brain Behav Cogn*, *11*(September).

Guinard, J. X., Souchard, A., Picot, M., Rogeaux, M., & Sieffermann, J. M. (1998). Sensory determinants of the thirst-quenching character of beer. *Appetite*, *31*(1), 101–115. https://doi.org/10.1006/appe.1998.0165

Gunst, R. F., & Mason, R. L. (2009). Fractional factorial design. *WIREs Computational Statistics*, *1*(2), 234–244. https://doi.org/10.1002/wics.27

Güzel, N., Güzel, M., & Savaş Bahçeci, K. (2020). Nonalcoholic Beer. In *Trends in Non-alcoholic Beverages* (pp. 167–200). Elsevier. https://doi.org/10.1016/b978-0-12-816938-4.00006-9

Hammersley, R., & Reid, M. (2009). Theorising transient mood after ingestion. *Neuroscience & Biobehavioral Reviews*, *33*(3), 213–222. https://doi.org/10.1016/j.neubiorev.2008.07.010

Harrison, N. L., Skelly, M. J., Grosserode, E. K., Lowes, D. C., Zeric, T., Phister, S., & Salling, M. C. (2017). Effects of acute alcohol on excitability in the CNS. *Neuropharmacology*, *122*, 36–45. https://doi.org/10.1016/j.neuropharm.2017.04.007

Hascher, J., Desai, N., & Krajbich, I. (2021). Incentivized and non-incentivized liking ratings outperform willingness-to-pay in predicting choice. *Judgment and Decision Making*, *16*(6), 21.

Hayes, A. F., & Cai, L. (2007). Using heteroskedasticity-consistent standard error estimators in OLS regression: An introduction and software implementation. *Behavior Research Methods*, *39*(4), 709–722. https://doi.org/10.3758/BF03192961

Heinz, A. J., Beck, A., Meyer-Lindenberg, A., Sterzer, P., & Heinz, A. (2011). Cognitive and neurobiological mechanisms of alcohol-related aggression. *Nature Reviews Neuroscience*, *12*(7), 400–413. https://doi.org/10.1038/nrn3042

Higgs, S. (2016). Cognitive processing of food rewards. *Appetite*, *104*, 10–17. https://doi.org/10.1016/j.appet.2015.10.003

Hoffman, L., & Rovine, M. J. (2007). Multilevel Models For The Experimental Psychologist. *Behavior Research Methods*, *39*(1), 101–117.

Hohwy, J. (2007). Functional integration and the mind. *Synthese*, *159*(3), 315–328. https://doi.org/10.1007/s11229-007-9240-3

Holland, C. W., & Cravens, D. W. (1973). Fractional Factorial Experimental Designs in Marketing Research. *Journal of Marketing Research*, *10*(3), 270–276. https://doi.org/10.1177/002224377301000307

Hull, J. G., & Bond, C. F. (1986). Social and behavioral consequences of alcohol consumption and expectancy: A meta-analysis. *Psychological Bulletin*, *99*(3), 347. https://doi.org/10.1037/0033-2909.99.3.347

Iatridi, V., Hayes, J. E., & Yeomans, M. R. (2019). Reconsidering the classification of sweet taste liker phenotypes: A methodological review. *Food Quality and Preference*, *72*(August 2018), 56–76. https://doi.org/10.1016/j.foodqual.2018.09.001

Inquisit 5 [Computer software]. (2016). https://www.millisecond.com.

Ivanova, N. (2018). Focusing on body: Consumer understanding of the mouthfeel concept in beer and wine products. *Focusing on Body: Consumer Understanding of the Mouthfeel Concept in Beer and Wine Products*. Eurosense, 2018, Verona, Italy.

Ivanova, N., Yang, Q., Bastian, S. E. P., Wilkinson, K. L., & Ford, R. (2022). Consumer understanding of beer and wine body: An exploratory study of an ill-defined concept. *Food Quality and Preference*, *98*, 104383. https://doi.org/10.1016/j.foodqual.2021.104383

Jackowski, M., & Trusek, A. (2018). *Non-alcoholic beer production – an overview*. *20*(4), 32–38.

Jacobs, L., Keown, C., Worthley, R., & Ghymn, K.-I. K. (1991). Cross-cultural colour comparisons: Global marketers beware! *International Marketing Review*, *8*(3), 21–30. https://doi.org/10.1108/02651339110137279

Jaeger, S. R., Worch, T., Phelps, T., Jin, D., & Cardello, A. V. (2020). Preference segments among declared craft beer drinkers: Perceptual, attitudinal and behavioral responses underlying craft-style vs. Traditional-style flavor preferences. *Food Quality and Preference*, *82*(January), 103884. https://doi.org/10.1016/j.foodqual.2020.103884

Jaeger, S. R., Xia, Y., Le Blond, M., Beresford, M. K., Hedderley, D. I., & Cardello, A. V. (2018). Supplementing hedonic and sensory consumer research on beer with cognitive and emotional measures, and additional insights via consumer segmentation. *Food Quality and Preference*, *73*(September 2018), 117–134. https://doi.org/10.1016/j.foodqual.2018.11.015

Jongen, S., Vuurman, E., Ramaekers, J., & Vermeeren, A. (2014). Alcohol calibration of tests measuring skills related to car driving. *Psychopharmacology*, *231*(12), 2435–2447. https://doi.org/10.1007/s00213-013-3408-y

Kähkönen, P., & Tuorila, H. (1998). Effect of Reduced-fat Information on Expected and Actual Hedonic and Sensory Ratings of Sausage. *Appetite*, *30*(1), 13–23. https://doi.org/10.1006/appe.1997.0104

Kauppinen-Räisänen, H., & Luomala, H. T. (2010). Exploring consumers' product-specific colour meanings. *Qualitative Market Research: An International Journal*, *13*(3), 287–308. https://doi.org/10.1108/13522751011053644

Kim, J., & Mueller, C. W. (1976). STANDARDIZED AND UNSTANDARDIZED COEFFICIENTS IN CAUSAL ANALYSIS. *Spociological Methods & Research*, *4*(4), 423–438.

King, M. C., Hall, J., & Cliff, M. A. (2001). A Comparison of Methods for Evaluating the Performance of a Trained Sensory Panel1. *Journal of Sensory Studies*, *16*(6), 567–581. https://doi.org/10.1111/j.1745-459X.2001.tb00321.x

King, S. C., Meiselman, H. L., Hottenstein, A. W., Work, T. M., & Cronk, V. (2007). The effects of contextual variables on food acceptability: A confirmatory study. *Food Quality and Preference*, *18*(1), 58–65. https://doi.org/10.1016/j.foodqual.2005.07.014

Kishimoto, T., Teramoto, S., Fujita, A., & Yamada, O. (2021). Evaluation of Components Contributing to the International Bitterness Unit of Wort and Beer. *Journal of the American Society of Brewing Chemists*, *0*(0), 1–15. https://doi.org/10.1080/03610470.2021.1878684

Knill, D. C., & Pouget, A. (2004). The Bayesian brain: The role of uncertainty in neural coding and computation. *Trends in Neurosciences*, *27*(12), 712–719. https://doi.org/10.1016/j.tins.2004.10.007

Kobayashi, M. (2006). Functional Organization of the Human Gustatory Cortex. *Journal of Oral Biosciences*, *48*(4), 244–260. https://doi.org/10.1016/S1349-0079(06)80007-1

Koch, C., & Koch, E. C. (2003). Preconceptions of Taste Based on Color. *The Journal of Psychology*, *137*(3), 233–242. https://doi.org/10.1080/00223980309600611

Koelega, H. S. (1995). Alcohol and vigilance performance: A review. *Psychopharmacology*, *118*(3), 233–249. https://doi.org/10.1007/BF02245951

Kok, P., Failing, M. F., & de Lange, F. P. (2014). Prior Expectations Evoke Stimulus Templates in the Primary Visual Cortex. *Journal of Cognitive Neuroscience*, *26*(7), 1546–1554. https://doi.org/10.1162/jocn_a_00562

Kokole, D., Jané Llopis, E., & Anderson, P. (2021). Non-alcoholic beer in the European Union and UK: Availability and apparent consumption. *Drug and Alcohol Review*, *n/a*(n/a). https://doi.org/10.1111/dar.13429

Koren, D., Hegyesné Vecseri, B., Kun-Farkas, G., Urbin, Á., Nyitrai, Á., & Sipos, L. (2020). How to objectively determine the color of beer? *Journal of Food Science and Technology*, *57*(3), 1183–1189. https://doi.org/10.1007/s13197-020-04237-4

Kumar Yadav, A., & Velaga, N. R. (2021). A comprehensive systematic review of the laboratory-based research investigating the influence of alcohol on driving behaviour. *Transportation Research Part F: Traffic Psychology and Behaviour*, *81*, 557–585. https://doi.org/10.1016/j.trf.2021.07.010

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2017). lmerTest Package: Tests in Linear Mixed Effects Models. *Journal of Statistical Software*, *82*(13), 2017. https://doi.org/10.18637/jss.v082.i13

Lafontaine, S., Senn, K., Knoke, L., Schubert, C., Dennenlöhr, J., Maxminer, J., Cantu, A., Rettberg, N., & Heymann, H. (2020). Evaluating the Chemical Components and Flavor Characteristics Responsible for Triggering the Perception of "Beer Flavor" in Non-Alcoholic Beer. *Foods*, *9*(12), Article 12. https://doi.org/10.3390/foods9121914

Landauer, A. A., & Howat, P. A. (1982). Alcohol and the cognitive aspects of choice reaction time. *Psychopharmacology*, *78*(3), 296–297. https://doi.org/10.1007/BF00428170

Langstaff, S. A., Guinard, J. -X, & Lewis, M. J. (1991). Instrumental Evaluation of the Mouthfeel of Beer and Correlation With Sensory Evaluation. *Journal of the Institute of Brewing*, *97*(6), 427–433. https://doi.org/10.1002/j.2050-0416.1991.tb01081.x

Langstaff, S. A., & Lewis, M. J. (1993). The mouthfeel of beer—A review. *Journal of the Institute of Brewing*, *99*(1), 31–37. https://doi.org/10.1002/j.2050-0416.1993.tb01143.x

Lawless, H. T., & Heymann, H. (1999). *Sensory evaluation of food: Principles and practices*. https://books.google.co.uk/books?id=u-XpBwAAQBAJ&pg=PA99&lpg=PA99&dq=assigning+codes+to+sensory+samples+how+to&source=bl&ots=Eeow9dsvSc&sig=Quyj7axgss2RWzUbf2JoloEXeCw&hl=en&sa=X&ved=2ahUKEwi0wNCAmePeAhVDbBoKHX2mAGkQ6AEwA3oECAcQAQ#v=onepage&q=assigning codes to sensory samples how to&f=false

Lawless, H. T., Schlake, S., Smythe, J., Lim, J., Yang, H., Chapman, K., & Bolton, B. (2004). Metallic taste and retronasal smell. *Chemical Senses*, *29*(1), 25–33.

Lee, L., Frederick, S., & Ariely, D. (2006). Try It, You'll Like It. *Psychological Science*, *17*(12), 1054–1058. https://doi.org/10.1111/j.1467-9280.2006.01829.x

Lelièvre, M., Chollet, S., Abdi, H., & Valentin, D. (2009). Beer-trained and untrained assessors rely more on vision than on taste when they categorize beers. *Chemosensory Perception*, *2*(3), 143–153. https://doi.org/10.1007/s12078-009-9050-8

Levin, I. P., & Gaeth, G. J. (1988). How Consumers Are Affected by the Framing of Attribute Information Before and After Consuming the Product. *Journal of Consumer Research*, *15*(3), 374–378. https://doi.org/10.1086/209174

Lichters, M., Möslein, R., Sarstedt, M., & Scharf, A. (2021). Segmenting consumers based on sensory acceptance tests in sensory labs, immersive environments, and natural consumption settings. *Food Quality and Preference*, *89*, 104138. https://doi.org/10.1016/j.foodqual.2020.104138

Liem, D. G. G., Miremadi, F., Zandstra, E. H., & Keast, R. S. (2012). Health labelling can influence taste perception and use of table salt for reduced-sodium products. *Public Health Nutrition*, *15*(12), 2340–2347. https://doi.org/10.1017/S136898001200064X

Liem, D. G. G., Toraman Aydin, N., & Zandstra, E. H. H. (2012). Effects of health labels on expected and actual taste perception of soup. *Food Quality and Preference*, *25*(2), 192–197. https://doi.org/10.1016/j.foodqual.2012.02.015

Liguori, L., De Francesco, G., Russo, P., Perretti, G., Albanese, D., & Di Matteo, M. (2015). Production and characterization of alcohol-free beer by membrane process. *Food and Bioproducts Processing*, *94*, 158–168. https://doi.org/10.1016/j.fbp.2015.03.003

Lindman, R. E., & Lang, A. R. (1994). The Alcohol-Aggression Stereotype: A Cross-Cultural Comparison of Beliefs. *International Journal of the Addictions*, *29*(1), 1–13. https://doi.org/10.3109/10826089409047365

Lindman, R. E., Sjöholm, B. A., & Lang, A. R. (2015). Expectations of alcohol-induced positive affect: A cross-cultural comparison. *Journal of Studies on Alcohol*. https://doi.org/10.15288/jsa.2000.61.681

Littell, R. C., Pendergast, J., & Natarajan, R. (2000). *No Title* (Vol. 19). John Wiley & Sons, Ltd. https://doi.org/10.1002/1097-0258(20000715)19:13<1793::AID-SIM482>3.0.CO;2-Q

Liu, C., Dong, J., Wang, J., Yin, X., & Li, Q. (2012). A comprehensive sensory evaluation of beers from the Chinese market. *Journal of the Institute of Brewing*, *118*(3), 325–333. https://doi.org/10.1002/jib.43

Low-alcohol descriptors guidance. (2018). 6.

Macht, M., Gerer, J., & Ellgring, H. (2003). Emotions in overweight and normal-weight women immediately after eating foods differing in energy. *Physiology & Behavior*, *80*(2–3), 367–374. https://doi.org/10.1016/j.physbeh.2003.08.012

MacKinnon, D. P., Fairchild, A., & Fritz, M. (2007). Mediation Analysis. *Annual Review of Psychology*, *58*(Hebb 1966), 593–602. https://doi.org/10.1146/annurev.psych.58.110405.085542.Mediation

Madden, T. J., Hewett, K., & Roth, M. S. (2000). Managing Images in Different Cultures: A Cross-National Study of Color Meanings and Preferences. *Journal of International Marketing*, *8*(4), 90–107. https://doi.org/10.1509/jimk.8.4.90.19795

Manippa, V., van der Laan, L. N., Brancucci, A., & Smeets, P. A. M. (2019). Health body priming and food choice: An eye tracking study. *Food Quality and Preference*, *72*, 116–125. https://doi.org/10.1016/J.FOODQUAL.2018.10.006

Mano, H., & Oliver, R. L. (1993). Assessing the Dimensionality and Structure of the Consumption Experience: Evaluation, Feeling, and Satisfaction. *Journal of Consumer Research*, *20*(3), 451–466.

Maylor, E. A., Rabbitt, P. M. A., James, G. H., & Kerr, S. A. (1990). Effects of alcohol and extended practice on divided-attention performance. *Perception & Psychophysics*, *48*(5), 445–452. https://doi.org/10.3758/BF03211588

McCollam, J. B., Burish, T. G., Maisto, S. A., & Sobell, M. B. (1980). Alcohol's effects on physiological arousal and self-reported affect and sensations. *Journal of*

Abnormal Psychology, *89*(2), 224–233. https://doi.org/10.1037/0021-843X.89.2.224

McGraw, K. O., Tew, M. D., & Williams, J. E. (2000). Chapter 9 - PsychExps: An Online Psychology Laboratory. In M. H. Birnbaum (Ed.), *Psychological Experiments on the Internet* (pp. 219–233). Academic Press. https://doi.org/10.1016/B978-012099980-4/50010-1

Meilgaard, M. C., Dalgliesh, C. E., & Clapperton, J. F. (1979). BEER FLAVOUR TERMINOLOGY [1]. *Journal of the Institute of Brewing*, *85*(1), 38–42. https://doi.org/10.1002/j.2050-0416.1979.tb06826.x

Meillon, S., Urbano, C., Guillot, G., & Schlich, P. (2010). Acceptability of partially dealcoholized wines—Measuring the impact of sensory and information cues on overall liking in real-life settings. *Food Quality and Preference*, *21*(7), 763–773. https://doi.org/10.1016/j.foodqual.2010.07.013

Meiselman, H. L., Johnson, J. L., Reeve, W., & Crouch, J. E. (2000). Demonstrations of the influence of the eating environment on food acceptance. *Appetite*, *35*(3), 231–237. https://doi.org/10.1006/appe.2000.0360

Mejlholm, O., & Martens, M. (2006). Beer identity in Denmark. *Food Quality and Preference*. https://doi.org/10.1016/j.foodqual.2005.10.001

Menichelli, E., Almøy, T., Tomic, O., Olsen, N. V., & Næs, T. (2014). SO-PLS as an exploratory tool for path modelling. *Food Quality and Preference*, *36*, 122–134. https://doi.org/10.1016/j.foodqual.2014.03.008

Mitchell, J. M., O'Neil, J. P., Janabi, M., Marks, S. M., Jagust, W. J., & Fields, H. L. (2012). Alcohol Consumption Induces Endogenous Opioid Release in the Human Orbitofrontal Cortex and Nucleus Accumbens. *Science Translational Medicine*, *4*(116), 116ra6-116ra6. https://doi.org/10.1126/scitranslmed.3002902

Mitchell, M. C., Teigen, E. L., & Ramchandani, V. A. (2014). Absorption and peak blood alcohol concentration after drinking beer, wine, or spirits. *Alcoholism: Clinical and Experimental Research*, *38*(5), 1200–1204. https://doi.org/10.1111/acer.12355

Mojet, J., Köster, E. P., & Prinz, J. F. (2005). Do tastants have a smell? *Chemical Senses*, *30*(1), 9–21. https://doi.org/10.1093/chemse/bjh251

Molnár, M., Boha, R., Czigler, B., Gaál, Z. A., Benyovszky, M., Róna, K., & Klausz, G. (2009). The acute effect of low-dose alcohol on working memory during mental arithmetic. *International Journal of Psychophysiology*, *73*(2), 138–142. https://doi.org/10.1016/j.ijpsycho.2009.02.007

Moss, R., Barker, S., & McSweeney, M. B. (2022). An analysis of the sensory properties, emotional responses and social settings associated with non-alcoholic beer. *Food Quality and Preference*, *98*, 104456. https://doi.org/10.1016/j.foodqual.2021.104456

Muñoz-Vilches, N. C., van Trijp, H. C. M., & Piqueras-Fiszman, B. (2019). The impact of instructed mental simulation on wanting and choice between vice and virtue food products. *Food Quality and Preference*, *73*, 182–191. https://doi.org/10.1016/j.foodqual.2018.11.010

Napolitano, F., Braghieri, A., Piasentier, E., Favotto, S., Naspetti, S., & Zanoli, R. (2010). Effect of information about organic production on beef liking and consumer willingness to pay. *Food Quality and Preference*, *21*(2), 207–212. https://doi.org/10.1016/J.FOODQUAL.2009.08.007

Napolitano, F., Caporale, G., Carlucci, A., & Monteleone, E. (2007). Effect of information about animal welfare and product nutritional properties on acceptability of meat from Podolian cattle. *Food Quality and Preference*, *18*(2), 305–312. https://doi.org/10.1016/J.FOODQUAL.2006.02.002

Nehlig, A. (2010). Is Caffeine a Cognitive Enhancer? *Journal of Alzheimer's Disease*, *20*(s1), S85–S94. https://doi.org/10.3233/JAD-2010-091315

Nguyen, Q. C., & Varela, P. (2021). Identifying temporal drivers of liking and satiation based on temporal sensory descriptions and consumer ratings. *Food Quality and Preference*, *89*(August 2020), 104143. https://doi.org/10.1016/j.foodqual.2020.104143

Niimi, J., Danner, L., Li, L., Bossan, H., & Bastian, S. E. P. (2017). Wine consumers' subjective responses to wine mouthfeel and understanding of wine body. *Food Research International*, *99*, 115–122. https://doi.org/10.1016/j.foodres.2017.05.015

Nijman, M., James, S., Dehrmann, F., Smart, K., Ford, R., & Hort, J. (2019). The effect of consumption context on consumer hedonics, emotional response and beer choice. *Food Quality and Preference*, *74*, 59–71. https://doi.org/10.1016/J.FOODQUAL.2019.01.011

Nitschke, J. B., Dixon, G. E., Sarinopoulos, I., Short, S. J., Cohen, J. D., Smith, E. E., Kosslyn, S. M., Rose, R. M., & Davidson, R. J. (2006). Altering expectancy dampens neural response to aversive taste in primary taste cortex. *Nature Neuroscience*, *9*(3), 435–442. https://doi.org/10.1038/nn1645

Non-Alcoholic Beer Market Report | Industry Forecasts 2026. (n.d.). Global Market Insights, Inc. Retrieved 10 November 2021, from https://www.gminsights.com/industry-analysis/non-alcoholic-beer-market

Nutt, D. (2020). *Drink?: The New Science of Alcohol and Your Health*. Hachette UK.

Okamoto, M., & Dan, I. (2013). Extrinsic information influences taste and flavor perception: A review from psychological and neuroimaging perspectives. *Seminars in Cell and Developmental Biology*, *24*(3), 247–255. https://doi.org/10.1016/j.semcdb.2012.11.001

Okamoto, M., Wada, Y., Yamaguchi, Y., Kimur, A., Dan, H., Masuda, T., Singh, A. K., Clowney, L., & Dan, I. (2009). Influences of food-name labels on perceived tastes. *Chemical Senses*, *34*(3), 187–194. https://doi.org/10.1093/chemse/bjn075

Oliveira, D., Ares, G., & Deliza, R. (2018). The effect of health/hedonic claims on consumer hedonic and sensory perception of sugar reduction: Case study with orange/passionfruit nectars. *Food Research International*. https://doi.org/10.1016/j.foodres.2018.03.003

Oliver, G., & Colicchio, T. (2013). The Oxford Companion to Beer. In *The Oxford Companion to Beer*. Oxford University Press. http://www.oxfordreference.com/view/10.1093/acref/9780195367133.001.0001/acref-9780195367133

Olson, J. C., & Dover, P. a. (1978). Cognitive effects of deceptive advertising. *Journal of Marketing Research*, *15*(1), 29. https://doi.org/10.2307/3150398

Olson, J. C., & Jacoby, J. (1972). Cue Utilization in the Quality Perception Process. *ACR Special Volumes*, *SV-02*.

Osorio-Paz, I., Brunauer, R., & Alavez, S. (2019). Beer and its non-alcoholic compounds in health and disease. *Critical Reviews in Food Science and Nutrition*, *0*(0), 1–14. https://doi.org/10.1080/10408398.2019.1696278

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*(June 2018), 66–75. https://doi.org/10.1016/j.foodqual.2018.06.002

Parker, A. R., Penfield, M. P., & Qu. (2005). Labeling of Vanilla Type Affects Consumer Perception of Vanilla Ice Cream. *Sens Nutr Qual Food*, *70*(8), 553–553. https://doi.org/10.1111/j.1365-2621.2005.tb11533.x

Parker, G., Parker, I., & Brotchie, H. (2006). Mood state effects of chocolate. *Journal of Affective Disorders*, *92*(2–3), 149–159. https://doi.org/10.1016/j.jad.2006.02.007

Pavsler, A., & Buiatti, S. (2009). 2—Non-lager Beer. In V. R. Preedy (Ed.), *Beer in Health and Disease Prevention* (pp. 17–30). Academic Press. https://doi.org/10.1016/B978-0-12-373891-2.00002-X

Piqueras-Fiszman, B., & Spence, C. (2012a). The Influence of the Color of the Cup on Consumers' Perception of a Hot Beverage. *Journal of Sensory Studies*, *27*(5), 324–331. https://doi.org/10.1111/j.1745-459X.2012.00397.x

Piqueras-Fiszman, B., & Spence, C. (2012b). The influence of the feel of product packaging on the perception of the oral-somatosensory texture of food. *Food Quality and Preference*, *26*(1), 67–73. https://doi.org/10.1016/j.foodqual.2012.04.002

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 and Preference*, *40*. https://doi.org/10.1016/j.foodqual.2014.09.013

Piqueras-Fiszman, B., Velasco, C., & Spence, C. (2012). Exploring implicit and explicit crossmodal colour-flavour correspondences in product packaging. *Food Quality and Preference*, *25*(2), 148–155. https://doi.org/10.1016/j.foodqual.2012.02.010

Pohorecky, L. A. (1977). Biphasic action of ethanol. *Biobehavioral Reviews*, *1*(4), 231–240. https://doi.org/10.1016/0147-7552(77)90025-0

Prescott, J., & Young, A. (2002). Does information about MSG (monosodium glutamate) content influence consumer ratings of soups with and without added MSG? *Appetite*, *39*(1), 25–33.

Proulx, M. J. (2010). Size Matters: Large Objects Capture Attention in Visual Search. *PLoS ONE*, *5*(12), e15293. https://doi.org/10.1371/journal.pone.0015293

Qualtrics. (2018). https://www.qualtrics.com

Ramsey, I., Ross, C., Ford, R., Fisk, I., Yang, Q., Gomez-Lopez, J., & Hort, J. (2018). Using a combined temporal approach to evaluate the influence of ethanol concentration on liking and sensory attributes of lager beer. *Food Quality and Preference*, *68*, 292–303. https://doi.org/10.1016/j.foodqual.2018.03.019

Rebollar, R., Gil, I., Lidón, I., Martín, J., Fernández, M. J., & Rivera, S. (2017). How material, visual and verbal cues on packaging influence consumer expectations and willingness to buy: The case of crisps (potato chips) in Spain. *Food Research International*. https://doi.org/10.1016/j.foodres.2017.05.024

Recio-Román, A., Recio-Menéndez, M., & Román-González, M. V. (2020). Food reward and food choice. An inquiry through the liking and wanting model. *Nutrients*, *12*(3), 18–24. https://doi.org/10.3390/nu12030639

REGULATION (EU) No 1169/2011. (2011). REGULATION (EU) No 1169/2011 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 October 2011 on the provision of food information to consumers, amending Regulations (EC) No 1924/2006 and (EC) No 1925/2006 of the European Parliament and of the Council, an. *Official Journal of the European Union*, *1169*, 18–63. https://doi.org/2004R0726 - v.7 of 05.06.2013

Rehm, J., Lachenmeier, D. W., Llopis, E. J., Imtiaz, S., & Anderson, P. (2016). Evidence of reducing ethanol content in beverages to reduce harmful use of alcohol. *The Lancet Gastroenterology & Hepatology*, *1*(1), 78–83. https://doi.org/10.1016/S2468-1253(16)30013-9

Reinoso-Carvalho, F., Dakduk, S., Wagemans, J., & Spence, C. (2019a). Dark vs. Light drinks: The influence of visual appearance on the consumer's experience of beer. *Food Quality and Preference*, *74*(June 2018), 21–29. https://doi.org/10.1016/j.foodqual.2019.01.001

Reinoso-Carvalho, F., Dakduk, S., Wagemans, J., & Spence, C. (2019b). Dark vs. Light drinks: The influence of visual appearance on the consumer's experience of beer. *Food Quality and Preference*, *74*, 21–29. https://doi.org/10.1016/J.FOODQUAL.2019.01.001

Reips, R. (2002). Standards for Internet-based experimenting. *Experimental Psychology*, *49*(4), 243–256. https://doi.org/10.1027/1618-3169.49.4.243

Reverdy, C., Schlich, P., Köster, E. P., Ginon, E., & Lange, C. (2010). Effect of sensory education on food preferences in children. *Food Quality and Preference*, *21*(7), 774–780. https://doi.org/10.1016/j.foodqual.2010.07.011

Ritchie, & Rosser. (2019). *Alcohol Consumption—Our World in Data*. https://ourworldindata.org/alcohol-consumption

Robinson, J. A., Sareen, J., Cox, B., & Bolton, J. (2009). Self-medication of anxiety disorders with alcohol and drugs: Results from a nationally representative sample. *Journal of Anxiety Disorders*. https://doi.org/10.1016/j.janxdis.2008.03.013

Roehrs, T., & Roth, T. (2001). Sleep, Sleepiness, and Alcohol Use. *Alcohol Research & Health*, *25*(2), 101–109.

Roque, J., Auvray, M., & Lafraire, J. (2018). Understanding freshness perception from the cognitive mechanisms of flavor: The case of beverages. In *Frontiers in Psychology* (Vol. 8). Frontiers Media S.A. https://doi.org/10.3389/fpsyg.2017.02360

Rudnitskaya, A., Polshin, E., Kirsanov, D., Lammertyn, J., Nicolai, B., Saison, D., Delvaux, F. R., Delvaux, F., & Legin, A. (2009). Instrumental measurement of

beer taste attributes using an electronic tongue. *Analytica Chimica Acta*, *646*(1–2), 111–118. https://doi.org/10.1016/j.aca.2009.05.008

Sailis, R. E., & Buckalew, L. W. (1984). Relation of Capsule Color and Perceived Potency. *Perceptual and Motor Skills*, *58*(3), 897–898. https://doi.org/10.2466/pms.1984.58.3.897

Salanță, L. C., Coldea, T. E., Ignat, M. V., Pop, C. R., Tofană, M., Mudura, E., Borșa, A., Pasqualone, A., Anjos, O., & Zhao, H. (2020). Functionality of special beer processes and potential health benefits. In *Processes* (Vol. 8). https://doi.org/10.3390/pr8121613

Sarinopoulos, I., Dixon, G. E., Short, S. J., Davidson, R. J., & Nitschke, J. B. (2006). Brain mechanisms of expectation associated with insula and amygdala response to aversive taste: Implications for placebo. *Brain, Behavior, and Immunity*, *20*(2), 120–132. https://doi.org/10.1016/j.bbi.2005.11.006

Sayette, M. A. (2017). The effects of alcohol on emotion in social drinkers. *Behaviour Research and Therapy*, *88*, 76. https://doi.org/10.1016/J.BRAT.2016.06.005

Schifferstein, H. N. J. (2006). The perceived importance of sensory modalities in product usage: A study of self-reports. *Acta Psychologica*, *121*(1), 41–64. https://doi.org/10.1016/j.actpsy.2005.06.004

Schifferstein, H. N. J., Kole, A. P. W., & Mojet, J. (1999). Asymmetry in the disconfirmation of expectations for natural yogurt. *Appetite*, *32*(3), 307–329. https://doi.org/10.1006/appe.1998.0208

Schlauch, R. C., Waesche, M. C., Riccardi, C. J., Donohue, K. F., Blagg, C. O., Christensen, R. L., & Lang, A. R. (2010). A meta-analysis of the effectiveness of placebo manipulations in alcohol-challenge studies. *Psychology of Addictive Behaviors*, *24*(2), 239–253. https://doi.org/10.1037/a0017709

Schmelzle, B. A. (2009). The Beer Aroma Wheel. *Brewing Science*, *62*, 26.

Schouteten, J. J., De Steur, H., De Pelsmaeker, S., Lagast, S., De Bourdeaudhuij, I., & Gellynck, X. (2015). Impact of Health Labels on Flavor Perception and Emotional Profiling: A Consumer Study on Cheese. *Nutrients*, *7*(12), Article 12. https://doi.org/10.3390/nu7125533

Schulte, T., Müller-Oehring, E. M., Strasburger, H., Warzel, H., & Sabel, B. A. (2001). Acute effects of alcohol on divided and covert attention in men. *Psychopharmacology*, *154*(1), 61–69. https://doi.org/10.1007/s002130000603

Schweizer, T. A., & Vogel-Sprott, M. (2008). Alcohol-Impaired Speed and Accuracy of Cognitive Functions: A Review of Acute Tolerance and Recovery of

Cognitive Performance. *Experimental and Clinical Psychopharmacology*, *16*(3), 240–250. https://doi.org/10.1037/1064-1297.16.3.240

Seo, Y., Kwak, H. S., Kim, M., Jeong, Y., & Lee, Y. (2015). Effectiveness of palate cleansers on various alcoholic beverages. *Journal of the Institute of Brewing*, *121*(4), 474–480. https://doi.org/10.1002/jib.248

Shams, L., & Beierholm, U. (2022). Bayesian Causal Inference: A Unifying Neuroscience Theory. *Neuroscience & Biobehavioral Reviews*, 104619. https://doi.org/10.1016/j.neubiorev.2022.104619

Shankar, M. U., Levitan, C. A., Prescott, J., & Spence, C. (2009). The influence of color and label information on flavor perception. *Chemosensory Perception*, *2*(2), 53–58. https://doi.org/10.1007/s12078-009-9046-4

Shankar, M. U., Levitan, C. A., & Spence, C. (2010). Grape expectations: The role of cognitive influences in color–flavor interactions. *Consciousness and Cognition*, *19*(1), 380–390. https://doi.org/10.1016/j.concog.2009.08.008

Shepherd, R., Sparks, P., & Raats, M., M. (1991). The effects of information on sensory ratings and preferences: The importance of attitudes—ScienceDirect. *Food Quality and Preference*, *3*(3), 147–155.

Sher, K. J. (1985). Subjective effects of alcohol: The influence of setting and individual differences in alcohol expectancies. *Journal of Studies on Alcohol*, *46*(2), 137–146. https://doi.org/10.15288/jsa.1985.46.137

Shizgal, P. B., & Hyman, S. E. (2014). Homeostasis, Motivation, and Addictive States. In *Principles of Neural Science* (Fifth Edition). McGraw-Hill Education. neurology.mhmedical.com/content.aspx?aid=1101682701

Siegrist, M., & Cousin, M. E. (2009). Expectations influence sensory experience in a wine tasting. *Appetite*, *52*(3), 762–765. https://doi.org/10.1016/j.appet.2009.02.002

Silva, A. R. de A., Bioto, A. S., Efraim, P., & Queiroz, G. de C. (2017). Impact of sustainability labeling in the perception of sensory quality and purchase intention of chocolate consumers. *Journal of Cleaner Production*, *141*, 11–21. https://doi.org/10.1016/j.jclepro.2016.09.024

Silva, Jager, G., Voss, H. P., van Zyl, H., Hogg, T., Pintado, M., & de Graaf, C. (2017). What's in a name? The effect of congruent and incongruent product names on liking and emotions when consuming beer or non-alcoholic beer in a bar. *Food Quality and Preference*, *55*, 58–66. https://doi.org/10.1016/j.foodqual.2016.08.008

Siman-Tov, T., Granot, R. Y., Shany, O., Singer, N., Hendler, T., & Gordon, C. R. (2019). Is there a prediction network? Meta-analytic evidence for a cortical-subcortical network likely subserving prediction. *Neuroscience and Biobehavioral Reviews*, *105*(January), 262–275. https://doi.org/10.1016/j.neubiorev.2019.08.012

Singh, S. (2006). Impact of color on marketing. *Management Decision*, *44*(6), 783–789. https://doi.org/10.1108/00251740610673332

Skaczkowski, G., Durkin, S., Kashima, Y., & Wakefield, M. (2016). The effect of packaging, branding and labeling on the experience of unhealthy food and drink: A review. In *Appetite* (Vol. 99). https://doi.org/10.1016/j.appet.2016.01.022

Smeets, P. A. M., & de Graaf, C. (2019). Brain responses to anticipation and consumption of beer with and without alcohol. *Chemical Senses*, *8*(1), 51–60. https://doi.org/10.1093/chemse/bjy071

Sohrabvandi, S., Mousavi, S. M., Razavi, S. H., Mortazavian, A. M., & Rezaei, K. (2010). Alcohol-free beer: Methods of production, sensorial defects, and healthful effects. *Food Reviews International*, *26*(4), 335–352. https://doi.org/10.1080/87559129.2010.496022

Sousa, M. M. M. de, Carvalho, F. M., & Pereira, R. G. F. A. (2020). Colour and shape of design elements of the packaging labels influence consumer expectations and hedonic judgments of specialty coffee. *Food Quality and Preference*, *83*(February), 103902. https://doi.org/10.1016/j.foodqual.2020.103902

Spearot, J. W. (2016). *Influence of Beer Color on Perception of Bitterness*. *March*, 104.

Spence, C. (2015a). Perspective Multisensory Flavor Perception. *Cell*, *161*(1), 24–35. https://doi.org/10.1016/j.cell.2015.03.007

Spence, C. (2015b). On the psychological impact of food colour. *Flavour*, *4*(1), 21. https://doi.org/10.1186/s13411-015-0031-3

Spence, C. (2016). Multisensory Packaging Design: Color, Shape, Texture, Sound, and Smell. In *Integrating the Packaging and Product Experience in Food and Beverages: A Road-Map to Consumer Satisfaction* (pp. 1–22). https://doi.org/10.1016/B978-0-08-100356-5.00001-2

Spence, C. (2019). On the changing colour of food & drink. *International Journal of Gastronomy and Food Science*, *17*, 100161. https://doi.org/10.1016/J.IJGFS.2019.100161

Spence, C., Levitan, C. A., Shankar, M. U., & Zampini, M. (2010). Does food color influence taste and flavor perception in humans? In *Chemosensory Perception* (Vol. 3). Springer-Verlag. https://doi.org/10.1007/s12078-010-9067-z

Spence, C., & Piqueras-Fiszman, B. (2016). Food Color and Its Impact on Taste/Flavor Perception. In *Multisensory Flavor Perception: From Fundamental Neuroscience Through to the Marketplace*. Woodhead Publishing. https://doi.org/10.1016/B978-0-08-100350-3.00006-7

Spence, C., Smith, B., & Auvray, M. (2014). Confusing taste and flavours. In D. Stokes, M. Matthen, & S. Biggs (Eds.), *Perception and Its Modalities* (p. 512). oxford university press.

Spence, C., & Wan, X. (2015). Beverage perception and consumption: The influence of the container on the perception of the contents. *Food Quality and Preference*, *39*, 131–140. https://doi.org/10.1016/j.foodqual.2014.07.007

Spence, C., Wan, X., Woods, A. T., Velasco, C., Deng, J., Youssef, J., & Deroy, O. (2015). On tasty colours and colourful tastes? Assessing, explaining, and utilizing crossmodal correspondences between colours and basic tastes. *Flavour*, *4*(1), 23. https://doi.org/10.1186/s13411-015-0033-1

Stevenson, R. J., Prescott, J., & Boakes, R. A. (1999). Confusing Tastes and Smells: How Odours can Influence the Perception of Sweet and Sour Tastes. *Chemical Senses*, *24*(6), 627–635. https://doi.org/10.1093/chemse/24.6.627

Stolzenbach, S., Bredie, W. L. P., Christensen, R. H. B., & Byrne, D. V. (2013). Impact of product information and repeated exposure on consumer liking, sensory perception and concept associations of local apple juice. *Food Research International*, *52*(1), 91–98. https://doi.org/10.1016/j.foodres.2013.02.018

Sugrue, M., & Dando, R. (2018). Cross-modal influence of colour from product and packaging alters perceived flavour of cider. *Journal of the Institute of Brewing*, *124*(August 2017), 254–260. https://doi.org/10.1002/jib.489

Testa, M., Fillmore, M. T., Norris, J., Abbey, A., Curtin, J. J., Leonard, K. E., Mariano, K. A., Thomas, M. C., Nomensen, K. J., George, W. H., VanZile-Tamsen, C., Livingston, J. A., Saenz, C., Buck, P. O., Zawacki, T., Parkhill, M. R., Jacques, A. J., & Hayman, L. W. (2006). Understanding alcohol expectancy effects: Revisiting the placebo condition. *Alcoholism: Clinical and Experimental Research*, *30*(2), 339–348. https://doi.org/10.1111/j.1530-0277.2006.00039.x

Thong, N. T., Thanh, B. Q., Solgaard, H. S., & Yang, Y. (2018). The role of packaging format, alcohol level and brand in consumer's choice of beer: A best-worst

scaling multi-profile approach. *Food Quality and Preference*, *65*, 92–100. https://doi.org/10.1016/j.foodqual.2017.11.005

Thorelli, H. B., Lim, J. S., & Ye, J. (1989). Relative Importance of Country of Origin, Warranty and Retail Store Image on Product Evaluations. *International Marketing Review*, *6*(1). https://doi.org/10.1108/EUM0000000001501

Tijssen, I. O. J. M., Zandstra, E. H., den Boer, A., & Jager, G. (2019). Taste matters most: Effects of package design on the dynamics of implicit and explicit product evaluations over repeated in-home consumption. *Food Quality and Preference*, *72*, 126–135. https://doi.org/10.1016/J.FOODQUAL.2018.09.009

Törrönen, J., Roumeliotis, F., Samuelsson, E., Kraus, L., & Room, R. (2019). Why are young people drinking less than earlier? Identifying and specifying social mechanisms with a pragmatist approach. *International Journal of Drug Policy*, *64*, 13–20. https://doi.org/10.1016/j.drugpo.2018.12.001

Tsiotsou, R. (2006). The role of perceived product quality and overall satisfaction on purchase intentions. *International Journal of Consumer Studies*, *30*(2), 207–217. https://doi.org/10.1111/j.1470-6431.2005.00477.x

Tuorila, H., Meiselman, H. L., Bell, R., Cardello, A. V., & Johnson, W. (1994). Role of Sensory and Cognitive Information in the Enhancement of Certainty and

Linking for Novel and Familiar Foods. *Appetite*, *23*(3), 231–246. https://doi.org/10.1006/appe.1994.1056

Tzambazis, K., & Stough, C. (2000). ALCOHOL IMPAIRS SPEED OF INFORMATION PROCESSING AND SIMPLE AND CHOICE REACTION TIME AND DIFFERENTIALLY IMPAIRS HIGHER-ORDER COGNITIVE ABILITIES. In *Alcohol & Alcoholism* (No. 2; Vol. 35, pp. 197–201). https://academic.oup.com/alcalc/article-abstract/35/2/197/152694

Unger, R. W. (2004). Types of Beer and Their International Exchange. In *Beer in the Middle Ages and the Renaissance* (pp. 184–194). University of Pennsylvania Press. http://www.jstor.org/stable/j.ctt3fj2zx.17

van der Stelt, A. J., Mehring, P., Corbier, C., van Eijnatten, E. J. M., & Withers, C. (2019). A "Mouthfeel wheel" terminology for communicating the mouthfeel attributes of medical nutrition products (MNP). *Food Quality and Preference*, *80*(October 2019), 103822. https://doi.org/10.1016/j.foodqual.2019.103822

van Dijken, J. H., Veldstra, J. L., van de Loo, A. J. A. E., Verster, J. C., van der Sluiszen, N. N. J. J. M., Vermeeren, A., Ramaekers, J. G., Brookhuis, K. A., & de Waard, D. (2020). The influence of alcohol (0.5‰) on the control and manoeuvring level of driving behaviour, finding measures to assess driving impairment: A

simulator study. *Transportation Research Part F: Traffic Psychology and Behaviour*, *73*, 119–127. https://doi.org/10.1016/j.trf.2020.06.017

Van Doorn, G., Timora, J., Watson, S., Moore, C., & Spence, C. (2019). The visual appearance of beer: A review concerning visually-determined expectations and their consequences for perception. *Food Research International*, *126*, 108661. https://doi.org/10.1016/j.foodres.2019.108661

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. https://doi.org/10.1016/j.foodqual.2016.10.013

Varela, P., Ares, G., Giménez, A., & Gámbaro, A. (2010). Influence of brand information on consumers' expectations and liking of powdered drinks in central location tests. *Food Quality and Preference*, *21*(7), 873–880. https://doi.org/10.1016/J.FOODQUAL.2010.05.012

Vecchio, R., & Cavallo, C. (2019). Increasing healthy food choices through nudges: A systematic review. *Food Quality and Preference*, *78*(June 2018), 103714. https://doi.org/10.1016/j.foodqual.2019.05.014

Velasco, C., Hyndman, S., & Spence, C. (2018). The role of typeface curvilinearity on taste expectations and perception. *International Journal of Gastronomy and Food Science*, *11*, 63–74. https://doi.org/10.1016/j.ijgfs.2017.11.007

Velasco, C., Salgado-Montejo, A., Marmolejo-Ramos, F., & Spence, C. (2014). Predictive packaging design: Tasting shapes, typefaces, names, and sounds. *Food Quality and Preference*, *34*, 88–95. https://doi.org/10.1016/J.FOODQUAL.2013.12.005

Velasco, C., Wan, X., Salgado-Montejo, A., Woods, A., Oñate, G. A., Mu, B., & Spence, C. (2014). The context of colour-flavour associations in crisps packaging: A cross-cultural study comparing Chinese, Colombian, and British consumers. *Food Quality and Preference*, *38*. https://doi.org/10.1016/j.foodqual.2014.05.011

Velasco, C., Woods, A. T., Hyndman, S., & Spence, C. (2015). The taste of typeface. *I-Perception*, *6*(4), 1–10. https://doi.org/10.1177/2041669515593040

Velasco, C., Woods, A. T., Petit, O., Cheok, A. D., & Spence, C. (2016). Crossmodal correspondences between taste and shape, and their implications for product packaging: A review. *Food Quality and Preference*, *52*. https://doi.org/10.1016/j.foodqual.2016.03.005

Vuorre, M., & Bolger, N. (2018). Within-subject mediation analysis for experimental data in cognitive psychology and neuroscience. *Behavior Research Methods*, *50*(5), 2125–2143. https://doi.org/10.3758/s13428-017-0980-9

Wang, Q. J., Mielby, L. A., Thybo, A. K., Bertelsen, A. S., Kidmose, U., Spence, C., & Byrne, D. V. (2019). Sweeter together? Assessing the combined influence of product-related and contextual factors on perceived sweetness of fruit beverages. *Journal of Sensory Studies*, e12492. https://doi.org/10.1111/joss.12492

Wansink, B. (2000). How soy labeling influences preference and taste. *The International Food and Agribusiness Management Review*, *3*(1), 85–94. https://doi.org/10.1016/S1096-7508(00)00031-8

Wegman, J., van Loon, I., Smeets, P. A. M., Cools, R., & Aarts, E. (2018). Top-down expectation effects of food labels on motivation. *NeuroImage*, *173*, 13–24. https://doi.org/10.1016/j.neuroimage.2018.02.011

WHO. (2005). *Global strategy to reduce the harmful use of alcohol*.

Wigmore, S. W., & Hinson, R. E. (1991). The influence of setting on consumption in the balanced placebo design. *Addiction*, *86*(2), 205–215. https://doi.org/10.1111/j.1360-0443.1991.tb01770.x

Woods, A. T., Lloyd, D. M., Kuenzel, J., Poliakoff, E., Dijksterhuis, G. B., & Thomas, A. (2011). Expected taste intensity affects response to sweet drinks in primary taste cortex. *NeuroReport*, *22*(8), 365–369. https://doi.org/10.1097/WNR.0b013e3283469581

Woods, A. T., Poliakoff, E., Lloyd, D. M., Dijksterhuis, G. B., & Thomas, A. (2010). Flavor expectation: The effect of assuming homogeneity on drink perception. *Chemosensory Perception*, *3*(3–4), 174–181. https://doi.org/10.1007/s12078-010-9080-2

Wunderlich, S., & Back, W. (2009). Overview of Manufacturing Beer: Ingredients, Processes, and Quality Criteria. In *Beer in Health and Disease Prevention* (pp. 3–16). Elsevier. https://doi.org/10.1016/B978-0-12-373891-2.00001-8

Yeomans, M. R., & Chambers, L. (2011). Satiety-relevant sensory qualities enhance the satiating effects of mixed carbohydrate-protein preloads. *The American Journal of Clinical Nutrition*, *94*(6), 1410–1417. https://doi.org/10.3945/ajcn.111.011650

Yeomans, M. R., Chambers, L., Blumenthal, H., & Blake, A. (2008). The role of expectancy in sensory and hedonic evaluation: The case of smoked salmon ice-cream. *Food Quality and Preference*, *19*(6), 565–573. https://doi.org/10.1016/j.foodqual.2008.02.009

Yeomans, M. R., Lartamo, S., Procter, E. L., Lee, M. D., & Gray, R. W. (2001). The actual, but not labelled, fat content of a soup preload alters short-term appetite in healthy men. *Physiology and Behavior*, *73*(4), 533–540. https://doi.org/10.1016/S0031-9384(01)00502-9

Yeomans, M. R., Mobini, S., Elliman, T. D., Walker, H. C., & Stevenson, R. J. (2006). Hedonic and sensory characteristics of odors conditioned by pairing with tastants in humans. *Journal of Experimental Psychology. Animal Behavior Processes*, *32*(3), 215–228. https://doi.org/10.1037/0097-7403.32.3.215

Yeomans, M. R., Ripley, T., Davies, L. H., Rusted, J., & Rogers, P. J. (2002). Effects of caffeine on performance and mood depend on the level of caffeine abstinence. *Psychopharmacology*, *164*(3), 241–249. https://doi.org/10.1007/s00213-002-1204-1

Yon, D., de Lange, F. P., & Press, C. (2019). The Predictive Brain as a Stubborn Scientist. *Trends in Cognitive Sciences*, *23*(1), 6–8. https://doi.org/10.1016/j.tics.2018.10.003

Zellner, D. A., & Durlach, P. (2003). Effect of color on expected and experienced refreshment, intensity, and liking of beverages. *American Journal of Psychology*, *116*(4), 633–647. https://doi.org/10.2307/1423663

Zellner, D. A., Strickhouser, D., Tornow, C. E., The, S., Journal, A., & Autumn, N. (2004). Disconfirmed Hedonic Expectations Produce Perceptual Contrast, Not Assimilation. *The American Journal of Psychology*, *117*(3), 363. https://doi.org/10.2307/4149006&ISSUEID=10.2307