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"I guess it's quite trendy": A qualitative insight into young meat-eaters' sustainable food consumption habits and perceptions towards current and future protein alternatives

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ABSTRACT

As the market for sustainable food continues to expand, there is a need to understand how consumers' consumption habits and perceptions are changing. Targeting the younger populations is of interest as they arguably will shape the future of food. Therefore, the present study aimed to provide in-depth consumer insights on a range of topics from current consumption habits (i.e., meat reduction, plant-based meat/seafood (PBM/S)), towards future protein alternatives (i.e., cell-based meat/seafood (CBM/S), precision fermented dairy (PFD)). Online focus groups were conducted in the UK with meat-eaters (n = 38) aged 18–34. Codebook thematic analysis was applied using the Framework Matrix as a tool for data analysis. Key themes were presented using the COM-B model (Capability, Opportunity, Motivation), which identified areas of behavioural change. Results found a trend towards meat reduction, partially initiated by moving away from home and limited food budgets. Overall, participants acknowledged the environmental impact of food, but a notable knowledge gap was apparent when quantifying the effect, especially for dairy and seafood. Compared to PBM, few participants had tried PBS products, partially due to lower availability and familiarity. Enablers for PBM/S included convenience, positive sensory experiences and the influence of others, whilst barriers related to negative health connotations and over-processing. For CBM/S and PFD, animal welfare, curiosity and optimised nutrition acted as enablers, whilst barriers related to wider consumer acceptance, affordability and unnaturalness. In general, participants felt changing food consumption habits can have an impact on climate change and were optimistic about novel technologies supporting future protein transitions. Increasing public understanding around the environmental impact of food, especially seafood and dairy, and prioritising the affordability of sustainable food are suggested as intervention strategies to encourage sustainable food consumption.

1. Introduction

Food production and consumption causes detrimental environmental impacts to our ecosystems which include, amongst other factors, greenhouse gas emissions (GHG), biodiversity loss, high land and water use and polluted oceans (Barange et al., 2018; Poore & Nemecek, 2018; Willett et al., 2019). In response, consumers are encouraged to follow more sustainable food consumption habits which reflect a low consumption of animal sourced foods, a high intake of plant-based and whole foods, whilst consuming fish from sustainable sources (IPCC, 2022; Poore & Nemecek, 2018; Willett et al., 2019).

For the UK population, a 20% reduction in beef, lamb and dairy by 2030 is recommended (Committee on Climate Change, 2020). Despite being a country reliant on animal-derived products, recent surveys provide promising results, in that >60% of UK adults are willing to reduce meat (Eating Better, 2022; Ford et al., 2023). Research has also found UK participants are able to define sustainable eating and are willing to change towards more sustainable food consumption habits (Whittall et al., 2023). Yet, trends in UK meat consumption have found reductions to be modest (Stewart et al., 2021), which suggests an 'attitude behaviour gap'. Therefore, more research needs to be done to understand the underlying behaviours to accelerate changes.

Understanding the barriers and enablers surrounding meat reduction provides valuable insights for behavioural intervention strategies

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aiming to promote more plant-based diets (Graça et al., 2019). Qualitative studies amongst UK participants have reviewed a range of topics related to sustainable consumption habits, some of which include; the environmental impact of food and willingness to reduce meat (Macdiarmid et al., 2016), potential changes to food-related practices (O'Keefe et al., 2016), meat reduction in everyday life (Mylan, 2018), nudging strategies to reduce meat consumption (McBey et al., 2019), and consumer understanding of sustainable diets (Whittall et al., 2023). Alongside, quantitative studies with UK consumers, findings have found key motives in meat reduction to relate to; animal welfare, cost savings and personal health/wellbeing (Clonan et al., 2015; Eating Eating Better, 2022; Mylan, 2018; Whittall et al., 2023). Whilst barriers include the pleasure gained from eating meat, a lack of awareness of the link between meat and climate change and social influences (Macdiarmid et al., 2016; Mylan, 2018; O'Keefe et al., 2016; Whittall et al., 2023).

Although the aforementioned studies allow for a greater understanding of sustainable consumption, it is important to provide updated insights, especially following the Covid-19 pandemic which may have created a shift towards more sustainable food habits at home (Filimonau et al., 2021; Pluck & Morrison-Saunders, 2022; Williams et al., 2023). To extend findings it's also important to understand perceptions towards current protein alternatives such as plant-based meat (PBM) and plant-based seafood (PBS) products, as well as future protein alternatives such as cell-based meat (CBM), cell-based seafood (CBS) products and precision fermented dairy (PFD) (also known as animal free dairy).

1.1. Plant-based meat and seafood

Plant-based products are predominantly made using a variety of ingredients (e.g., soy, wheat, pea protein, fungi, beans and lentils) and have grown in popularity, with the UK having the second highest plant-based food sales in Europe (GFI, 2023). Products often imitate the role of meat and seafood in the diet and provide viable opportunities for consumers to transition towards a reduced meat and seafood diet (Hoek et al., 2011; Nowacka et al., 2023). Many reviews have assessed consumer acceptance towards PBM products (Andreani et al., 2023; Onwezen et al., 2021; Weinrich, 2019), but there is little evidence regarding consumer perceptions towards PBS (Kim et al., 2023). Current research suggests concerns around PBS, relate to the taste and texture (GFI & Kelton Global, 2021). Whilst familiarity with PBS, ingredient information, price and consumer age are important factors determining willingness to pay (Kim et al., 2023). In relation to PBM, consumers in the UK are thought to perceive them as being healthier but lacking in sensory appeal compared to conventional meat (Hoek et al., 2011; Vural et al., 2023). Indeed, previous research suggests sensory appeal could be both a motive and a barrier for consumer acceptance (Onwezen et al., 2021; Weinrich, 2019). Therefore, one solution to this sensory dilemma, comes from the development of cellular agriculture/aquaculture technologies, which produce animal/seafood proteins through fermentation, in theory, enabling a closer replication of the sensory properties (Waschulin & Specht., 2018).

1.2. Cell-based meat and seafood

Cellular agriculture/aquaculture, is thought to have the potential to alleviate environmental degradation, improve animal/fish welfare, and provide health benefits (Halpern et al., 2021; McClements et al., 2021; Mendly-Zambo et al., 2021; Nobre, 2022; Saget et al., 2021). In its simplest form, the process for making CBM starts by harvesting stem cells from a living animal, inoculating the cells in a suitable nutrient dense media and transferring to a bioreactor to allow for cell proliferation (i.e., expansion and differentiation of cells) (Post, 2012). A similar process is used to make CBS, with muscle strands extracted from fish, molluscs or crustaceans (Halpern et al., 2021). Whilst for PFD, the desired protein (e.g., whey and casein) are extracted and inserted into the DNA of the host organism (e.g., yeast) before being transferred to a bioreactor (Waschulin & Specht., 2018).

There is a growing body of research exploring consumer acceptance towards CBM (Bryant & Barnett, 2020; Pakseresht et al., 2022), including comparisons with plant-based products (Hartmann & Siegrist, 2017; Onwezen et al., 2021). Research with UK consumers found prevalent motives for CBM to be associated with curiosity, environmental friendliness, and reassurance in relation to the health benefits and sensory appeal compared to conventional meat (Circus & Robison, 2019; Verbeke et al., 2015), whist barriers relate to it being perceived as 'unnatural', evoked disgust, and fear of long-term health effects (Circus & Robison, 2019; Verbeke et al., 2015). Negative perceptions of CBM are also found to be greater in omnivores who have high levels of food technology neophobia (Krings et al., 2022).

In contrast, research reviewing consumer acceptance towards CBS is currently under reported but is likely to align with CBM findings given the similar production processes. Current literature has focused on the influence of nomenclature with 'cell-based' often perceived more positively compared to other names (Hallman, 2020, 2021; Malerich & Bryant, 2022). A recent study reviewing a range of novel food technologies, found both CBM and CBS to have low consumer acceptance, especially amongst American and Australian consumers (Giacalone & Jaeger, 2023). However, cross-cultural differences in dietary habits are likely to influence willingness to accept novel food technologies like CBM, as research has found higher meat-eating countries like Australia, to be less accepting compared to the UK (Ford et al., 2023).

1.3. Precision fermented dairy

Another notable gap in research relates to understanding consumer acceptance towards PFD products. This is surprising considering products are currently available to purchase in the United States and Singapore with a high likelihood of reaching wider markets due to technological advancements, and simpler production processes compared to CBM (Mendly-Zambo et al., 2021). To date, current research has found 28% of consumers in the UK to be willing to try PFD (labelled as 'synthetic milk' in the survey), with 50% concerned about what it would contain (Perkins, 2018). Considering this survey was over five years ago, consumers' views and perceptions could be rapidly evolving. For example, a more recent survey found 67.6% of UK consumers to be willing to try cheese made using this method (Zollman Thomas & Bryant, 2021). To some extent, consumer acceptance is dependent on high taste expectations and a need for it to be sensorily better or comparable to conventional dairy products (Perkins, 2018; Powell et al., 2023; Zollman Thomas & Bryant, 2021). Additional motives for trying PFD are thought to relate to potential animal welfare and environmental benefits (Powell et al., 2023). Whilst barriers are associated with concerns over safety, naturalness and its contribution to health and climate change (Broad et al., 2022). Interestingly, PFD was found to be more appealing to non-vegan consumers under the age of 35 (Powell et al., 2023). Therefore, the target consumers could potentially be younger generations who incorporate dairy into their diet.

1.4. Focus groups and the COM-B model

Understanding consumer perceptions towards novel alternatives requires a conducive environment, as many consumers may be unfamiliar with the concept of products made through novel technologies such as cellular agriculture/aquaculture. Focus Groups (FG) provide an efficient qualitative consumer research method allowing participants to openly discuss their opinions, attitudes and habits in detail whilst allowing for debates. It is also thought consumers of a similar age are likely to feel more comfortable sharing opinions given the comparable life reference points (Grønkjær et al., 2011).

Increasingly, a range of qualitative studies have applied focus groups to review sustainable food behaviours (Collier et al., 2021; Kemper, 2020; Macdiarmid et al., 2016; Markowski & Roxburgh., 2019; McBey

et al., 2019; O'Keefe et al., 2016; Tucker, 2018; Varela et al., 2022), perceptions towards PBM/S (Collier et al., 2022; Elzerman et al., 2013; Kerslake et al., 2022; Weinrich, 2018), CBM (Shaw & Mac Con Iomaire, 2019; van der Weele & Driessen, 2019; Verbeke et al., 2015) and PFD (Broad et al., 2022). FG's are therefore a valuable research tool in which to gain deeper qualitative insights towards sustainable consumption which is currently under-represented compared to quantitative methods (Graça et al., 2019; Onwezen et al., 2021).

Identifying coherent behavioural change strategies is difficult as findings regarding sustainable food consumption habits and the acceptance of alternatives remain disjointed. To assist in providing structure to findings, the COM-B framework, a theoretical behavioural model that covers three key components: Capability (e.g., knowledge, cooking skills, planning ability), Opportunity (e.g., social norms, environmental influences, availability of resources), Motivation (e.g., conscious decisions, desires and habits) can be utilised. The model allows for interactions between the three essential components which are thought to form the core of a 'behaviour system' as part of a 'behaviour change wheel' (BCW) (Michie et al., 2011). The BCW is based on the synthesis of 19 frameworks of behaviour which demonstrates its high heuristic value. The BCW includes nine intervention functions (e.g., Education, Incentivisation, Restrictions) that can be targeted dependent on the COM-B analysis output (Michie, 2014). In general, it is thought that a behaviour will occur in an individual if they have the capability and opportunity to engage in the behaviour, and they feel motivated to prioritise that behaviour above others in a given time (West & Michie, 2020). Further classification breaks down each component into two types (e.g., physical, psychological), as detailed in Fig. 1. It should be noted that capability and opportunity are both thought to influence the relationship between behaviour and motivation. By reviewing the interactions and exploring the barriers and enablers within each domain, behavioural change strategies can be identified and implemented (Michie, 2014; Michie et al., 2011; West & Michie, 2020). Currently, the model is increasingly being recommended and used as a tool to inform behavioural change strategies in relation to food and sustainability (Bryant et al., 2023; Graça et al., 2019; Graça et al., 2023; Hyland et al., 2022; Jiang & Farag, 2023; Nguyen et al., 2022; Onwezen, 2022; Ran et al., 2022; Trewern et al., 2022; van den Berg et al., 2022; Veiga et al., 2023).

1.5. Study aims and outcomes

In recent years, there has been an explosion of research conducted around the general topics of sustainable consumption, transitioning towards more plant-based diets and acceptance of protein alternatives, some of which are summarised in recent literature reviews (Biasini et al., 2021; Dagevos, 2021; Graça et al., 2019; Harguess et al., 2020; Hartmann & Siegrist, 2017; Hoek et al., 2021; Kwasny et al., 2022; Onwezen et al., 2021; Onwezen, 2022; Stoll-Kleemann & Schmidt, 2017; van Bussel et al., 2022; (van der Weele & Driessen, 2019).

In general, it is suggested that young consumers are more accepting of PBM/S, CBM/S and PFD (Bryant & Barnett, 2020; Bryant & Sanctorum, 2021; Ford et al., 2023; Giacalone & Jaeger, 2023; Powell et al., 2023; Siegrist & Hartmann, 2019; Szejda et al., 2021; Zollman Thomas & Bryant, 2021; Wilks et al., 2019). In addition, research analysing trends in UK consumption found Millennials[1] to be amongst the highest consumers of both meat and plant-based products, whilst Generation Z[2] reportedly increased meat intake over time (Alae-Carew et al., 2022; Stewart et al., 2021). Considering these trends in food consumption habits and the high acceptance towards alternatives, this demographic is a particularly interesting and important one to understand.

[1] Millennials, also known as Generation Y, is the demographic cohort born between 1981 and 1996.

[2] Generation Z is the demographic cohort born between 1997 and 2012.

Studies which have incorporated young adults include quantitative surveys exploring; meat consumption and reduction (Choi & Lee., 2023; de Boer et al., 2017), attitudes and knowledge towards plant-based diets (Faber et al., 2020) and acceptance of CBM (Bogueva & Marinova, 2020). Whilst qualitative findings with young adults have reviewed lived experiences of flexitarianism (Kemper & White, 2021), transitions towards plant-based and vegan diets (Von Essen, 2021; Williams et al., 2023), and motives, barriers and strategies towards meat reduction (Kemper, 2020; McBey et al., 2019). With the exception of two studies (McBey et al., 2019; Williams et al., 2023), findings are in relation to consumers from outside of the UK, where differences in cultural backgrounds and dietary habits may influence outcomes (Faber et al., 2020). Furthermore, the focus is often on one topic, which does not always comprehend the holistic nature of diets. Additionally, a review by Onwezen et al. (2021) highlighted a need for future research to compare across multiple alternative proteins, especially plant-based products and CBM. Consequently, there is a need to extend findings to explore the enablers and barriers towards a range of topics from current consumption habits (i.e., meat reduction, substitution with PBM/S products), towards potential future consumption habits (i.e., inclusion of CBM/S and PFD products). To assist in the organisation of a broad range of topics the COM-B model will be applied.

In summary, this study aimed to firstly identify any changes young meat-eaters are making to consumption habits and perceptions towards sustainable foods. Findings will provide added insights to current literature amongst UK consumers on similar topics (Bryant et al., 2023; Macdiarmid et al., 2016; McBey et al., 2019; Trewern et al., 2022; Whittall et al., 2023). Furthermore, it will provide results from a meat-eater perspective which was not explicitly stated in previous research (McBey et al., 2019; Trewern et al., 2022; Whittall et al., 2023). Secondly, this study will extend findings by comparing the barriers and enablers to a range of protein alternatives (PBM/S, CBM/S, PFD), some of which are comparably under-explored (e.g., PBS, CBS and PFD). Considering young consumers to some extent shape the future of food, we expect findings to provide insights for product developers when marketing and launching new products.

2. Materials and methods

The study was approved by the University of Nottingham's Faculty of Medicine and Health Sciences Ethics Committee (UK Ref. number:354–0921). Participants were asked to acknowledge a series of statements and give their consent to take part in this research before completing the FG screening questionnaire which checked eligibility. Upon completion of the FG session, participants were given a small shopping voucher.

2.1. Participants and recruitment

Participants were recruited through poster advertisements on social media platforms (Twitter, LinkedIn) as well as via email chains across the University of Nottingham. The recruitment information outlined the eligibility requirements which included: Aged between 18 and 34, consumer of meat, fish and dairy, and being computer literate with access to a camera and microphone. Interested participants voluntarily filled out a screening questionnaire administered through Jisc online surveys (JISC®, 2022). The first part of the screener captured general socio-demographic data (age, gender, ethnicity, education, urban/rural living, income). Next, to ensure meat, fish and dairy consumers were selected, participants self-identified their dietary preference (omnivore, flexitarian, vegan, vegetarian, pescatarian) and were given definitions for each dietary category to avoid misinterpretation. Consumption frequencies were captured for beef, lamb, chicken, pork, meat from other animals, fish/seafood, dairy, and meat substitutes using the following categories; 'Do not consume', 'Less than once per month', '1–3 times per month', 'Once per week', '2–3 times per week', '4–6 times per week',

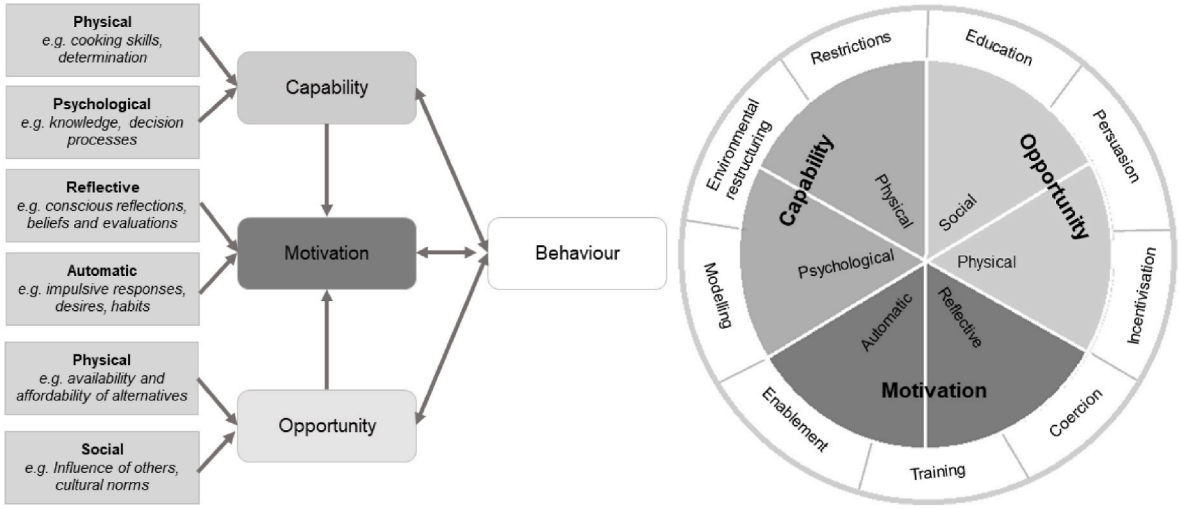

Fig. 1. The Capability, Opportunity, Motivation and Behaviour (COM-B) framework and Behavioural Change Wheel (BCW). The inner wheel represents the sources of behaviour, and the outer wheel represents the intervention functions. Reproduced from (Michie et al., 2011).

'Everyday'. As the level of meat consumed can influence food choice motives and mindsets (de Boer et al., 2017; Lentz et al., 2018), participants were grouped into High (H), Standard (STD) and Low (L) meat-eater categories.[3] This enabled a balanced representation of consumption rates within each group.

Subjective knowledge was also captured to gauge how informed consumers are on the topic of sustainable foods. Five statements adapted from a validated scale (Flynn & Goldsmith, 1999) measured responses with the anchors 'strongly disagree (1)' to 'strongly agree (7)'. Where possible, participants were grouped based on similar knowledge levels to help them feel at ease when discussing topics related to sustainability.

In total, eight online FGs were conducted (n = 38) using the video-call platform Microsoft Teams lasting approximately 90–120 min, with the same moderator throughout to ensure consistency. Eight FGs ensured both code and meaning saturation had been achieved (Braun & Clarke, 2021; Hennink et al., 2019). The number of participants within each FG ranged from four to five with a balance of ages and meat consumption habits. The demographic composition and responses of FG participants to the screening questionnaire can be found in Table 1.

Following the FG session, participants completed a short follow-up questionnaire consisting of thirteen statements related to the Food Technology Neophobia Scale (Cox & Evans, 2008). Responses were captured with the anchors 'strongly disagree (1)' to 'strongly agree (7)'. In general, participants overall disagreed that new food technologies were unnecessary (M = 3.55, SD ± 1.08) but also disagreed that they were a healthy choice (M = 2.66, SD ± 1.01). Largely participants agreed that the media provides a balanced and unbiased view of new food technologies (M = 5.34, SD ± 1.68) but gave on average neutral scores for perception of risk (M = 4.20, SD ± 1.01) (Table 1).

2.2. Focus group design

The FG sessions were designed to understand the responses and behaviours of the participants, as well as to encourage further group discussions and debates. Two initial FG pilot sessions (n = 7) helped refine the topics and maximise discussions. A range of open-ended questions were constructed to explore five key topics as outlined in the FG discussion guide (Supplementary material, Table S1).These were; 1) Sustainable consumption habits, 2) Awareness of the environmental impact of food, 3) Consumer experiences and perceptions of PBM/S,[4] 4) Consumer perceptions of CBM/S, 5) Consumer perceptions of PFD. The range of topics were accompanied by PowerPoint slides containing images and definitions to support interpretation. The chat box function was also utilised throughout to reference questions and obtain quick one-word responses and maintain engagement. Microsoft Forms were used to create interactive poll questions which were integrated within the Microsoft Teams meetings and allowed for full traceability of the author and respondents. The results of the poll questions are shown in Table 2. All FG sessions were video-recorded and accompanied by notes taken by the moderator during the call.

2.3. Data analysis

The FG video recordings were imported into the Qualitative data analysis software NVivo 12 for Windows (Burlington, USA) where they were transcribed verbatim. Personal identifiers were removed to ensure participant confidentiality. Codebook Thematic Analysis (TA) using the Framework approach was applied to explore the transcribed data following a mixed inductive-deductive approach. Initially, inductive reasoning was applied, meaning the codes were data-driven (Thomas, 2006). Only when the final themes were determined was the coded data subsequently applied following a deductive approach to the appropriate barriers and enablers within each COM-B domain. Initial coding was conducted by one of the authors (HF) and cross-checked with another author (QY). Themes were further identified and discussed by all authors to ensure credibility, with ongoing analysis deliberated in regular meetings to ensure inter-coder reliability was kept consistent over time. This qualitative content analysis method allowed for a comprehensive review of consumers original narratives in an efficient and structured way, whilst allowing for transparency and rigour (Gale et al., 2013). The five phases outlined by Braun and Clarke (2022), were used as guidance

[3] Meat-eater categories are based on the sum of the five meat consumption frequencies (beef, lamb, chicken, pork, other meat). Quartile analysis identified three cut-off points (25th, 50th, 75th) to allow for total meat consumption to be split into low (<25th), standard (25th – 75th) and high meat-eaters (>75th).

[4] Plant-based products were defined as any products which imitate the role of meat/seafood. Examples of plant-based products were shown to participants via a power point slide and the moderator followed a script which read: *"plant-based products most commonly contain a variety of; soy, wheat, and pea protein while others are based on mushrooms, beans or even tofu. Alternatively, you have Quorn products which are made from mycoprotein, a form of fungi. These products come in a wide array of formats from ingredients to cook with like mincemeat, ready-to-eat products like the turkey slices and tuna flakes or ready meals like the plant-based lasagne"*.

Table 1
Demographic composition of focus groups and participant responses to the Subjective Knowledge Scale and the Food Technology Neophobia Scale.

	N	(%)
Age groups		
18–24 y/o	19	50
25–34 y/o	19	50
Gender		
Female	26	68.4
Male	12	31.6
Ethnicity		
Caucasian	25	65.8
Asian	6	15.8
African or African American	3	7.9
Mixed or multiple ethnic groups	3	7.9
Prefer not to say	1	2.6
Education		
Some secondary school	8	21.1
Technical/trade/diploma/vocational training	2	5.3
Completed University graduate (Bachelor's degree)	9	23.7
Completed Postgraduate/Doctorate degree	17	44.7
Prefer not to say	2	5.3
Location		
Urban/Suburban;	31	81.6
Rural	6	15.8
Prefer not to say	1	2.6
Estimated household income		
<£20,000	16	42.1
£20,000 - £35,000	7	18.4
£35,001 - £50,000	6	15.8
£50,001 - £75,000	3	7.9
£75,001 - £100,000	1	2.6
>£100,000	1	2.6
Prefer not to say	4	10.5
Dietary preferences		
Omnivore	31	81.6
Flexitarian	7	18.4
Meat eater status		
Low	8	21.1
Standard	16	42.1
High	14	36.8
Have you recently heard anything about sustainable food in the mass media?		
Yes	32	84.2
No	6	15.8
Subjective knowledge towards sustainable foods		
1–3 (disagree)	11	29.0
4 (neutral)	15	39.5
5–7 (agree)	12	31.6
Food Technology Neophobia Scale	**M**	**SD**
New food technologies are unnecessary	**3.55**	**1.08**
New food technologies are something I am uncertain about	3.71	1.80
New foods are not healthier than traditional foods	4.29	1.23
The benefits of new food technologies are often grossly overstated	4.05	1.25
There are plenty of tasty foods around, so we do not need to use new food technologies to produce more	2.97	1.72
New food technologies decreases the natural quality of food	3.50	1.72
There is no sense trying out high-tech food products because the ones I eat are already good enough	2.79	1.44
Perception of risk	**4.20**	**1.01**
New food technologies are unlikely to have long term negative health effects*	3.71	1.35
New food technologies may have long term negative environmental effects	4.29	1.18
It can be risky to switch to new food technologies too quickly	4.89	1.41
Society should not depend heavily on technologies to solve its food problems	3.89	1.96
Healthy Choice	**2.66**	**1.01**
New food technologies gives people more control over their food choices*	2.58	1.22
New products using new food technologies can help people have a balanced diet*	2.74	1.18
Information media	**5.34**	**1.68**
The media usually provides a balanced and unbiased view of new food technologies*		

Please note: Subjective knowledge scale and Food Technology Neophobia Scale, 1 = strongly disagree, 4 = neutral, 7 = strongly agree. M = mean, SD = standard deviation. Reverse coded statements indicated by *.

Table 2
Poll questions asked during the FG discussions (n = 38).

Poll questions	(%)
Participants who are willing to reduce meat	86
Participants who are willing to reduce dairy	69
Participants who have previously heard of cell-based meat	82
Participants who have previously heard of cell-based seafood	13
Participants who find both cell-based meat and seafood appealing	74

***Please note*:** Willingness is a sum of participants who scored slightly, moderately, and extremely willing.

and included; Stage 1) familiarisation with data to understand initial patterns, 2) systematic data coding, 3) generation of initial themes based on coded data, 4) review and development of themes, 5) refining, defining, and naming themes taking into consideration the thematic map and the data set. To answer the research objectives and identify behavioural change strategies, the themes which captured topic summaries were grouped into barriers and enablers under the respective domains of the COM-B model of behaviour (Michie, 2014; Michie et al., 2011; West & Michie, 2020).

3. Results

3.1. Changes to consumption habits

A reduction and/or complete removal of meat was the most frequently cited change to consumption habits, mentioned by 63% of participants. Subsequently, many increased their consumption of plant-based foods as substitute products to meat. Moving away from the family home and/or to university was one of the main drivers for changing consumption habits, especially meat intake. Being self-sufficient, the influence of others and a restricted food budget were reasons given for behavioural change, highlighting the significance of this life stage.

> *"I'm definitely reducing the amount of red meat, kind of moving to alternatives like Tofu or just veggie".* (F, 25–34, STD).

> *"I've sort of tried to cut down on meat specifically just because of like money being a student and moving away as well".* (F, 18–24, H).

Additional motives driving meat reduction are frequently related to environmental and sustainability reasons, indicating growing awareness. Consumer trends and health benefits were also mentioned although by fewer participants.

3.2. Perceptions towards sustainable food consumption

When describing sustainable food consumption habits, the top factors mentioned related to eating British produce and/or locally sourced food and making conscious food choices that consider the production and environmental impact of food. Reducing food waste and eating seasonal produce were also discussed by a few, however the ethical elements of sustainable diets (e.g., animal welfare, fair labour practices) received little mention (Table 3). Furthermore, some participants talked about meat reduction, but there was slight disagreement as to whether it should be completely removed from the diet or reduced.

3.3. Applying the COM-B framework to understand sustainable food consumption habits

In relation to the poll questions answered during the FG, the majority of participants were willing to reduce meat intake (86%) for the

Table 3
Themes mentioned by individual participants when discussing what sustainable food consumption means, from high to low frequency. The frequency count in brackets refers to how many individuals mentioned the themes. Example quotes are given beside each theme.

Themes	Direct Quotes
High frequency (16-20 mentions)	
Eating home grown and or locally sourced food.	*"Making sure when you, I don't know, if you go to the supermarket reading labels and choosing the radishes that come from the UK instead of South Africa for example".* (F, 18-24, S)
	"Some sustainable changes you can make would be eating foods that are produced locally like vegetables from farmers market maybe". (M, 18-24, S).
Considers the environment	*"I would say like sustainable food consumption is all about like eating stuff in a sensible way so if you are gonna eat meat you need to make sure the meat you are eating isn't impacting on the environment too much"* (F, 25-34, H)
	"For me sustainable consumption would take into consideration not just health but the environment as well so looking at things like the carbon footprint, food miles and things like that". (M, 18-24, H)
Reducing food waste	*"I would say also try and not waste too much like I try and like eat everything I have got in my fridge rather than letting things go past their sell by date and then throwing it in the bin".* (F, 18-24, L)
Medium frequency (6-11 mentions)	
Reducing meat	*"I feel like eating sustainably is mostly about cutting out meat, so red meats".* (M, 18-24, STD)
Eating seasonally	"*When you eat more seasonally it means that the demands of water or fertiliser is dropping a little bit"* (F, 25-34, L).
Eating more plant based	*"How do you eat more sustainably, eat less meat, more fruit and veg"* (M, 25-34, L).
Reducing or selecting recyclable packaging	*"I guess it's more like buying vegetables that are not wrapped in plastic when they don't need to be".* (F, 25-34, STD)
Low frequency (<5 mentions)	
Affordable and convenient	*"Whatever you do has to work well financially yes with what's accessible to you but also with your lifestyle and those external pressures as well".* (F, 25-34, STD).
Considers animal welfare	*"Not compromising on the quality of sort of welfare and the food production I think that is part of sustainability as well".* (F, 18-24, H).
Supporting farmers and growers	*"It's also supporting all those who work in the British food supply chain as well".* (F, 18-24, H).

environment's sake. Fewer participants were willing to reduce dairy (69%), but overall, the scores indicate potential for changing habits (Table 2). Following the COM-B framework, a range of themes with barriers and enablers to sustainable consumption habits were identified. Findings have been broken down by domain and summarised below. In general, there were no variations in the types of responses between genders and age brackets, but meat-eater status did reveal some variations.

3.3.1. *Capability*

Overall, participants were very knowledgeable regarding the environmental impact of the livestock industry and consumption of meat, perceiving it to play a contributing role in climate change. However, notable knowledge gaps were also observed, specifically relating to uncertainty around making sustainable food choices (e.g., which plant-based milk is better for the environment) and mixed perceptions around the environmental impact of different foods (e.g., local meat is better/worse compared to plant-based foods shipped from abroad). In particular, participants lacked awareness when discussing the sustainability of seafood, especially in contrast to meat. Interestingly, a range of information sources that had influenced consumption habits were mentioned (e.g., documentaries, articles, magazines, social media, labelling). One example included the Netflix documentary 'Seaspiracy', which for some viewers resulted in a reduction or complete removal of fish from their diet. Participants mentioned being in control of the food shop, planning meals and cooking skills enhanced their sustainable consumption. Feeling more responsible led some to reduce meat and food waste, whilst cooking skills provided the ability to utilise alternative ingredients to meat. One participant gave the example of using mushrooms and a beef stock cube instead of beef mince to make a bolognaise. However, for participants who lacked cooking skills, a dissatisfaction with meat-free meals not being filling and an increased reliance on meat were mentioned. Findings from the capability domain are summarised in Table 4.

3.3.2. *Opportunity*

Social opportunities included the influences of others, which were positively linked to consumer trends and acted as an enabler to change. Some participants noted how the increase in non-meat eaters has increased the availability of alternatives and started to normalise the

Table 4
Thematic themes for the capability domain, listing the Barriers (B) and Enablers (E) towards sustainable food consumption habits with supporting quotes taken directly from the FG sessions with young UK consumers.

Capability - *psychological*	**Direct quotes**
Uncertainty around making sustainable food choices (B)	*"Moving from normal milk to like almond milk or oat milk or soy milk for instance, I don't actually know the answers to this, but which one is actually better for the environment?" (F, 25-34, STD).*
	"If I can't have beef and I can't have chicken and stuff like that or like milk or something and then I now shift towards having fruit like am I still eating unsustainably?" (F, 18-24, H).
Mixed perceptions around the environmental impact of food (B)	*"You know eating a potato that's come from Australia will have a lot lower carbon footprint than eating a cow that's come from the UK".* (M, 25-34, L).
	"My like gut reaction would be meat is worse than dairy but then….to be honest I think neither of them are great like yeah I don't know if one is worse than the other". (F,18-24, L).
Lack of knowledge regarding the environmental impact of fish (B)	*"I don't really know too much about how the fish thing affects the environment and overfishing and things like that and I don't think it's much of a focus generally when people talk about food and sustainability which is probably why I haven't thought about it too much".* (F, 18-24, STD).
	"I feel like you don't hear as much about it [referring to fish] so it makes you...I guess you just presume that maybe it's not as bad as meat consumption". (F, 18-24, H).
Media sources influencing consumption habits (E & B)	*"I guess I've always thought that eating fish or the way you know we as a society consume fish is more sustainable and I don't know where I got that idea from, then I watched of course the Netflix documentary Seaspiracy and that sort of turned my idea on its head but yeah until that I always just saw fish as a more sustainable option for consumption than other you know types of meat".* (M, 25-34, H).
	"I watched a documentary recently about the impact that avocados had on the water supply where they're grown so trying to limit the consumption of that". (F, 25-34, L).
Ecolabels & magazines as information sources (E)	*"I look out for like accredited you know like the accredited symbols that you get on the packet that say it's like a sustainable fish or caught in a sustainable way".* (F, 25-34, STD).
	"I follow recipe magazines and stuff so I'm aware of what's in season because the recipes were based on what's coming in season and I'm probably quite led by the offers by supermarkets as well which usually sinks in with what is in season". (F, 25-34, H).
Being in control of the shopping/ planning of meals (E)	*"Because I am more in control and more responsible when I am shopping like it's easier to take time to look at the labels and plan out my meals".* (F, 18-24, H).
	"I am sorting all my own stuff out, so I am probably buying less meat but also trying to utilise like the ingredients that I do buy in several different ways over the week, trying to not buy too many different things but do different things with them". (F, 18-24, STD).
Capability - *Physical*	
Cooking skills (B & E)	*"I feel like I am not really a good cook so I kind of have to use meat to make it taste better".* (M, 25-34, H)
	"The hardest bit is like bulking out meals because I just get very hungry so if you cut out meat its harder to make those meals more filling". (M, 18-24, STD).

phenomenon of selecting meat-free options. Indeed, one participant mentioned, they had reduced meat intake because, *'I guess it's quite trendy'*. However, a few participants touched on the topic of masculinity and meat, stating that the men in their life tend to be the most resistant to change.

Physical opportunities related to changing environments and lifestyle factors, such as moving away from the family home and being in control of what to cook and eat, which both acted as enablers to

sustainable consumption. This was partly related to being on a low income which for some meant they could no longer afford to eat as much meat as before. However, in general, sustainable food consumption was perceived as expensive and not always attainable on a low budget. This was especially apparent when participants discussed packaging, sharing their frustration that often loose fruit and vegetables are more expensive than the packaged equivalents. Access to zero waste shops and recycling centres provided examples of services that enabled sustainable practices. Findings from the opportunity domain are summarised in Table 5.

3.3.3. Motivation

High attachment to meat and dairy and personal beliefs around being incapable of living without animal products emphasised the habitual nature of consumption. Despite consciously recognising the sustainability benefits of reducing meat and dairy, some participants were still unwilling to reduce highlighting an awareness behaviour gap. In general, the environmental benefits related to meat reduction were repeatedly mentioned whilst other factors such as health, animal welfare and ethical elements of sustainability did not dominate discussions. The belief that individual changes can make a difference were stated by many participants indicating individuals were engaged on a personal level and showed an optimistic outlook for the future. However, there were still a couple of participants who felt that changes on the individual level would not make a difference in tackling climate change. For some participants, being sustainably minded evoked negative emotions. Feelings of guilt, pressure and exhaustion were mentioned with a level of annoyance evident when discussing the impact food consumption may have on climate change as one participant commented, "*the best thing for the climate is to just lie down and die, and I don't really want to do that*". Findings from the motivation domain are summarised in Table 6.

4. Applying the COM-B framework to understand consumer acceptance towards current and future protein alternatives

The most frequently mentioned themes discussed within each domain differed across the three alternatives as summarised below and detailed in Tables 7–9.

4.1. Plant-based meat/seafood

Few participants had tried PBS products, which were thought to be less prevalent in shops. However, the majority of participants had tried a wide range of PBM, with Quorn (mycoprotein-based products) most frequently mentioned. Some participants who didn't like the imitation aspect preferred unprocessed plant foods, such as chickpeas and lentils. The main reason for trying PBM products related to the influence of others, highlighting the importance of social norm and consumer trends. Although many recounted negative sensory experiences, this was outweighed by the number of mentions for positive sensory experiences. This indicates how trial and error these products can be, which to some

Table 5
Thematic themes for the opportunity domain, listing the Barriers (B) and Enablers (E) towards sustainable food consumption habits with supporting quotes taken directly from the FG sessions with young UK consumers.

Opportunity - *Social*	**Direct quotes**
Influence of others (B)	"*Genuinely speaking I would be happy to eat less meat, would be willing to buy less meat, but my partner wouldn't*". (F, 18-24, H).
	"*There's a trend certainly in my life that the men in my life tend to be keener on having meat in the meal for their protein source than having veggie alternatives*". (F, 25-34, STD).
Consumer trends and social norm (E)	"*If I eat out with my friends instead of with my family I tend to have more plant-based dishes especially since there are more vegetarian vegan people now*". (F, 18-24, STD).
	"*I feel like year on year there's just more and more pressure personally to eat less meat like there's a lot more people doing it so there's more pressure for you to kind of have a go, so I've kind of just started trying to do that recently*". (F, 18-24, STD).
Opportunity - *Physical*	
Changing environments - moving away from the family home (E)	"*I do have quite a lot of veggie days during the week especially now that I am living at uni and I am cooking for myself and can cook for my friends and stuff it does take more of a veggie route*". (F, 18-24, STD)
Low income (E & B)	"*I've sort of tried to cut down on meat specifically just because of like money being a student and moving away as well*". (F, 18-24, H).
	"*I am on a student budget so I'm not, I've not got a lot of you know, finance is not necessarily the easiest part for me to be able to be sustainable, so I'd like to be*". (F, 18-24, STD).
Unnecessary packaging (B)	"*For students its especially you want to be sustainable but if the packaged option is cheaper then sometimes you can't help it*". (F, 18-24, STD).
	"*In some supermarkets its just impossible form a financial point of view it's so much cheaper to buy a multipack of peppers for example than each loose pepper*". (F, 18-24, STD).
Zero waste shops and recycling services (E)	"*I often, not all the time, go to zero waste shops as well so there seem to be now on most highstreets zero waste shops*". (F, 25-34, STD).
	"*I was glad to find the soft plastic recycling in Tesco's now so you can take it there and a lot of the stuff is now recyclable so yeah*". (F, 25-34, STD).

Table 6
Thematic themes for the motivation domain, listing the Barriers (B) and Enablers (E) towards sustainable food consumption habits with supporting quotes taken directly from the FG sessions with young UK consumers.

Motivation – *reflective*	**Direct quotes**
Attachment to meat and dairy (B)	***"****I'd like to be the kind of person that does like help the environment and eat more sustainably but then at the same time I just do prefer meat ".* (F, 18-24, STD).
	"It's just purely selfish because I don't think I could live without cheese". (F, 25-34,STD)
Environmental benefits of reducing meat (E)	*"My main reason for cutting down on meat is more environmental and more fairness about eating protein sources from plants".* (F, 25-34, L).
Scepticism around logos and accreditation (B)	*"If you're buying a tin of tuna from I don't know a supermarket and like what we've learnt from those logos, those ethical logos, actually don't mean anything apparently".* (F, 25-34, STD).
	"So, it's kind of just like the education, kind of knowing like them [referring to ecolabel certification schemes] tricking the consumer into thinking they are shopping sustainably when they actually aren't, I know there's quite a lot of that trickery especially in the fish kind of trade area". (F, 18-24, STD).
Individual changes can make a difference (E)	*"I think there's more of a focus on food often because that's actually somewhere where we can make a difference by changing personally what we do we can have a big impact".* (M, 25-34, L).
	"If people collectively are conscious about sustainability then in a way we are going to influence what we think is sustainable production and sustainable economics". (M, 18-24, H).
Individual changes will not make a difference (B)	*"I don't think myself if it's just me making a change I don't think I'm gonna solve climate change at all I think the problem is more at an industrial level".* (F, 18-24, L).
	"I always have this perception that if I walk into the supermarket and I choose not to pick up that packet of mince beef or that litre of oat milk, if I choose not to pick it up eventually someone else will pick it up". (M, 18-24, H).
Motivations - *automatic*	
Negative emotions towards sustainability (B & E)	*"We can't write off everything, we can't not have everything in our lives".* (F, 18-24, H).
	"I think there's a lot of pressure, it can be very easy to fall into the trap of feeling like you are not doing enough". (F, 25-34, STD).

degree involves a certain level of risk taking. The 'booming' plant-based market was referenced by some participants, who found substituting meat easier due to increased availability. One participant commented on how PBM provided support for people who really enjoyed meat to transition towards a non-meat diet. Convenience and ease of cooking also acted as enablers, with functionality and food safety in terms of being able to cook from frozen and not worrying about under cooking products mentioned.

The biggest barrier towards acceptance related to the negative perception that plant-based products are overly processed and therefore unhealthy. The level of processing led to scepticism around how environmentally friendly plant-based products are compared to their conventional counterparts. However, a large majority of participants perceived them to be advantageous towards sustainable consumption, predominantly due to the supportive role they play in reducing the consumption of animal products. Only a few participants mentioned animal welfare as a motive for consuming plant-based products, with sustainability and environmental benefits dominating the discussions. Participants were uncertain as to whether PBM/S products are healthier compared to conventional meat and fish and therefore it was not considered a main driver. Findings for PBM/S products are summarised in Table 7.

4.2. Cell-based meat/seafood

The majority of participants had heard of CBM (82%) and only a minority had heard of CBS (13%). In terms of consuming for the sake of the environment, once the methods of production were explained, the majority of participants felt both technologies appealed to them (74%). However, during discussions a minority of participants felt CBS would be harder to emulate due to the large variety of fish species and the whole format in which they are often presented and or eaten. One participant suggested '*squid rings*' as a more suitable product rather than '*whole prawns or something like that*'.

A large majority of participants demonstrated an optimistic outlook and attitude when discussing the future potential of CBM/S, with a few perceiving them to be a more environmentally friendly option compared to conventional meat/seafood. However, a lack of knowledge surrounding CBM/S was frequently mentioned as a barrier towards acceptance, due to reduced confidence and scepticism over food safety and possible long-term health risks.

In general, several participants were concerned about wider consumer acceptance rather than personal approval and questioned the role of CBM/S within cultural norms. However, curiosity was identified as a key driver, predominantly linked to an interest in sensory attributes. When discussing advantages, the most frequently mentioned motive

Table 7
COM-B model with thematic themes for PBM/S products, listing the Barriers (B) and Enablers (E) with supporting quotes taken directly from the FG sessions with young UK consumers.

Opportunity - *Social*	**Direct quotes**
Influence of others (E)	*"I am only having them if I'm out with my vegetarian friends".* (M, 25-34, H).
	"I think the main reason why I started trying them was because one of my flatmates went vegetarian and we used to cook together, and I was like yeah why not and then realised they're actually quite nice, I'm not sure if I would have eventually tried them just by myself". (F, 18-24, STD).
Opportunity - *Physical*	
Convenience and easy to substitute in cooking (E)	"I think the good thing about Quorn mince is that you can cook it from frozen which obviously you can't do with regular beef mince". (F, 18-24, STD).
	"I think that they are sometimes easier to cook and there's less sort of space for error I think in terms of like over cooking or under cooking". (F, 18-24, STD).
Availability of plant-based alternatives (E)	*"Meat I could definitely reduce a lot more easily because some really good substitutes out there now".* (F, 18-24, STD).
	"I would say it has sort of become easier just because there are so many alternatives now, there's like, I don't feel like I am missing out on meat as much". (F, 18-24, STD).
Motivation - *reflective*	
Negative health connotations (B)	*"A problem that I have with them is that the nutritional value is not exactly the same, for example if you swap a sausage for the mushroom sausage you might not be getting the same nutrients".* (F, 25-34, STD).
	"They can contain products in the processing that aren't good for you". (F, 18-24, H).
Overly processed (B)	*"For me it just seems a bit too much processing that's really what puts me off".* (F, 18-24, H).
	"My experience genuinely with them is that they are so highly processed, and they have so many additives and so many things added that are not necessarily good for us but just to replicate the taste or I don't know the smokiness or certain things that meat has, or fish has". (F, 25-34, STD).
Negative environmental impact (B)	*"Another disadvantage is that it might like leave people to think that that they are being more environmentally friendly when it might not necessarily be the case because of all the processing involved and sourcing of all the wide range of ingredients".* (M, 18-24, STD).
	"Often ultra-processed foods, could lead to environmental damage such as issues with palm oil and soybean production". (F, 25-34, H).
Sustainability and environmental benefits (E)	*"I think one of the obvious advantages is that you're not eating meat or fish so that has a big impact especially on the environment".* (F, 25-34, L)
Motivation - *automatic*	
Positive sensory experience (E)	*"Things like the hoisin duck I have tried which is really tasty I would like definitely recommend those ".* (F, 18-24, STD).
	"Usually, it's a choice for taste it's like ah I love these, these are brilliant, I'll buy them". (M, 25-34, STD).
Negative sensory experience (B)	*"I think I found with a lot of them that they might do well with replicating the taste of meat but then the texture would always fall down".* (M, 18-24, STD).
	"To be honest everything that I have ever tried that's trying to copycat in this world of like replacement meat and fish is just a poor comparison, so I don't really seek it out". (F, 25-34, H).

Table 8
COM-B model with thematic themes for CBM/S, listing the Barriers (B) and Enablers (E) with supporting quotes taken directly from the FG sessions with young UK consumers.

Capability - *Psychological*	**Direct quotes**
Scepticism over food safety & health (B)	"*I'll try it now, but I am also quite sceptical and want to wait until studies have been done on like nutritional content and like long term health implications for people that consume that for a long period of time."* (M, 25-34, STD).
Lack of knowledge regarding production methods (B)	*"For me the whole lack of information and the lack of knowledge around cell-based foods and things really reduces my confidence".* (F, 18-24, STD).
	"I've like heard about it I've heard the name, but I really don't know enough about it for me to straight away be like yes I am willing to put that in my body". (F, 18-24, H).
Increasing knowledge on production methods and health implications (E)	*"I think they should share with the consumers more details on the methodology and if they're using chemicals or if the process creates like bad ingredients for people's health*". (F, 25-34, L)
Opportunity - *Social*	
Consumer acceptance (B)	*"As much as it could be a good sustainable option it's actually getting consumers to want to buy, and some are going ah there's a lab-based piece of bacon here over a normal slice of bacon people tend to go with what they know over what's new even if it could have a positive impact".* (F, 18-24, H).
	"*I think one disadvantage I can think of would be the cultural acceptance, I think food brings people together right so if you were to present a plate of cell based or cell cultured meat over Christmas dinner for example I think many of the older generations adults would be resistant to try probably question its origins and how it came about".* (M, 18-24, H).
Opportunity - *Physical*	
Affordability (E&B)	*"I just think that it's really exciting and I would definitely be keen if it was affordable".* (F, 18-24, STD).
	"I can imagine it being very expensive". (F, 18-24, STD).
Motivation - *reflective*	
Unnatural (B)	*"The way to be sustainable in my opinion is going down the natural route erm rather than starting to bring in something like cell-based meat, as much as it's interesting and exciting it just doesn't appeal to me".* (F, 18-24, H).
	"The thought of having something that has been made in the lab I don't know it's just a bit scary". (F, 18-24, H).
Optimistic sustainability outlook (E)	*"I feel like there's a lot of potential in the future for it to become more environmentally friendly even if it's not the case at the moment compared to like the same amount you produce from a cow."* (M, 18-24, STD).
	*"I just think it's great it's so exciting why would you not want to have meat that tastes like meat is fundamentally meat doesn't hurt animals and doesn't damage the planet so much".(*F, 18-24, STD)
Animal welfare (E)	*"It depends why someone would be reducing meat and fish consumption and I think if its animal cruelty then 100% I think this is better".* (F, 18-24, L).
Environmental benefits (E)	*"If I know that it's going to be more eco-friendly then definitely".* (F, 18-24, STD).
Optimised nutrition (E)	*"Being able to control fat content precisely which could help to tackle some chronic health issues associated with overconsumption of saturated fat".* (F, 18-24, STD).
Motivation - *automatic*	
Curiosity (E)	*"I would like to see how it tastes, how it cooks, and you know whether or not whether it looks or feels any different to regular meat".* (F, 18-24, STD).
	"It is just curiosity I'd be really intrigued to see what it's like compared to you know naturally grown meat". (M, 25-34, H).
Positive sensory experience (E)	*"If I would carry on consuming it, it's another question because it depends on how it would be on the first experience".* (F, 25-34, L).

Table 9
COM-B model with thematic themes for PFD, listing the Barriers (B) and Enablers (E) with supporting quotes taken directly from the FG sessions with young UK consumers.

Opportunity - *Social*	**Direct quotes**
Consumer acceptance (B)	*"Would be hard for people to wrap their heads around".* (F, 18-24, H).
	"Consumer acceptance, it needs to be marketed well!" (F, 25-34, STD).
Opportunity - *Physical*	
Current dairy alternatives not appealing (E)	*"I don't know whether anyone has tried dairy free cheese, it's generally quite disgusting in my opinion, it's just kind of plastic smells a bit weird doesn't last for very long".* (F, 18-24, STD).
	" No one milk alternative makes a bechamel as well as it goes in a porridge as well as it you know goes in a cake so it's just easier just to have milk because I know it's got the functionality for everything I want to do with milk". (M, 25-34, Low).
Affordability (E&B)	*"Depending on the price, if it's like five times as expensive then I'll wait a few years or months".* (M, 25-34, STD).
	"This sounds like quite an expensive way to make the milk and until it's you know really common and it's the same price as normal milk then it would become like something that I would always buy just from a cost point of view." (F, 18-24, STD).
Motivation - *reflective*	
Scepticism over sensory appeal (B)	"*In my head I'm just thinking it's going to be fizzy I don't know why*". (F, 18-24, STD).
	"*The milk I just can't imagine it tasing that nice, but I could be wrong*". (F, 18-24, H).
Health and optimised nutrition (E)	"*I know that sometimes the plant-based milks are not very easy to digest for some people so yeah I think it's really interesting.* " (F, 25-34, L).
	"*Opportunity to improve nutrition*". (M, 25-34, STD).
Environmental benefits (E)	"*If they were able to have lab-grown cheese that erm is better for the environment I would be willing to try*". (F, 18-24, STD).
Animal welfare (E)	*"I have been all about the environment and then when it comes to dairy products before the environmental impact I think of animal welfare and that's purely because I've seen dairy cows and I've seen calf's be separated from mums you know as soon as they are born and put into crates really quickly and I think that it's that emotional impact that then makes me think I want less of that and I will try anything.*" (F, 25-34, STD).
Motivation - *automatic*	
Positive sensory experience (E)	"*As long as it tastes the same, same texture and everything then you know everyone should be doing it.*" (F, 18-24, STD).
	"*I have got to consume quite a lot of this stuff in my lifetime, so I want to enjoy it I don't want to dread making a coffee because I know the milk is going to taste horrible or whatever just because I am trying to do the sustainable thing".* (F, 25-34, H).
Curiosity (E)	"*To be honest I have tried to eat cheese that is plant based and I didn't really like it so I would be very interested to see the flavour of those kind of cheese or milk".* (F, 25-34, L).

related to animal welfare. The potential environmental benefits and the opportunity to personalise products to reflect optimised nutrients also steered conversations. Findings for CBM/S are summarised in Table 8.

4.3. Precision fermented dairy

Overall, participants were intrigued by the concept of PFD but recognised it would need to be marketed well and would take time for consumers to understand and accept. Only a minority of participants were optimistic about the production method, but they were not challenged on this opinion by other participants. Curiosity, especially in relation to what it would taste like dominated discussions and were key motives for trying. Many stated how current dairy alternatives were not appealing from both a sensory and functionality perspective which highlights a gap in the market which PFD could fulfil. Some participants also appreciated the opportunity for products to be nutritionally optimised, whilst meeting the needs of lactose intolerant consumers. Animal welfare was the most frequently mentioned advantage, with some participants mentioning the possible environmental benefits. Findings for PFD are summarised in Table 9.

5. Discussion

This study aimed to provide added insights into young meat-eaters consumption habits and perceptions towards sustainable foods. Furthermore, it aimed to provide novel insights by comparing the barriers and enablers to a range of protein alternatives, some of which are currently not well understood. The COM-B model gave structure to the findings and identified areas of behavioural change which are suggested and discussed below.

5.1. Changes to food consumption habits and perceptions of sustainable foods

Initial discussions regarding changes to food consumption habits, without any prompts regarding sustainability, identified an undeniable

trend towards meat reduction amongst the consumers in this study and subsequently an increase in the consumption of protein from other sources. Findings reflect current reports regarding reduced meat intake in the UK (Bryant et al., 2023; Deloitte, 2022; Stewart et al., 2021; The Vegan Society., 2022) and supports the growing demand for protein alternative products (GFI, 2023; YouGov, 2019).

Interestingly, the Covid-19 pandemic was not mentioned as an influential factor in changing dietary habits which is in contrast to previous qualitative studies amongst UK consumers (Filimonau et al., 2021; Pluck & Morrison-Saunders, 2022; Whittall et al., 2023; Williams et al., 2023). Instead, for many, moving away from home and living independently acted as the catalyst for change. Similar findings have been observed amongst studies with young adults (Kemper & White, 2021; van den Berg et al., 2022), in which transitional life stages are likely to influence eating habits (Poobalan et al., 2014). Although findings contradict a previous study (McBey et al., 2019), in general, research has shown that intervention strategies during life stages can lead to a greater openness to new information (Verplanken & Roy, 2016).

Environmental/sustainability benefits were mentioned by some as drivers for changing food habits, especially meat reduction, which supports previous FG findings amongst young adults (Kemper, 2020). Results also signify a shift in consumer awareness compared to previous studies with UK consumers (Clonan et al., 2015; O'Keefe et al., 2016). However, a more apparent motive on sustainable food choices related to limited food budgets. For some participants it facilitated meat reduction, but adversely it also meant choosing the cheapest option for fruit and vegetables which were often the most packaged. Practical concerns relating to the cost of sustainable foods have been previously noted amongst UK consumers (Whittall et al., 2023), and is considered a prominent barrier to eating a sustainable diet (FSA, 2021).

Trade-offs with price left some participants feeling that wealthier individuals were more at liberty to make sustainable food choices. Indeed, competing demands and the recognition that sustainable eating is a privilege for the wealthy has been a prior consideration (Weber et al., 2022; Whittall et al., 2023). Contradictory to previous studies with UK consumers, personal health and animal welfare were scarcely mentioned when discussing reductions to meat intake (Clonan et al., 2015; Defra., 2011; Dibb & Fitzpatrick., 2014; Mylan, 2018). To some extent this highlights the importance of alternative factors such as price and the influence of others in driving change. Furthermore, considering this study was conducted before the full effects of the 'cost of living crisis', (where inflation outweighs income wage and benefit increases), price may be even more significant now (Hourston, 2022). The notion that consumers following plant-based diets spend less could therefore unintentionally bring about change (Pais et al., 2022).

Reviewing participants perceptions towards sustainable foods, the most discussed themes related to consuming homegrown and or locally sourced food. The importance placed on these factors have been observed in previous studies and is often linked to eating seasonally (Bows et al., 2012; Lea & Worsley, 2008; Polleau & Biermann, 2021; Whittall et al., 2023). However, as the UK imports 46% of the food it consumes, it is not always possible to eat locally sourced food (Defra., 2021). In general, participants considered the environmental impact of food based on the distance it had travelled, with many mentioning 'food miles' and 'carbon footprints'. As the origin of production is often one of the few pieces of information on pack, it makes sense that consumers are more aware of this attribute. However, 'localness' is not always an accurate measurement of sustainability as the carbon footprint is not always lower (Stein & Santini, 2022). Instead, the type of food commodity is more important (Ritchie, 2020). To some extent this was discussed when a participant compared the carbon footprint of an Australian potato compared to local beef. Findings therefore reinforce that it is not easy to know how to be a "sustainable consumer" and how best to quantify the environmental impact of food choices (van Bussel et al., 2022).

When describing sustainable food behaviours, a reduction in meat, especially red meat, was not mentioned as frequently as other behaviours (e.g., eating local, seasonal, reducing food waste), despite it being the main self-reported dietary change in earlier discussions. Dietary changes were also not explicitly linked to a specific type of diet (i.e., vegetarian, vegan or plant-based) (Faber et al., 2020). Findings support results from a recent survey of nationally representative UKadults, in which meat reduction is not listed as the top sustainable lifestyle action (Deloitte, 2022). Perhaps the results re-affirm that meat reduction is driven by alternative factors discussed (e.g., moving away, the influence of others, restricted budgets) compared to 'sustainability' reasons. In addition, only one participant mentioned a reduction in dairy, perhaps indicating even lower awareness compared to meat. Instead, the importance was placed on how environmentally friendly the processes involved in the production methods are (e.g., transport, GHG emissions, water usage). Findings therefore indicate the mounting evidence that sustainability is increasingly being viewed through an ecological lens, with the social and economic elements (e.g., decent working conditions, fair trade, supporting communities) often overlooked (Jones et al., 2016).

5.2. *Barriers and enablers towards following sustainable food consumption habits*

In general, participants acknowledge food production and consumption negatively contributes to climate change, with a minority specifically referencing meat. Similar to Bryant et al. (2023), reflective motivations were greater than automatic motivations, with the majority of participants positive towards the idea that individual changes to food consumption habits will make a difference to climate change. Findings indicate an increase in awareness regarding the environmental impact of food, and a potential shift in consumers attitudes compared to prior research conducted with UK consumers (Macdiarmid et al., 2016; Mylan, 2018). It also supports the idea that younger consumers are more informed (McBey et al., 2019) and likely to believe their food choices will affect the environment (Ran et al., 2022). This shift in awareness could partially be due to the majority of participants indicating they had recently heard about sustainability in the mass media (Table 1). To some extent increased awareness is likely to enable conscious sustainable food consumption habits. In particular, intervention strategies involving information have been successful in encouraging red meat reduction and increased green eating behaviours (Carfora et al., 2019; Monroe et al., 2015). However, information as an intervention may have limited effectiveness, dependent on the length and time of exposure and participants subjective knowledge (Weingarten, 2022). It may also only be effective for consumers who believe in the negative impact of meat on the environment (Vainio et al., 2018). Therefore, strategies should be combined with other approaches, as information on its own may be insufficient (McBey et al., 2019).

Despite increased awareness, it was apparent that the majority of participants struggled to quantify the size of the environmental impact of food which has been previously observed (Hartmann et al., 2022; Hoek et al., 2017; Shi et al., 2018; van Bussel et al., 2022). This is to be expected as it depends on many factors (e.g., water and land use, carbon footprints, pollution issues, waste management) and there is still considerable debate amongst the scientific community. Lack of information as a psychological barrier was particularly applicable when participants discussed the sustainability of seafood, and to some extent dairy. Subsequently, concern around the environmental impact of these food commodities appeared lower and dominated discussions less than meat. Indeed, some participants felt that the environmental impact of meat was more of a prevalent topic of conversation compared to seafood. Apart from the origin and sustainability certification on pack, participants had little knowledge from which to make informed choices when purchasing seafood. Furthermore, only a small minority mentioned the issue of overconsuming the same variety of fish which are

usually non-native species to the UK. Therefore, better education is required to help consumers understand how to consume seafood as part of a sustainable diet, which includes a broader variety of fish species (Steenson & Creedon, 2022). Different cooking methods could be applied as a strategy to increase the diversification of fish species consumed. For example, preparing oysters outside of their traditional raw format and into familiar foods such as burgers provided a viable approach to increase consumption in Sweden (Costa et al., 2023).

Labelling schemes which communicate the sustainability of food (e.g., carbon footprints) provide a promising avenue for tackling the knowledge gap and changing consumer behaviour, especially towards meat consumption (Camilleri et al., 2019). However, a level of scepticism towards accreditations such as 'dolphin friendly' and the 'Marine Stewardship Certification' (MSC) was evident amongst some participants during the FG discussions. The mistrust being partially driven by information gained through media outputs, such as the 2021 Netflix documentary 'Seaspiracy', where amongst other topics, the efficacy of the MSC label was discussed. This highlights the power the media has in shaping consumers consumption habits, but it could be argued not always in a sustainable direction. For example, after watching 'Seaspiracy' a number of participants recounted reducing or removing fish from their diet, yet fish is considered to be part of a healthy and sustainable diet in the UK (PHE, 2018). The recommendation to 'stop eating fish' in the documentary has subsequently been criticised and questioned by many scientists and organisations (Sivertsvik, 2021). It is therefore essential that messaging is accurate and reliable considering on average participants agreed that the media provides a balanced and unbiased view of new food technologies (Table 1).

Another theme that dominated discussions was the influence of others on changing behaviour, especially in relation to preventing meat reduction. As discussed in a previous study, whether meat consumption was avoided or consumed depended on the social context and the need to avoid inducing a negative effect on others (Collier et al., 2022). Some participants mentioned consuming more meat when returning home and or being with family which supports a recent study reviewing influences on meat consumption in the UK (Horgan et al., 2019). In addition, some participants mentioned the presence of men as being a barrier to reducing personal meat intake, which supports the notion that meat consumption continues to be linked and shaped by masculinity (Carroll et al., 2019; Mesler et al., 2022). It also highlights a level of fear and stigmatization associated with avoiding meat consumption (Markowski & Roxburgh., 2019). However, as the number of non-meat eaters and the availability of meat-free options continues to rise in the UK, new trends and social norms are becoming established and should be utilised to facilitate sustainable food consumption habits. Currently, further research is needed to understand the effectiveness of interventions on social norms which could prove successful (Kwasny et al., 2022). For example, 'dynamic' social norms (i.e., norms about the number of other people engaging in a behaviour), have been proven to encourage a reduction in meat consumption in a cafeteria setting (Sparkman & Walton, 2017).

An interesting finding related to the negative emotions that arose when discussing the potential role food plays in contributing to climate change. The multidimensional nature of what sustainable food encompasses meant consumers were often confused, and in some instances frustrated as to how to eat sustainably when substituting out a particular food source. A small minority of participants perceived being sustainable meant denying enjoyable foods. Others echoed sentiments of guilt that they were not doing enough, feelings of pressure to change their ways and mental exhaustion regarding food choices. This supports the notion that transitioning towards plant-based diets can be physically and emotionally challenging for young adults (Von Essen, 2021). Research has shown that guilt can positively impact consumers perceptions towards healthier and more sustainable food choices and eating habits (Yu et al., 2021). However, these negative emotions could deter some from engaging with sustainable food behaviours. Therefore, a successful behavioural change strategy could be to instead highlight the positive emotions. For example, highlighting how good consumers can feel when reducing their meat consumption is one way to positively influence consumers intention to reduce meat intake (Taufik, 2018). Alternative emotional motivations could come direct from consuming sustainable products which can elicit positive emotions and less guilt (Yang et al., 2020). However, initiating behavioural change can be the biggest challenge and a good first impression, often sensory related, is critical in creating a shift in behaviour.

5.3. *Barriers and enablers towards plant-based meat and seafood products*

The majority of participants had tried PBM products or were regular consumers which reflects the growing popularity in the UK (GFI, 2023; Smart Protein project, 2021). Unlike previous FG discussions, affordability was not mentioned as a barrier towards acceptance (Kerslake et al., 2022) but then price is likely to be a culturally sensitive factor (Weinrich, 2018). Instead, the functionality of products, being convenient, easy to cook and a good substitute for meat were mentioned frequently as advantages and supports previous findings (Elzerman et al., 2013). Fewer participants had tried PBS products which could be due to the smaller market presence compared to PBM (GFI, 2023). Subsequently, less availability and familiarity alongside an 'awareness gap' regarding the environmental impact of seafood, may explain the reduced need to replace seafood in a meal. Increasing consumer knowledge could help consumers better understand the supportive dietary role of PBS products, which potentially need to align with consumer seafood preferences (Kim et al., 2023).

Sensory appeal was a prominent motive in discussions which further establishes it as a crucial factor for determining regular consumption (Weinrich, 2019). The balance of positive and negative sensory experiences did not seem to deter participants from trying a range of products, which tended to be processed PBM substitutes (e.g., mince, burgers, sausages, nuggets). Only a few consumers in this study mentioned being against the mimicking aspect of substitutes, which is in contrast to previous FG's with French and Norwegian consumers (Varela et al., 2022). Indeed, meat-replacers that mimic the taste and texture of meat are most likely to succeed and appeal to high meat consumers (Hoek et al., 2011; Michel et al., 2021). However, in order to make plant-based products functional and palatable, they often undergo high levels of processing. For the majority of participants, the overly processed nature of some plant-based products acted as a barrier towards acceptance and led to discussions around lengthy ingredient lists, nutritional content and health implications.

The perception that plant-based products are overly processed and potentially non-beneficial to health has also been observed in previous studies (Collier et al., 2021; Hartmann et al., 2022; Weinrich, 2018). Although similar associations were not made during the FG when discussing conventional meat products, a quantitative study amongst UK consumers found PBM to be perceived as a 'healthier' option (Vural et al., 2023). This topic has been explored in the literature, especially from a nutritional perspective compared to conventional meat and seafood products. In general, findings show PBM products tend to be lower in fat, higher in dietary fibre, with many products high in salt (Alessandrini et al., 2021; Curtain & Grafenauer, 2019). PBS alternatives had similar nutritional shortcomings compared to their conventional counterparts, with some lacking in protein content and high in salt, but findings varied widely dependent on the product (Boukid et al., 2022). Overall, the balance between the advantage of sensory appeal and the disadvantages of processing on nutritional benefits needs to be considered.

Lastly, there was a level of scepticism about how beneficial plant-based products are for the environment, which has also been found in a FG amongst Swedish consumers (Collier et al., 2021) and remains widely debated in the literature, especially when compared to

conventional meat (Andreani et al., 2023). Conversely, consuming PBM/S products were viewed by some as beneficial for the environment, due to the subsequent removal of meat and fish products from the diet. This indicates the participants in this study had a different perspective from previous literature, which found consumers to rate the environmental impact of meat and meat substitutes similarly (Siegrist & Hartmann, 2019). Therefore, highlighting the environmental impact on the packaging is one strategy found to increase acceptance (Martin et al., 2021), with a lack of information seen as a negative (Elzerman et al., 2013).

5.4. Barriers and enablers towards cell-based meat/seafood and precision fermented dairy products

In general, participants were positive about CBM/S and PFD being, curious and in some instances excited about the future potential of these novel technologies. This reflects the responses from the food technology neophobia scale, where on average participants felt that new food technologies were necessary (Table 1). However, as higher levels of food neophobia and food technology neophobia have been found to be associated with negative perceptions towards CBM, the findings may have been different amongst a wider cohort (Krings et al., 2022; Wilks et al., 2019). Additionally, it is important to note that these products are hypothetical and when available consumers may feel differently. For example, the level of processing was a concern for PBM/S products but was not mentioned during discussions around CBM/S and PFD. Potentially this is due to products and ingredient lists not being available.

In contrast to previous FG discussions, the disruptive nature of these cellular agricultural methods was only mentioned by a few participants (Verbeke et al., 2015). These few participants described having connections and or experiences with the farming industry which may explain the greater level of concern (Crawshaw & Piazza, 2023). Additionally, as the majority of participants lived in urban areas (Table 1), awareness and therefore concern of the impact CBM could have on agri-food businesses are likely to be lower than rural living consumers (Shaw & Mac Con Iomaire, 2019). However, it was apparent that PFD had fewer barriers compared to CBM/S which had greater levels of scepticism regarding food safety and health. This may be due to the name and description given to participants, where 'animal free dairy' was likened to the process of making beer and wine using fermentation tanks. Research has highlighted the importance of names and framing on consumer acceptance, and it is likely that the familiarity of the process method reduced consumer concern around food safety (Bryant & Barnett, 2019; Bryant & Dillard, 2019). Therefore, the way information is delivered and marketed for CBM/S and PFD will to some extent underpin acceptance and should be carefully considered. In the case of CBM, providing consumption frames that align conventional meat with CBM are likely to create more favourable attitudes (Fidder & Graça, 2023), whilst for PFD, frames related to animal welfare were viewed as the most pertinent for acceptance (Broad et al., 2022). Considering animal welfare was a key motive for PFD amongst the young meat-eaters in this study, which aligns with previous research (Powell et al., 2023), this frame is also likely to be the most influential.

The importance of sensory appeal was frequently mentioned for CBM/S and PFD, with repeat consumption reliant on a positive first sensory experience (GFI & Kelton Global, 2021; Perkins, 2018; Powell et al., 2023; Verbeke et al., 2015; Zollman Thomas & Bryant, 2021). Furthermore, participants predicted products will be expensive once they become available. This is probable especially in the case of CBM as the serum/medium used to grow cells during production is costly and often uses animal-derived foetal bovine serum (Hubalek et al., 2022). Therefore, not only will affordability and ethical concerns act as barriers to acceptance, but it is likely the high costs may increase consumer expectations around taste and quality. Consequently, compared to PBM/S products, it is questionable whether consumers will be as willing to compromise on a bad sensory experience for CBM/S and PFD.

Interestingly, several participants felt the main barrier towards CBM/S and PFD related to wider consumer acceptance rather than personal preferences. As one participant mentioned, food brings people together, questioning whether CBM would be appropriate for Christmas dinner and accepted by older generations. This in turn highlights situational appropriateness. Furthermore, whether CBM will be a societal success has previously been a concern associated with older rather than younger consumers (van der Weele & Driessen, 2019). The hypothetical nature of these products means we don't yet know how successful products will be and the consumer following they will get. Currently, research has suggested that compared to other novel food technologies, acceptance towards CBM/S is likely to be lower (Giacalone & Jaeger, 2023). We can predict based on the concerns participants had around cell-based products being 'unnatural' that this will be a key barrier towards acceptance and will need to be addressed (Laestadius, 2015; Siegrist et al., 2018; Verbeke et al., 2015). Strategies to overcome this negative perception have included changing the label to 'clean-meat' and highlighting the unnaturalness of conventional meat (Bryant & Barnett, 2019; Bryant et al., 2019). Whether similar approaches would work for CBS and PFD is yet to be understood. However, these strategies come with limitations and an alternative approach could be to highlight the top advantages discussed. For both CBM/S and PFD advantages included the animal welfare benefits, which have been previously observed in FG discussions around CBM in the UK (Bows et al., 2012; O'Keefe et al., 2016). Another advantage related to optimised nutrition (e.g., adjusting fat composition of meat and lactose-free dairy) which could be a unique selling point that product developers and marketing campaigns could take advantage of. As quantitative research amongst UK consumers found CBM to be perceived as a 'healthier' option compared to conventional meat this could become a key motive for acceptance (Vural et al., 2023).

6. Strengths and limitations

The findings contribute to an existing body of literature exploring sustainable food consumption habits in the UK and includes the novel topics of PBS, CBS and PFD which are considerably under-researched compared to meat substitutes. This study also provides a unique comparison of the barriers and enablers towards a range of topics, reviewing the diet from a more holistic perspective. However, due to the hypothetical situation of including novel alternatives it is hard to accurately define consumers perceptions to products which are not currently available in the UK (Palmieri et al., 2020; Weinrich et al., 2020). In comparison, plant-based products continue to rise in popularity and therefore FG participants had formed perceptions of them based on personal experiences, which may have contributed to the different barriers and enablers discussed.

In terms of the methods used, qualitative research using online FG's have increased in popularity especially following the Covid-19 pandemic and have the advantage of accessing participants from a wider geographical area making it more convenient than face-to-face sessions (Nobrega et al., 2021). Furthermore, it allows participants to talk in a familiar and safe environment which has been shown to result in greater disclosure than offline methods (Wilkerson et al., 2014). The use of FG's in this study allowed for rich insights into the reasoning underlying sustainable food choices. To our knowledge this is the first study to apply the COM-B model to FG data exploring the barriers and enablers towards protein alternatives. The use of the model is an additional step in the analysis that has increased study clarity and efficiency. Therefore, we recommend future studies aiming to encourage more sustainable food consumption consider using this model to allow for comparisons to be made, especially when reviewing intervention strategies.

However, several limitations should also be noted when interpreting these qualitative results. The first relates to the small sample size, meaning the results are not generalizable to the UK population. Also, the

use of convenience sampling introduces self-selection bias. Despite efforts to recruit a range of young consumers, there was a skew towards female participants and more educated consumers. This may have influenced the changes participants made to their consumption habits, the level of awareness and knowledge around the environmental impact of food and the acceptance of alternatives. Future research should therefore employ quantitative research methods, with larger more representative sample sizes to explore additional demographic groups. For example, consumers with lower education and income levels may face more barriers towards sustainable consumption habits and be more resistant to accepting alternatives. Other factors worth considering relate to dietary preferences, cultural backgrounds, food neophobia, meat attachment and personality traits.

7. Practical implications

Our increased experiences with plant-based products provides foundational learnings for the barriers and enablers towards cell-based products. In general, to enable a more effective shift in behaviour, first impressions could be key, and therefore it is critical that products consider the balance between sensory appeal and over-processing. To initiate and maintain a shift in behaviour, the following factors mentioned should also be considered; affordability, functionality and convenience, as well as environmental, ethical and health benefits. If products are set to launch in the UK, the below factors may be of interest.

When developing PBM/S and CBM/S, consideration should be given to the preferred format in which to market products (i.e., processed, unprocessed, whole, species type). Findings from this study, suggest consumers expect cell-based products to be available in a processed format (e.g., nuggets, burgers, calamari) instead of unprocessed (e.g., chicken breast, steaks, prawns). Partially, this could be due to consumers current experiences with processed plant-based products. Although presenting cell-based products whole could be more technologically challenging, which was acknowledged by participants, it would offer an opportunity for the cell-based market to differentiate itself from the plant-based market, which is somewhat saturated with processed alternatives. Furthermore, presenting CBM/S as unprocessed and whole (e.g., steaks, fish fillets) may reduce negative perceptions around over-processing, which plant-based products currently experience. Whether this is related to a more 'natural' appearance or reduced ingredient list is yet to be understood.

To improve and promote liking for PBS, CBS and PFD, it is important to clarify the necessity of these products in supporting sustainable seafood and dairy consumption. Messages should communicate the benefits of consuming seafood sustainably (e.g., protecting fish-stocks, reducing by-catch) and consuming dairy sustainably (e.g., reducing GHG emissions, improving animal welfare). Advice should also be given as to how best to consume seafood sustainably (e.g., consuming a wider variety of fish, consuming in moderation, substituting with PBS/CBS) and dairy sustainably (e.g., consuming in moderation, substituting with PFD).

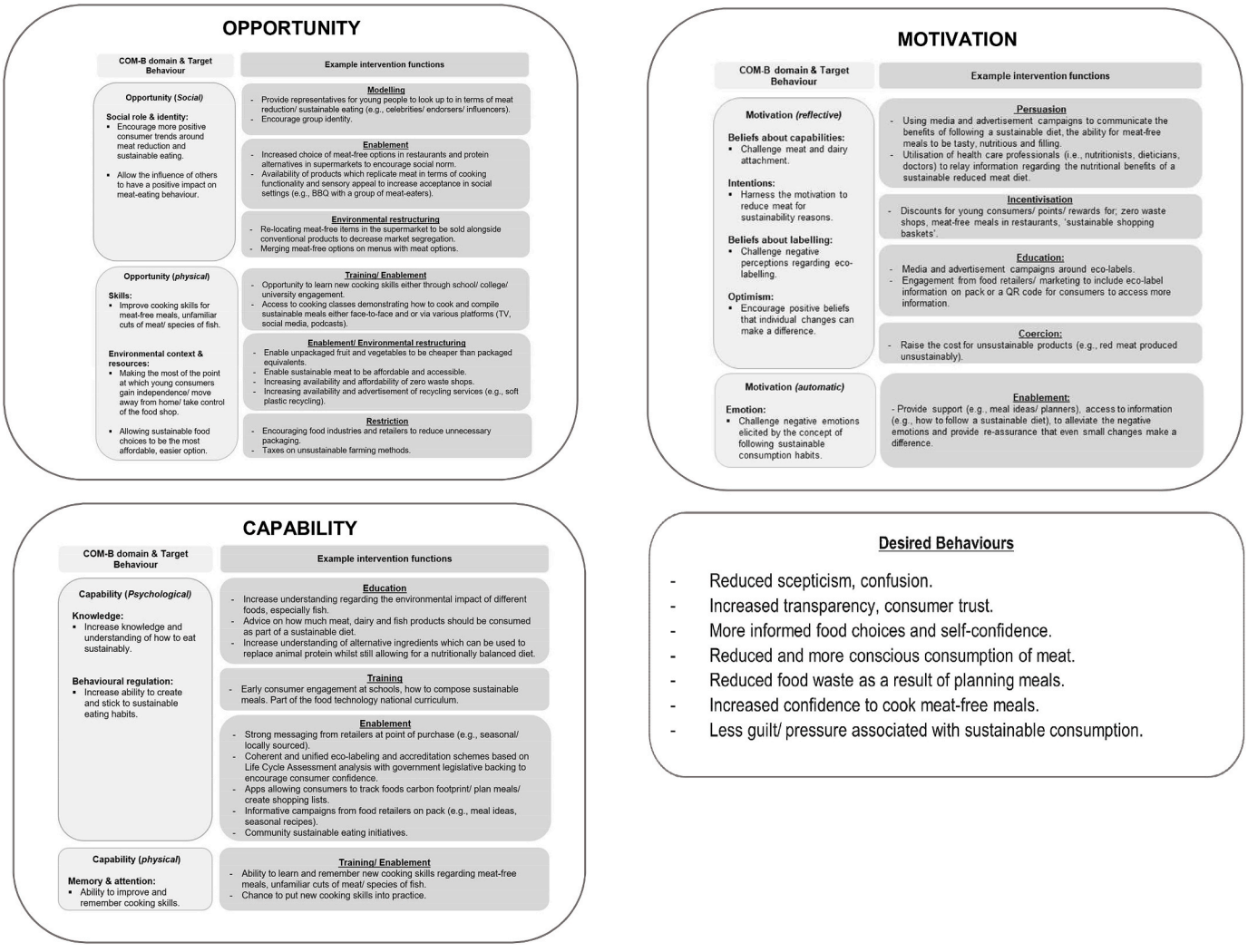

Fig. 2. COM-B domain and target behaviour with example interventions following the BCW model components.

In addition, for PFD, it will be important to highlight the added benefits products can potentially provide over current dairy alternatives. For many participants, not being able to find dairy alternatives that tasted the same or performed the same way when cooking or baking acted as barriers towards acceptance. It also prevented many from reducing dairy intake in general. So, highlighting the potential sensory and functional benefits alongside positive environmental, ethical and welfare factors is key when marketing products.

Lastly, Fig. 2 provides a summary of behavioural intervention strategies given as general suggestions and opportunities for encouraging sustainable food consumption and builds on previous literature using the COM-B model (Onwezen, 2022). Strategies within each domain should be combined, as simply providing information, or making products affordable is not enough (Abrahamse, 2020). Considering the suggestions are generalised, future research would benefit from providing actionable routes for individual bodies, such as the food industry and policy makers. For example, a previous study applying the COM-B model outlined separate proposed actions around meat reduction for consumers and external agents (Veiga et al., 2023).

8. Conclusion

Consumers are increasingly encouraged to follow sustainable food consumption habits for personal and planetary health, which includes moving away from animal derived products. Current and future protein alternatives have the potential to support dietary transitions, but their success largely depends on consumer perceptions. This exploratory study with young adults identified some sustainable consumption habits and perceptions, in that there was a general trend towards meat reduction, an awareness of the link between food and climate change and an optimistic view of new food technologies supporting future protein transitions. New-found self-sufficiency gained from moving away from home, alongside limited food budgets and the influence of others created changes in consumption, which signifies the importance of this transitional life stage on the formation of new behaviours. However, barriers related to quantifying the environmental impact of food, which led to uncertainty around how best to make sustainable food choices. This knowledge gap was especially apparent for dairy and seafood compared to meat. To some extent this was reflected in the acceptance of plant-based products, in which consumers had increased consumption of PBM, but had little experience or interest in trying PBS. There was also a greater level of awareness around the concept of CBM compared to CBS and PFD. Moving forward, quantitative data and longitudinal studies with larger more representative samples are needed to monitor the ongoing changes consumers make to their dietary habits and to further understand perceptions towards future protein alternatives. Based on these findings, the research suggests opportunities for intervention strategies aiming to encourage more sustainable food consumption habits amongst young meat-eaters. Importantly, this includes increasing public awareness around the environmental impact of food, especially for seafood and dairy. The research also outlines factors that should be considered when developing and launching current and future protein alternatives aimed at young meat-eaters. Notably, this includes prioritising affordability.

Author statement

Hannah Ford: Conceptualisation; Data curation; Formal analysis, Investigation; Methodology; Project administration; Visualization; Writing – original draft, review & editing; **Joanne Gould**: Supervision; Writing - review and editing; **Lukas Danner**: Supervision; Writing - review and editing; **Susan E.P. Bastian**: Supervision; Writing - review and editing; **Qian Yang**: Conceptualisation; Funding acquisition; Methodology; Supervision; Writing – review and editing.

Data statement

The lead author has full access to the data reported in the manuscript. Data will be made available on request.

Ethical statement

The study was approved by the University of Nottingham's Faculty of Medicine and Health Sciences Ethics Committee (Ref. number:354–0921,22nd October 2021).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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