

Article

Going Vegan: The Role(s) of ICT in Vegan Practice Transformation

Dennis Lawo , Margarita Esau , Philip Engelbutzeder and Gunnar Stevens

Information Systems, University of Siegen, 57068 Siegen, Germany; margarita.esau@uni-siegen.de (M.E.); philip.engelbutzeder@uni-siegen.de (P.E.); gunnar.stevens@uni-siegen.de (G.S.)

* Correspondence: dennis.lawo@uni-siegen.de

Received: 5 June 2020; Accepted: 23 June 2020; Published: 25 June 2020



Abstract: With the debate on climate change, topics of diet change and the reduction of animal products have become increasingly important in both public and academic discourses. However, sustainable ICT studies have so far focused on individual aspects, in particular investigating the criticized persuasive design approach. We argue for a broader perspective on the role(s) of ICT, one that helps in identifying opportunities to support consumer practice transformation, beyond motivational aspects. Based on retrospective interviews with 16 vegans, we argue to understand practice transformation as co-evolution of practices and ICT artefacts, as this perspective helps to understand how tensions arising from complex entanglements of practices, socio-material contexts, and communities can be resolved. Rather than a motivational process, we observe various roles of ICT artefacts co-evolving with practices: Ranging from initial irritation, to access to information about vegan practices, to the learning of vegan food literacy, to the negotiation of a vegan identity, and vegan norms at the intersection of the ‘odd’ and the ‘norm’.

Keywords: vegan; practice theory; co-evolution; ICT; consumer informatics; sustainability; design

1. Introduction

“A shift in the social norm of meat consumption is a transition that is repeatedly called for in climate change policy discourse. Yet this rarely sets out practically how such reduction might be achieved and, surprisingly, has yet to look to vegans as a knowledge resource.” [1]

From an ecological perspective, Veganism, once considered to be something over-ethical and nearly religious, has taken on new significance as the ecological consequences of diet choice have become more apparent. Nowadays, it is acknowledged that dietary choices have significant consequences for sustainability [2,3]. Compared to a regular omnivorous diet, veganism usually causes a much lower carbon footprint [4,5] and is associated with health improvements [6]. Indeed, “the Intergovernmental Panel on Climate Change (IPCC) includes a policy recommendation to reduce meat consumption” [7].

This raises the question of how ICT could support the transformation of omnivorous consumer practices towards plant-based practices. Sustainable ICT research has hitherto been dominated by a ‘persuasive’ perspective focusing on rational [8] and sluggish consumers [9]. These approaches usually have a positive short-term impact on the motivation to change behaviors, but their long-term impact is uncertain [10–14]. The argument is that we need to understand, in more detail, how people construct sustainable practices themselves and how such perception is shaped by their socio-material environment [15,16].

Addressing these issues, research on (non-)sustainable practices has emerged as an alternative lens [8]. This lens was applied to energy consumption (e.g., [10–12,15,16]), and also food waste [17], food sharing [18], and recently organic food consumption [19]. Yet, where studies on the transition

to vegan practices exist, they mainly originate from social science, neglecting the role of ICT artefacts [4,20,21].

Research Gap: While there is a rich body of knowledge about ICT in pro-environmental behavioral change and nudging, as well studies on sustainable consumer practices in general, less is known about practice theories in action and ICT not just for motivational aspects but for the long-term transformation of consumer practices [8,22].

It is exactly this knowledge about the complex evolution of entangled practices and the involvement of ICT artefacts that is important if design is for successfully supporting sustainable transformation [23]. However, the question of how “technology [can] promote reflection on diet [and sustainable practices] more strategically over longer periods?” [24] remains unanswered. In light of this research gap, we address the research questions of ‘How to support vegan practice transformation with ICT artefacts?’ and ‘How do these ICT artefacts co-evolve with practices in the transition towards vegan practices?’.

To answer these questions, we conducted a qualitative study with 16 participants, using semi-structured interviews. The focus was on vegan food practices, as food consumption is acknowledged for the high environmental impact and is more present in daily practices than buying clothes for example. Furthermore, diet is often the starting point for veganism [25]. Nonetheless, we provide related information on other consumption fields and discuss the extension of vegan design towards a broader inclusion of other consumption infrastructures. We used Shove et al.’s [26,27] and Twine’s work [1] together with work on appropriation [28,29] as a theoretical lens to understand the role of ICT artefacts in long term sustainable practice transformation.

From this retrospective perspective on practice transformation, our findings (as summarized in Figure 1) show that rather than a motivational process, we should understand practice transformations as a co-evolution of practices and ICT artefacts. We observe co-evolving artefacts ranging from initial irritation, to access to information about vegan practices, to the learning of vegan food literacy, to the negotiation of a vegan identity, and vegan norms at the intersection of the ‘odd’ and the ‘norm’. While our results at first sight only contribute to the study of vegan practices, we argue that co-evolution is a helpful lens to study and design for sustainable practice transformation in general, especially in the light of increasing awareness of the importance of green issues.

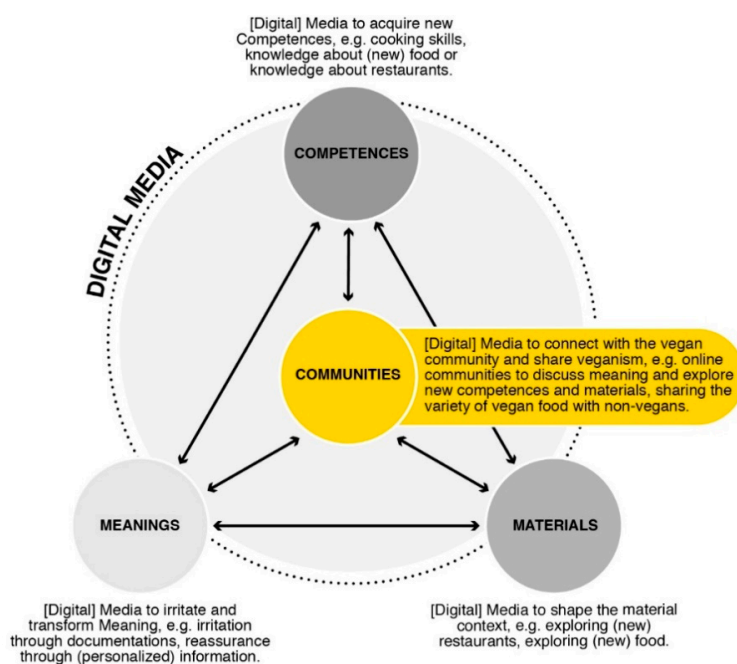


Figure 1. Summary of findings.

1.1. Transforming Practices and Forming New Practices

Practice-theoretically informed ICT interventions found a deeper understanding of sustainable consumption practices and the socio-material context that shapes them [8,17,30,31]. This lens has been used to uncover ICT design opportunities, such as food sharing as a means to procure and dispose of food [18], studying sweet spots in consumption practices to prevent food waste [17], or opportunities for other food-related practices, such as gardening [32], foraging [33], and recently, organic food consumption [19].

Practices, in general, are understood as the “routinized way in which bodies are moved, objects are handled, subjects are treated, things are described and the world is understood” [34]. Beyond this rather broad definition, one can distinguish between materials, competences, and meanings of a practice [26,27]. *Meanings* are understood as the “symbolic meanings, ideas and aspirations” [27]. It is related to what Reckwitz calls mental activities, emotions, and motivational knowledge [34]. *Competences* are understood as skills and know-how, practical knowledge, or techniques [27], for example, knowing how to prepare a particular recipe [35]. Lastly, *Materials* refers to “objects, infrastructures, tools, hardware and the body itself” [27]. They are related to Reckwitz’ [34] notion that “things [. . . and] objects [are] necessary components of many practices”.

Given this framework, the question of how to transform practices emerges. In daily consumer routines, the elements are connected stably, creating a kind of equilibrium [29]. A change of one of the elements creates an imbalance, resulting in a “crises of routine” [34]. For the resulting dynamics, Shove et al. [27] distinguish between *practices*, *proto-practices*, and *ex-practices*. *Practices* are the well-established and unconsciously performed routines. *Proto-practices* are practices that are not yet incorporated by the person because relevant elements are not yet appropriated or not yet linked. In contrast, *ex-practices* are practices that have been abandoned because one of the links has broken [27].

Based on this understanding, interventions aim to destabilize practices and reestablish new practices. However, still due to the complex entangled nature of practices [17] and how sustainable practices are still considered as something ‘odd’ [23] as the benefits of “good individual choices” [17] are not always recognized equally, designing and understanding these interventions is not straightforward. As most research hitherto has studied practice from a prospective standpoint, we lack strategies on how to transform practices in the long term [24], solving the tensions arising from the entanglement of practices [17,36] and departures from the ‘norm’ [23,37]. Indeed, this problem has been seen across a range of contexts, including car-free mobility [23], simple living [38], and water-reduced bathing [36].

1.2. Appropriation of ICT Artefacts

Hasselqvist et al.’s [23] work on transformation towards car-free mobility practices already highlights that practice transformation comes with the appropriation of new artefacts. For example, the usage of a planning tool to find suitable routes for the new vehicle. As stressed by Stevens and Pipek [29], such *making use* is a dual process that changes both the object and the subject. The adoption includes acquiring new competences through informal learning, resulting in a transformation of the practice itself [39,40]. However, it is not only the practice itself but the ecology of ICT artefacts that is dynamically adapted to the introduction of new artefacts, e.g., abandoning other artefacts or establishing of joint usage [41]. Appropriation is thus closely related to what Engeström [42,43] calls *expansive learning*. Expansive learning mainly happens in the wild, where neither the learning goals nor the learning activities are defined in advance but are open-ended. It starts with the diffuse feeling of a need and the reflection of inner contradictions in the situation at hand (unsatisfactory state), followed by exploring and trying out new options and ideas (excited state) and finally finds a new equilibrium in a stable state [41].

Appropriating new artefacts and learning new practices does not happen in isolation but involves enculturation into a community of practice [44–46]. With the ongoing performance of a practice, the community implicitly communicates knowledge, values, and identities that can be learned by newcomers. Members share their commitment to the community as well as the competences, materials,

and meanings, “in short a shared practice” [47]. Several studies [48–50] have demonstrated that practitioners do not need to be co-located and that newcomers can also become enculturated by participating in virtual communities of practice.

ICT artefacts play a twofold role in the process of appropriation, expansive learning, and enculturation. They are objects of appropriation [29,41], but at the same time, they are also the medium as they support practice transformation [23].

1.3. Sustainable Food Consumption Practices and Veganism

Veganism includes a general exclusion of animal products, e.g., in food, cosmetics, and clothing [25]. Besides the ethical reasons cited for veganism, criticism on industrial large-scale livestock farming, health considerations, and environmental protection can be motivations for vegans [4,25]. In particular, greenhouse gas emissions are strongly correlated with animal consumption [5,51].

Twine [4] shows how, for diet transition, different modes of food change are entangled with the adoption of vegan practices, ranging from substitution to the exploration of new dishes and products, as well as the adaption of competences relating to the new material (food). Such change is reflected in the ‘veganization’ of meals with plant-based substitutes for animal products or a shift towards two-part vegetable meals instead of a tripartite arrangement around meat as the main ingredient [4]. Adopting Shove et al.’s [26,27] practice lens, Twine [1] identifies essential elements that constitute new vegan practices. Their framework highlights the interaction of new competences, such as vegan cooking skills or knowledge about eating-out options, the new materials, e.g., the vegan food substitutes or the restaurants themselves, and the meaning of veganism in respect of pleasure, health, and/or ethical behavior [1]. Thus, a vegan diet transition not only affects eating, but also other practices, such as cooking or buying food.

As practices should be understood within their socio-material context, it is worth broadening the scope towards the environment vegan practices are currently conducted in. In general, vegan practices, as other anti-consumer movements that deviate from regular consumption patterns, can be referred to as a niche practice. This perspective highlights the gap between regime consumption infrastructures and the needs of niche practitioners [37]. Not only from a practice-perspective but also based on the number of vegans in Germany [25] and other European countries such as the UK [4], vegans remain a niche with a little over 1 percent of the population. In other countries such as Spain or France, the number remains even lower [52].

However, the situation is changing; over recent years, a continuous rise in the number of vegans could be observed [25,53]. This change is resembled in an increasingly growing market for vegan products and restaurants. Also, the market for media such as books is growing [53]. Here, it can be assumed that a similar trend can be observed for other media. In a similar vein, the vegan label (issued by a European Vegan NGO [53]), as well as other private labels [1], are increasingly established. For non-food consumption domains labeling is not yet widespread, but evolving [53]. However, there are various different labels, that not always follow a transparent and consumer-friendly definition of veganism, nor are all products labeled [54].

From a governmental and consumer protection perspective, this topic of regulating vegan labeling and facilitating consumer choice was neglected for a long time. Until today, there had been no governmental label and only a few years ago the German federal states agreed on a definition for the term ‘vegan’ [54]. The situation is similar on a European level, where no binding definition for vegan food exists [54]. Sustainable consumption, against the background of this market-based policy-making, is mostly treated as a consumers’ responsibility and a matter of informed choice, rather than a topic for pro-vegan or pro-environmental policy [55]. For Germany and France, consumer protection even goes in a different direction. In 2018, the German Federal Ministry of Food and Agriculture issued legislation that complicates the naming of substitutes, e.g., ‘vegan sausage’ [56]. In France, we found rulings than ban ‘meaty’ names for substitutes [57].

Not only from a legal perspective but also from a western cultural perspective, meat consumption is traditionally understood as a symbol of prosperity and wellbeing [21]. In the media, consuming animals and speciesism is reproduced as the norm [58]. This positive perception is also reflected in the negative reactions to ‘vegetarian day’ policy suggestions for public canteens. In 2013, the German Green Party suggested introducing a ‘vegetarian day’ in German public canteens, however their idea was broadly commented by public media as “‘an ideological lifestyle dictatorship’ or ‘a disenfranchisement of citizens’” [55]. Similar reactions to veganism were studied for UK media, that perpetuate vegan marginalization and bias [58]. Despite its positive aspects, veganism is still arguably perceived by many as somewhat abnormal and characterized by a puritanical view of life [21]. Such an attitude places vegans in the position of explaining and justifying their ‘niche’ practice [37] in their social environment. Various strategies can be identified as to how vegans deal with this kind of social pressure. The intentional choice of vegan partners (also called *vegan sexuality* [20]), for instance, aims to avoid such conflicts, at least within the partnership. There are also more inclusive behaviors such as the cooking and presentation of vegan dishes to show non-vegans the benefits that can be gained from vegan meals, attempting to trigger a change of values [21]. In summary, it can be stated that vegan practices are increasingly conducted, which follows an increasingly growing market and more and more labeling of products. Still, from a governmental and a consumer protection perspective, there is no clear support for veganism and the related issue. In a similar vein, despite the growing number of vegans, practitioners remain a niche that has to justify its anti-consumerism and face social pressure.

2. Materials and Methods

To answer our research questions, we conducted semi-structured interviews with vegans in Germany. Our qualitative sample of 16 vegans was recruited through a snowball sampling procedure [59]. We started our recruitment with vegans from the extended social network of the authors and social media. The main criterion for participation was the maintenance of a vegan diet (based on the participants’ self-images). We explained to participants the purpose of our research and informed them about the (anonymous) storage of data on university computers and use for research only. Further, we emphasized that participation was voluntary and that they could choose at any time to discontinue. Afterward, participants gave us their informed consent. We also ensured that the sample matched the socio-demographic structure of vegans in Germany: Vegans in Germany are 80% primarily female [25], have an average age of 31 [25], tend to have a higher formal education [60], and tend to live in urban areas [60]. This tendency of vegans to be female, young, and educated is also reflected in our participant sample (see Table 1).

Our interview guideline covered the participants’ vegan diet and lifestyle (e.g., duration, self-image, further dietary restrictions, motivation), reflection on artefact use alongside their dietary changes (including both artefacts still in use, but also once used), and reflection on how their practices (Planning, Procurement, Preparation, Eating, Disposal [48]) changed in the course of going vegan.

The interviews took between 13 and 50 min (Ø: 25 min). Afterward, the interviews were transcribed and coded using Catma (CATMA—For Undogmatic Textual Markup and Analysis (<https://catma.de/>)). The interview data were analyzed using thematic analysis [61]. Twine’s work [1] together with work on appropriation [28,29] is used as an initial template of codes [62]. During our inductive analysis, we especially drew upon the notion of the dynamic evolution of practices [27], the importance and appropriation of artefacts as part of vegan practices, as well as the transitions implicated. After each iteration, we discussed the codes and developed themes collaboratively. Note that, for the presentation of results participants’ quotes were translated to English, and location information was anonymized.

Table 1. Participating vegans.

No.	Age	Gender	Education	Job	Household	Residence
P1	17	Female	Student (Highschool)		With Family	Suburban
P2	17	Female	Student (Highschool)		With Family	Rural
P3	21	Female	Student (Bachelor)		Flat Sharing	Urban
P4	21	Female	Student (Bachelor)	Translator	Flat Sharing	Urban
P5	22	Female	Student (Bachelor)	Assistant in Finance	Flat Sharing	Urban
P6	22	Female	University Degree		Alone	Urban
P7	23	Female	Apprenticeship	Laboratory Assistant	Alone	Suburban
P8	25	Female	University Degree		Alone	Urban
P9	26	Female	University Degree	Job seeking	Alone/With Family	Urban/Rural
P10	26	Female	University Degree	Assistant	Flat Sharing	Urban
P11	27	Female	University Degree	HR-Manager	Alone	Urban
P12	29	Female	University Degree	Public Servant + Sports Teacher	With Partner	Urban
P13	26	Male	Student (Bachelor)		Alone	Urban
P14	28	Male	University Degree	Commercial Clerk	Alone	Urban
P15	29	Male	Apprenticeship	Accounting Clerk	Alone	Urban
P16	31	Male	Apprenticeship	Mid-Level Employee	With Partner	Rural

3. Results

3.1. Irritation and Reassurance

At the beginning of the vegan diet transition, the media immediately takes on an essential role in unfreezing established beliefs, meanings, and interpretation schema. While the first contact with a vegan diet is often due to exposure to documentary resources, leading to a questioning of one's diet, more critical is the role of media in establishing personal feasibility.

3.1.1. That is not True?

Asking about reasons and drivers of the transition towards a vegan lifestyle, P1, P3, and P10 reported that the first contact was mainly by video platforms such as Netflix and YouTube.

"There have been several, but for example the classic Netflix documentaries like Cowspiracy for example or Earthlings and on YouTube there's a lot of stuff like that ... and also channels of private people pushing stuff like that." P3

Documentaries such as *Cowspiracy*, *Earthlings*, *The End of Meat*, and *What the Health* were repeatedly mentioned in the interviews as a critical experience, e.g., by participants P3, P4, P8, and P9. Our participants found themselves confronted by such documentaries and related pro-vegan information resources serendipitously. For example, P15 could not in the first instance believe the facts shown in the documentaries and dismissed them as 'propaganda'. Such confrontation constitutes a 'friction' or 'irritation', which prompts reflection. Those terms refer to raising the self-reflection about previously unreflectively conducted practices. Where this occurred, we refer to the 'unfreezing' of practices. P4, P8, P9, and P11 also mention friends and acquaintances as triggers for questioning established food consumption practices. P14 also mentioned the importance of specific events such as the lasagna horse meat scandal in 2013 [63]. That event was his initial reason for rethinking his food consumption practices.

"In any case, the use of media played a big role because I also started with it. Those were mainly videos, videos about the vegan diet from different sources that I started watching, I motivated myself with those videos at the beginning where it was still difficult for me. I watched videos and different

pictures and yes, in any case, the media pushed me to go on, and yes I gathered further information from the media about how a healthy vegan lifestyle can be maintained.” P1

P1’s quote shows that various sources of information were used not only to validate the given information, but also to obtain even more details about the general feasibility of the diet. Hence, videos, which are, for example, accessed via YouTube, played an important role as did traditional print media. Indeed, the initial confrontation with health and livestock farming issues (especially animal suffering and dying) was frequently followed by a more intense encounter and exploration.

3.1.2. Does Veganism Work for Me?

In addition to the motivation mentioned by participant P1, the acquisition of nutritional skills and knowledge surrounding the maintenance of a vegan lifestyle also played an important role. P7 described how she received hints from YouTubers on nutrition and dietary supplementation, which reassured her, both about the feasibility and about the existence of a broader community. Besides the rather general information about the feasibility of a vegan diet, there was a demand for nutritional information. That information was gathered from YouTube, where different channels provide information that can be accumulated and measured by personal experience with a vegan diet. Another mode was mentioned by participant P12, who read books to triangulate information sources, thus aiming to make sense of the need for nutrients alongside the characteristics of food items.

“I think that it is difficult with your nutrients because as a vegan you have to make sure that you have all the nutrients and so on and it is also not necessarily so good to take vitamin B12, I mean continuously. It is excreted by the body. But it is not good to consume a permanent oversupply of it. I think I have no concrete idea, but I think that the nutrient thing, that it is important, because it is ultimately about your health. And you have to be reminded regularly that you have to do a blood test, that you just know if something is missing in your diet. I think that would be helpful, but I don’t have a specific approach.” P13

P13’s example shows her high degree of uncertainty regarding the correct amount of vitamins, especially vitamin B12, which is probably one of the most critical nutrients when maintaining a vegan diet since it only rarely occurs in plant-based food [64]. She explained how a blood test once a year ensures that the vegan diet meets bodily needs. This uncertainty demonstrates a desire for tailored and personalized information about one’s diet and whether the dietary needs in question are being met.

“Just to get a balanced diet. For example, beans, berries, other fruits and then it says how many portions you need. Then there are the vegetables. Other vegetables. Greens or what’s it called, cabbage, beans. Or just nuts. Whole grain, grain, water, sports. Vitamin B12. Vitamin D, water. And so on and so forth. I’ve tried that before, for a while. Well, that’s not so comprehensive now, it’s just an approximation, for example: One serving is 60g hummus. Zack. That’s it. When you’ve eaten that, you tick it off. Exactly here you have to eat three portions a day. Zack. Here you need one portion, how many berries are here, for example, frozen or fresh—60 g. It’s just so coarse. A rough guideline, so that you stop, yes.” P15

Instead of blood tests, 6 of our 16 participants started to use diet trackers. Those tools helped them, especially at the beginning of their transition, to increase their awareness about what food to eat in which amounts, but also to prove the feasibility of their diet to themselves. Nonetheless, the use of those devices was relatively brief for some participants due to the substantial effort required to track the food intake. Participants P7, P9, and P10 explained how they stopped using diet trackers because of the high workload entailed. Participant P15 stated that he stopped tracking and now “really hates” it, because it was “time-consuming”, although he admitted that a tracker could support “rough guidelines” for one’s nutrition.

Some participants seemed to dive straight into the vegan diet, while others described a step-by-step approach. P1 explained that she adopted a vegan lifestyle “from one day to another” and that she had

never dealt with a vegan diet before. Therefore, she did not eat a balanced diet for the first month but acquired insights into “how such a healthy, vegan lifestyle can work out” by watching videos. Participant P11 began her vegan diet with a “vegan week”, in which she made explicit and conscious choices every day, all geared to getting better informed about how a vegan perspective is constituted. During that time, she discovered a website by PETA ZWEI and signed up for 30 days of “vegan kick-start” in which she was supported by the organization. P11 found it helpful to get an organization newsletter every 2–3 days that she could respond to as well as a personal contact, to whom she could address questions.

3.2. Learning New Competences and Exploring Materiality

Once our participants had abandoned their former diet, they faced several practical problems. Restaurants and cafés are not necessarily vegan-friendly or beloved treats and recipes might include non-vegan ingredients. (Digital) media played a critical role in acquiring practical knowledge and exploring food, especially where to find it, answering questions such as the following.

3.2.1. Where can I Eat Vegan Food?

As a result of the change in diet, many previously visited restaurants were no longer suitable for the new vegans. To find more options, our participants used various websites, apps, and blogs (e.g., from PETA). Further sources for help were acquaintances and friends (P3, P11).

“In fact, over the Internet. I don’t know, I sat down and googled for some time. Vegan restaurants in (big city) and surroundings and there are actually unbelievable many in (big city).” P1

The quote shows how P1 rediscovered her environment with the help of Google and how she was surprised about how many vegan options there were in her neighborhood. Eight of the 16 participants used HappyCow or Vanilla Bean, which offer information created by other users and show different vegan options on a map. They use these apps to find vegan or vegan-friendly restaurants and cafés. Even so, they highlighted that they now primarily used these apps in foreign places.

“Yes, definitely. That’s HappyCow, I own the free version and especially when I’m traveling, or when I’m in a city where I don’t know any vegan places.” P11

This seems to be a general pattern for using such apps and websites: After the initial exploration of the surrounding neighborhood in the city of residence, regular use decreases over time. As the degree of familiarity with these features of the locality increased, the information provided by these apps was internalized. Apps of this kind continue to be used, unsurprisingly, when visiting unfamiliar locations.

A little surprising was that our participants did not use the resources of this kind to find vegan-friendly stores and supermarkets. Instead, the participants mostly continue to shop for their vegan foods in regular chain-supermarkets as well as known organic supermarkets. Only P5 stated that she occasionally bought special vegan food online.

3.2.2. What can I Eat?

In much the same way, the material quality of food was also rediscovered in vegan practices.

“I think CodeCheck definitely, that was a big thing for me, that I could always scan the... this barcode then and then it was in there whether it is vegan or whether it is maybe vegan or was tested on animals. That was a super big help, but after a while it is marginalized, because then I knew what is vegan and meanwhile it’s everywhere anyway. That means the time helped me there also a little bit.” P11

Participant P11 described the difficulty of a transition from relatively carefree shopping to shopping or consumption with a more considered approach to the ingredients and properties of the food. Participants P3, P4, and P7 also described how artefacts, especially CodeCheck, helped in

gathering further information about the product. However, according to nine participants, an initial assessment here is also possible by simply looking at the ingredients and allergens of a product, or solely at vegan-trade-signs. However, the former is not always valid because, as participant P3 stated, some products use flavoring substances, e.g., lard in potato chips, that is not declared in the ingredient list.

“You learn so much from the ingredients and then you’ve looked at the product 5 times, then you know what’s in there, it’s vegan and it’s okay. Or with things like marzipan, you look on the ingredients list one time and then you eat it all the time. Just because there’s a label, no just because there’s no label on it doesn’t mean it’s not vegan. You have to pay attention to the ingredients and eventually you know it by heart.” P13

Similarly, to exploring food ingredients 5 participants explained how they try to reduce leather and animal fibers when buying clothes. While these participants did not report on any ICT support for checking the material of clothing or showing plant-based clothing stores, trade-signs and material lists are a good starting point for the purchase decision.

This information also has a direct effect on food- or product-specific knowledge in the sense of a competence, which is sufficient for most consumption situations, so that the medium subsequently loses its significance for daily practice, as the example of participant P13 shows. However, five participants explained that media such as CodeCheck or Google were still used in situations of uncertainty, e.g., when buying an unfamiliar product.

3.2.3. What can I Make from My New Food?

Participants described how they needed information on how to prepare vegetables as well as how to include them into dishes. This information was usually accessed by simply searching the internet for recipes or specific tutorials on how to prepare the vegetable as well as looking at vegan cookbooks.

“Yeah. Also. Within the last year, after I started to eat vegan, I’ve learned about so many new vegetables that I simply got to know, which I did not know before. You always see the whole variety of vegetables, but how can I prepare this at all. That wasn’t even clear to me. Meanwhile, I know how to do it, so I do it gladly, really. Vegetables that I have never processed or never bought. That I see now so ok it is just the season and then I like to buy it and then I look online. What can I do with it at all and then. Partly the meal I cook depends on the vegetables I buy. So, I’ve always been experimental about what I do with all that stuff.” P5

The example of participant P5 shows how this additional mode of food exploration is supported by (digital) media. She explained how she discovered a whole new variety of vegetables that were previously not included in her diet.

Besides the exploration of new vegetable possibilities, dishes, in general, seem to be transformed from a three-part meal towards a two-part meal, as Twine [4] already mentions in his work. This change was described by participants P7, P8, and P11. They explained how they usually cook some source of carbohydrate, e.g., potatoes or rice and some vegetables with it. P11 further highlighted beans as an addition to the vegetables.

“But if I have a special idea, for example, I wanted to bake a banana bread then I just google “banana bread vegan” and click on any recipe from a blog, those are mostly blogs I didn’t know.” P8

When it comes to the ‘veganization’ of formerly known dishes, the internet is, as the examples of participant P8, P10, P12, and P16 show, a good source for recipes. The internet provides enormous variety and, moreover, a variety that is coded to vegan interests. Participant P10 explained how he searched the internet for recipes of beloved childhood meals and inspiring meals from restaurants to ‘veganize’ them by finding a vegan version of the recipe. The same applies for inspiration for more

complex weekend dishes or dishes prepared for friends or family. To prepare them, special vegan blogs, Google, Instagram, or YouTube cooking channels are visited to get some inspiration, as seven of our participants explained. P5 described how she, at first, had difficulties in making use of the whole variety of vegan recipes. Thereby, they had some “trusted” blogs, from which they get, from their perspective, healthy recipes, as participants P8 and P10 state. An additional mode of inspiration and food exploration is, of course, the usage of vegan-style cookbooks as several participants explain, e.g., P11.

3.3. Community and Sharing Veganism

Prior work [20,21] already highlights how vegans negotiate and exchange the experiences of their diet with other vegans but also with the omnivorous majority. Since our participants were often the only vegans in their circle of acquaintances, artefacts helped them to connect with other vegans, but also to share and negotiate their practices with others.

3.3.1. Connecting with Other Vegans

With the transition to a vegan diet, media, especially social media such as Facebook, are used to make contact with like-minded people. As six participants show, this contact can take place on a purely digital, passive basis, in the sense of receiving information about offers of local supermarkets, inspiration, or recipes. Participant P11, however, often asked questions and engaged in exchanges, as the Facebook group was seen as a place of mutual understanding, where vegans are safe from being “flamed by somebody”. Understanding and security were also taken up by participants P1 and P7 in the context of finding a vegan community. The reasons were the annoying questions about their diet or the lack of understanding on the part of non-vegan people.

“I’m also a member of a vegan [Facebook] community. (big city) vegan, that’s the name. There you sometimes get a notification when a new restaurant opens or when there are special offers or something like that.” P14

Besides the example of participant P14, participant P11 mentioned how she learned new cooking skills and formerly unknown ingredients from such a group, e.g., making macarons with aquafaba (liquid remaining after chickpea cooking) as a substitute for eggs. At this point, interestingly, the aforementioned vegan groups have a strong local connection, usually containing the city or region name as well as some sort of vegan identifier. Besides the names, the content of these groups is also tied to the local context at least to some extent. While nutritional information is universally valid, information about restaurants and retailers is only of value for the local community. Furthermore, food infrastructures participants reported on various other consumption infrastructures that are exchanged in the community. These range from clothing stores, locations of leather-free furniture, or shoes without an animal-based glue. At this point, the variety of consumption infrastructure resembles veganism if often not only a matter of food consumption, but is also entangled with various other consumption practices, for which we yet found no ICT designs, but the appropriation of social media to exchange such information.

However, this exchange was not always successfully established, as participant P6 explained. She described how she tried to join an online community but found it difficult to get in touch with the other vegans. This difficulty is primarily because—despite the perceived expectation of non-vegans—being a ‘member’ is not always straightforward. Where membership of such online groups is successfully established, it is sometimes used to establish ‘offline’ contact.

“Yeah, so that is just called vegan regulars’ table ah and there was. I was once joining such a running group the somehow called good night running group or something like that. And there you always meet at full moon here at (locality) and run five kilometers or so and then make a donation for some animal welfare project. And there were mostly vegans, too.” P7

The example of participant P7 shows that regulars' tables are often formed, which put a stronger focus on face-to-face exchange and information retrieval. Apart from this, however, there are also people meeting for other leisure activities, such as the good night running group, a run against animal suffering. In this respect, the media has less of an informative function but more of a mediating role, which enables people to find like-minded people who, for instance, share similar eating habits.

3.3.2. Sharing Veganism

Within "the mode of performing veganism in a demonstrative manner that draws omnivores or vegetarians into the sensual experience of vegan food" [21], participant P8, as well as six other participants, explained how pictures of home-made vegan food were shared, as were photos of food from restaurants via Instagram to a broader public or with friends via messengers such as WhatsApp. The example of P8 shows how she hoped that the sharing of the sensual experience through the visual representation of her food motivated others to try a vegan diet. However, the sharing of food experiences was not always tied to a sense of motivating or persuading others to change their diet. Participant P10 explained how she uses pictures and recipes to "break with prejudices" about her vegan diet.

"I think subconsciously, one has always a little bit of hope that one can maybe motivate someone to try it for themselves. And because I maybe want to show the people that vegan food can be totally great and doesn't mean abandoning anything." P8

The quote from P8 shows her desire to share the perceived positive characteristics of vegan dishes and diet. Similarly, Participant P5 started her own Instagram account to share pictures of her vegan food. She explained that the ongoing questions "what can you still eat?" motivated her to share the variety of food that she consumes. She and participant P7 argued that they got positive reactions and significant interest from their audience who, they suggested, are often astonished by the fact that the meal was made without animal products and even that friends sometimes stated that they wished they could eat the food as well. In the circle of friends and acquaintances, however, food was not exclusively shared via digital media in the form of pictures. Six participants also described how they made a special effort when they cooked for others to improve the sensual experience of the prepared dishes.

"I think only once, when I was at the Christmas market, there at a vegan food truck and then I just posted a picture, but under the cloak of 'Christmas market' and not with the tag 'vegan'." P11

The desire to promote veganism is not universal. The example of participant P11 shows that not all participants share their vegan diet via Instagram with the public. While in the beginning, she wanted to convince people within her family and friends that they should reduce the share of meat within their diet, she nowadays shares her experiences without a specific reference to veganism. Thus, the "cloak of Christmas market" allows her to share the experience without explicitly telling a broader public about the details of her diet and therefore aligning with the (omnivorous) majority's narrative interests.

4. Discussion

While prior research studied the role of artefacts for changing entangled practices from a prospective perspective [17,36], our research provides insights on how vegan practices and artefacts co-evolve from a retrospective perspective.

In contrast to TTM [65], co-evolution is not a stepwise process, but requires multiple iterations of learning, exploring, and adjusting practices in a dialectic relationship with artefacts. However, there seems to be some 'unfreezing' of change, as an initial step in triggering the "crises of routine" [34], that creates the need for new artefactual use [41] and a desire to rethink practices [27]. From there on, a continuous, iterative learning of practices and adapting of artefacts begins, with a constant tinkering as new issues arise. Eventually, co-evolution will come to a new 'more' stable and satisfactory state,

where vegans become comfortable with their status and familiar with the various sources that enable this stability. Nevertheless, this has to be achieved in a context where veganism is still regarded as ‘odd’, at least by some. Negotiating the relationship with more ‘normal’ practices is a constant challenge.

This view draws on prior research [17,23,36] that highlights the evolutionary nature of practice transformation as well as research on dynamic artefact ecologies [41,66], that shows the interrelationship and changing nature of artefacts. However, our work adds to this perspective, by arguing that artefact ecologies and practices should be understood in their mutual relationship manifested as a co-evolution, rather than individually, when designing for sustainable practice transformation. This co-evolution is presented in Figure 2.

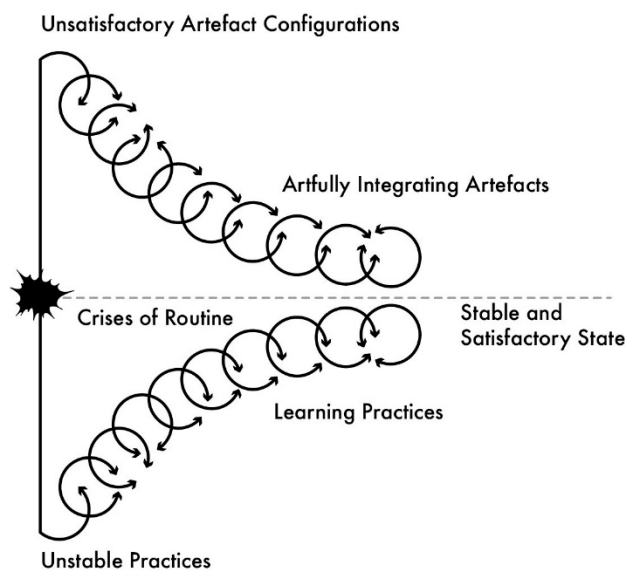


Figure 2. Co-evolving practices and artefacts (inspired by [67]).

From this perspective, artefact ecologies are not only dynamic [41] as new resources are found, but are also adaptive to the changing needs as people ‘become’ vegan. This is redolent of Becker’s [68] famous paper on marijuana use, where he demonstrates the cultural practices required to become a competent user.

4.1. Co-Evolution from a Perspective of Practices

From a perspective of evolving vegan practices, meanings, competences, materials [1,4], and communities [20,21] are underpinned by a dynamic ecology of artefacts contributing to the incorporation of elements and a progressive stabilization of use.

For *meaning*, the role of artefacts slightly shifts with the evolution of vegan practices. With the initial confrontation, we observed that artefacts helped to unfreeze the existing, routinized non-vegan practices by questioning established beliefs, views, and meanings. There are some parallels with persuasive approaches [69], even if none of the participants mentioned the use of persuasive and gamified technologies, e.g., eco-feedback to motivate and sustain diet-change. Instead, we observed something that could be called *persuasive rhetoric*. For instance, documentaries about veganism use persuasive rhetoric to raise people’s awareness about veganism and confront viewers with the negative effects of meat consumption and livestock farming. To validate the information seen in documentaries, our participants were making use of different information sources. For instance, some participants used diet trackers or medical tests to verify information consumed or practices explored. In particular, the reassurance of the personal feasibility of the diet went hand in hand with testing to understand what veganism means for oneself and one’s body.

Overall, we saw that the old interpretation schema is not suddenly and entirely replaced by a new one. Instead, meaning shifts over time. Most participants did not have a complete commitment to veganism as an alternative diet in the beginning but proved the feasibility and practicability of veganism with their ongoing evolutionary practices. When stabilizing, reflection turned to moral commitment, exhibited in various forms of sharing meaning with vegans as well as non-vegans.

For materials, we can distinguish between two mutually related areas: First, the materiality of practices, including physical performances, tools used, goods, infrastructures, etc., and second, how such materiality becomes relevant to practice.

For the first, we observed, in keeping with Twine [4], how some participants changed their diet patterns by substituting non-vegan products to veganize recipes and changed from the tripartite structure towards meals that consisted of vegetables and carbohydrates only. Our participants also abandoned a variety of practices involving certain materials such as visiting non-vegan restaurants and buying non-vegan food. For the second, our study reveals that artefacts help to compensate such loss by supporting the exploration of potential new materials, such as providing access to unknown vegetables, substitution recipes, or raising awareness of vegan-friendly restaurants.

For competences, as outlined by Twine [1,4], we also observed that a change of competence was linked to and mediated by changed material use. Vegan newcomers must acquire new competences in many areas, such as finding and preparing appropriate food, appropriating existing vegan infrastructures, such as vegan-friendly restaurants in their neighborhood, or figuring out how to make use of online recipe databases. Additionally, appropriate behaviors and actions must be learned and explored, e.g., how to stay politely when the own practice is commented by others or how to offer food to non-vegans without being the 'killjoy' [21]. Here, artefacts do not only serve as an 'awareness' tool, but also help people to incorporate new elements into their practice. They not only provide facts and information about veganism, but also what Pipek [70] calls appropriation support. For instance, cooking videos show how to perform practices such as substituting eggs when baking macarons.

For communities, artefacts play an important role in connecting vegan newcomers and experienced practitioners either online or (less often) offline. Vegans are sometimes confronted with the reaction by an omnivorous norm, ranging from the merely unhelpful to offensive reactions [21]. Against this background, it is not surprising that social and symbolic support becomes important. Our participants actively searched for like-minded people as they presented a kind of safe space to develop and try out a new vegan identity and role model. They actively oriented to the presentation of their lifestyle as 'valued'. However, as noted by Warde [71], such communities do not just provide symbolic support, but constantly negotiate rules and norms towards a mutual understanding of how the practice has to be adequately performed.

In contrast to this inner orientation, prior research [23,38] pinpoints the co-existence and tension of 'norm' and 'odd' practices. Our study shows that the two are linked in a dialogic relationship. Our participants, as newcomers to vegan practices, negotiate meanings and share knowledge and positive experience with their omnivorous families and friends. Similar to the conflicts and justification strategies (see [20,21]), presenting perceived advantages of the new, vegan diet seems to be aimed towards decreasing prejudice and exploring ways to co-exist, e.g., cooking for both vegan and non-vegan guests.

4.2. Co-Evolution from a Perspective of ICT Artefacts

We can observe how the composition of the artefact ecology changes with the ongoing incorporation of practices, enabling iterative learning steps that then cause a reconfiguration of artefacts.

Artefacts as irritation and reassurance tools are important especially at the beginning of practice transformation, as they trigger "crises of routine" [34] by *productive confrontation* [29], for example when challenging existing beliefs about one's diet when watching documentaries or reading about a food scandal. This irritation leads to a tension that unfreezes existing convictions and dismantles existing linkages between the practice elements, preparing the ground for the emergence of new

proto-practices (see [27]). Still, the reconfiguration of the artefact ecology with such media in use does not automatically lead to a practice transformation. At this point, either new artefacts need to be iteratively incorporated or artefacts need to be used in different ways as new practices evolve.

However, from time to time, tools to reassure become important again. This is similar to Engeström's cycle of expansive learning [42,43]. In our results, this is shown in the notion of 'reflecting on the process' by vegans, providing reassurance e.g., when identifying new meals as sufficiently nutritious by means of diet trackers or reflecting on diet change in more general terms by blood tests after a certain time.

Artefacts as information and learning tools play an essential role in recreating new linkages by exploring a 'vegan' material environment as well as supporting knowledge and competence building. Foundation for this exploration, is visibility of practices and the entangled infrastructures, that would otherwise remain hidden within an omnivorous practice regime. As the example of restaurant search shows, applications and information sources, such as *HappyCow*, are intensively used in the early evolution of vegan practices, but their use diminishes over time. Similarly, learning recipes or scanning food becomes less important when competences and materials are incorporated, and practices stabilize.

Although certain artefacts seem to decrease in importance with developing environmental familiarity, they re-emerge into the ecology when traveling to an unknown location or stumbling upon a new product when grocery shopping.

Artefacts as communication tools connect vegan newcomers with an (online) community of practice. For example, when tensions with the omnivorous 'norm' practices arise, communication tools provide a means for reassurance and defensive strategy. They also provide for more active use, such as exchange about new food, restaurants, or preparation techniques. While communication was mostly online, some communities' activities shift to the 'offline world'. In those cases, communication tools enable the formation of an offline community, but once friendships and regular meetings are established, it became less important.

From a more general perspective, the artefact ecology shifts in very contingent ways. Use can be thought of as a kind of "bricolage"—tinkering, exploration, and reassurance, characterized by discontinuities and situational factors. This bricolage has been demonstrated in other contexts [29,72], sometimes referred to as artful integration [73,74], or creative consumption [75,76]. Thereby, change to the ecology of ICT artefacts follows the logic of making vegan practices and practice transformation more convenient. In the beginning, it is the lack of routinization that is supported by ICT, while in later transformation, convenience is provided by again incorporating tools to deal with unusual situations. Still, convenience and the usage of ICT cannot be understood as a luxury problem but as a support of fundamental daily routines and the satisfaction of basic needs when infrastructures and practice elements are invisible. Based on early work on veganism [77], we assume that a lack of such visibility induced by technology would raise the perception of barriers to vegan practices as opportunities, e.g., in the neighborhood, would remain invisible. From a practice theoretical perspective on the technologies, this goes along with media as part of practice, to change meanings, learn competences, explore materials, and enculturate into communities [1]. These different role(s) that are part of practice [1] and their iterative contribution are in contrast to motivational design research that aimed to motivate rational consumers with enough motivational and informational resources [8,12]. Still, motivation is one aspect of practices, as the documentaries that accompany early vegan practice transformation show. However, these just provide some basic torque for transformation that would quickly decrease if the appropriation of a socio-materiality would be difficult.

CodeCheck, for example, was not designed for vegans. Still, it has become common practice in vegan communities to use it as a tool to determine more details about product ingredients and to avoid unintentionally buying and eating non-vegan food. The search for vegan-friendly restaurants presents another example of such creative consumption: There are specifically designed apps such as *VanillaBean* or *HappyCow* for this purpose. However, we also observed that participants adopt appropriate filtering strategies to obtain information about vegan restaurants when using Google and/or Google Maps.

In addition, single artefacts are used in combination to support the evolution of practice transformation, as the reflection of the new vegan cooking practices by means of diet tracking shows.

4.3. Designing for Co-Evolution of Vegan Practices

Our research uncovered the use of various ICT artefacts along with the practice transformation of *Going Vegan*, still, there are several blind spots in current design to be addressed by future research and design. Although we argue that no single ICT design transforms practices like a 'magic-bullet', novel and vegan sensitive design could contribute to small steps towards vegan practices and the appropriation of such. *Designing for Value Tensions between Livestock Farming and Consumed Reality*: By now design research focused on small changes of practices, e.g., by encouraging organic food consumption [19] or reducing food waste [17]. Often these studies aim to raise awareness about the lived reality of consumption and the therefrom caused environmental impacts [22]. For veganism, to the best of our knowledge, no such study was conducted [22]. While our research observed value tensions between the realities of livestock farming and consumer values, as well as information on perceived barriers of change, to cause reflection on consumption patterns, it remains unclear how to successfully design for encouraging (more) plant-based consumption. An interesting approach is the various challenges, e.g., Veganuary (<https://uk.veganuary.com/>). However, also linking effects of own consumption patterns to the conditions of livestock farming, environmental, and health impacts might be promising. At this point, tying up to previous work on visualizing organic food consumption [19] shows paths for awareness-raising designs. Still, vegan design needs supply-chain information, e.g., place of origin, living conditions, and transport conditions. Furthermore, how to communicate and design such information remains an open gap between research on vegan practices and environmental psychology.

Designing for Visibility of Consumption Infrastructures: While our research observed various tools to increase visibility and learning of consumption infrastructures, these still only cover restaurants and supermarket food. To facilitate practice change, future design should focus on other infrastructures, such as clothing and cosmetics or furniture. Thereby, it is not only about the products, but also entangled services, such as hairdressers that offer plant-based cosmetics or clothing companies that do not test their colors on animals. Given that our research mainly focused on food, future design research first needs to understand the visibility and perception of such infrastructures, especially against the background of satisfying the basic needs of daily life. Indeed, recent work on the practice of food teaming shows how a perspective on consumption infrastructures, their perception, substitution, and visibility is helpful to inform design [78].

Designing for Tradeoffs with Family and Friends: Having discussed the idea of more infrastructure aware design, still, it remains open how to bridge the gap between expectations of family and friends and their practice [21] e.g., on what a proper eating-out location is and one that is vegan friendly. By now, there are apps such a *HappyCow* for vegans and tools such as *FourSquare* or *TripAdvisor* that are used by regime practitioners. Bringing both ICT designs together to allow finding places, where vegans and their family and friends are satisfied, should be addressed in future research. More strongly including the making of trade-offs in such filtering and search mechanisms for infrastructures could reduce social tensions, decrease the perception of vegans as killjoys, and finally facilitate diffusion as barriers between practices are reduced.

Designing for Label and Ingredient Transparency: Against the background of missing European or national issued legislation on a consumer-friendly definition of vegan products and labels [54], future design should research current efforts of vegans to check and discuss ingredients, in particular with apps such as *CodeCheck*, to provide a transparent and unique interface for checking vegan qualities of products. An additional feature of this could be the inclusion of social, information, e.g., vegan negotiations in social media about products. Bridging social information on products, ingredients tables, producer information, and transparent label information together could be an improvement

of current services. Also, non-food products should be included in the related databases, as this is currently a blind-spot.

Designing for Learning Taste and Substitution: A particular blind-spot of current vegan design is substitution and the learning of new tastes. Already in the 1950s, Becker [68] showed how learning new practices comes with the learning of taste. In addition, Twine [4] also observed how vegan practitioners over time transition from an omnivorous regime taste to a celebration of plant-based foods. However, design does not yet support such iterative exploration of vegan foods. Recommender systems, although yet not designed for special diet requirements [79], offer the technological foundations to understand current consumption and recommend foods for the future. Therefore, future research should bridge the gap between the basic ideas of self-actualization and sustainable consumption in recommender systems and the process of learning new tastes. Here, it could be tied up to and extended on research that already explored recommendations based on flavor components [80]. For example, recommendations could start with substitutes that fit into beloved recipes and taste like meat, e.g., supermarket burger substitutes and then gradually shift and prepare towards pulses, tofu, and other vegan options. With such mechanisms, not only taste, but also competences, could be learned over time.

4.4. Designing for Co-Evolution of Sustainable Practices

Veganism might appear to be a somewhat narrow focus of interest, but we want to argue that it forms part of a developing, and increasingly important nexus of practices associated with ‘green consumerism’ and even ‘anti-consumption’ [81]. As we have seen, veganism is associated with complex and co-evolving practices and artefacts. An understanding of these new constellations from a more general perspective should bring attention to the same co-evolution if we are to design for sustainable practice formation in general. For other practices associated with green consumption [17,23], designing for change might require the same understanding of many learning iterations co-evolving with artefacts and how they integrate with emerging communities of practice.

Designing for Crises of Routine: As most of our participants highlighted a specific event or documentary that caused a “crises of routine” [34], persuasive design and gamification still might play an important role, as a starting point for co-evolution. Although these approaches are critiqued for not considering the socio-material context [15,16], we observed that triggering initial change is often a function of ‘awareness prompting’. That is, exposure to documentary and other formats can trigger this crisis of routine. Certainly, initial triggers of one kind or another seem to play an important role. The routines of Hasselqvist et al.’s [23] participants, for example, were brought into crises by challenging them to not use their cars anymore. How best to incorporate such triggers into design is an open question, since there will be ethical and other issues to contend with, as we cannot simply adopt showing slaughterhouse content. Persuasive design might, at these early stages, remain a viable proposition.

Designing for Iterative Learning of Practices: Once change is initiated, rather than designing for practice transformation as ‘absolute change’, we should focus on smaller iterations of learning the materials and competences for the new practice, as an appropriation of niche infrastructures. This involves exploring the infrastructure of restaurants and stores nearby, learning which ingredients are vegan, and building new cooking competences. However, evolving knowledge and competences change use, as with the restaurant tools we describe above. Similar evolutions can be seen with the move to car-free mobility [23], where appropriate travel planning tools are appropriated, used, and then abandoned. Another element of this process is the monitoring or tracking behavior as a reflection on the process that we observed with diet trackers and is also highlighted in other research [17]. *Designing for Artful Integration and Alignment:* However, what is currently evident is that there is no integrated provision for these heterogeneous practices, nor for different learning strategies. Multiple artefacts exist and are used but no current facility exists for integrating them. This is similar to the work of Ganglbauer et al. [17] who show that changing food-wasting practices needs multiple interventions. Therefore, design should be flexible enough to be abandoned, recombined, and used in completely

different ways, in short enabling artful integration by the users. On the other hand, designers can use the dialectic relationship with tools to resolve tensions arising from the entanglement of practices, e.g., diet trackers to change the meaning of vegan meals and recipes to learn the necessary competences to, in short, align the appropriation of artefacts and the learning of practices.

Designing for Tension between the Odd and the Norm: Design should be sensitive about the niche existence of practices and the difficulty arising from being perceived as the “odd” [23], “going against the [. . .] society” [38] or the “killjoy” [21]. Therefore, rather than breaking all ties to the ‘norm’ practice and its community, design should reconcile both, e.g., designing for ‘veganization’ of meals in omnivorous recipe apps, rather than directly providing completely new and unfamiliar recipes. This is similar to Hasselqvist et al. [23] who already suggest including sustainable modes of traffic in regular planning tools, creating visibility of alternatives, rather than providing for separate and already decided use. In addition, it is exactly this tension that causes some instability of niche practice even after most of the learning has happened. Here, design can play distinct roles, on the one hand by creating safe spaces for the community, allowing for support, reinforcement [38]. and temporary withdrawal, and on the other hand, allowing for productive exchange between the different communities. Both artefact usages have been observed in our study, with participants using online groups to be not exposed to commenting by the ‘norm’ and at the same time sharing pictures of vegan meals to create visibility for their ‘niche’ and decrease prejudice.

Co-Designing with Practitioners: Lastly, we want to reflect on the retrospective perspective of our research and the reflection on ICT usage along the practitioners’ transformation journeys. For this purpose, we want to come back to the quote we used at the beginning of this paper: “*Yet this rarely sets out practically how such reduction might be achieved and, surprisingly, has yet to look to vegans as a knowledge resource.*” [1]. While the idea of studying practices [8,17,22] and involving practitioners [82] is not a new one, often the starting point of design is the research of unsustainable practices. This usually leads to designs that just cover the first iterations of change, such as increasing the motivation of consumers or raising awareness about their unsustainability [8,22]. At this point, we do not want to argue that unsustainable practitioners should not be included in the co-design process, but that complementing design ideas with success stories and the experiences of already sustainable practitioners will allow for a more nuanced understanding of barriers of transformation, ICT designs that are practice-proven, and blind-spots in the ICT ecology.

5. Conclusions

Our research uncovered how vegan practices and the usage of ICT artefacts co-evolve. While our results at first sight only contribute to the study of vegan practices, we argue that co-evolution is a helpful lens to study and design for sustainable practice transformation in general. From this perspective, the role of persuasive design and gamification should be reconceptualized as a trigger for the “crises of routine” and reassurance when doubts arise. Understanding the role of different artefacts in knowledge and competence acquisition, and in supporting membership of evolving communities of practice, we suggest, has been under-rehearsed and will require ever more attention as sustainability becomes part of the mainstream agenda. Furthermore, we argue design should focus on the border between the ‘norm’ and the ‘odd’ to foster learning, exchange, and to support the negotiation of elements. Finally, we discussed how a retrospective perspective and learning from success stories complements practice research to inform design. For veganism, in particular, we formulate paths for future design and research:

1. Designing for Value Tensions between Livestock Farming and Consumed Reality, to encourage plant-based consumption practices and raises awareness about the gap between values and consumed reality.
2. Designing for Visibility of Consumption Infrastructures, that make vegan-friendly infrastructures and therefore vegan materiality visible, not only for restaurants and food but also for clothing, cosmetics, and various other services of daily life.

3. Designing for Tradeoffs with Family and Friends, to allow bridging that gap between omnivorous and vegan practices, such that leisure time activities and shared usage of infrastructures is facilitated.
4. Designing for Label and Ingredient Transparency, to support easy access to the information on vegan qualities of products and its labels against the background of social meanings of what veganism is about.
5. Designing for Learning Taste and Substitution, to support the exploration of vegan substitutes, recommend new foods with awareness to the practitioners' taste, and iteratively support the acceptance of vegan foods especially protein sources and the learning of related competences.

Reflecting on current ICT designs and the needs of the community, it is worth mentioning that a focus on food practices is a good starting point, as most participants' individual transformation journeys started from food practices. However, with the ongoing transformation questions of veganism and the relation to other consumption domains arose, such as clothing and even furniture. Therefore, design should broaden the perspective and besides food encourage a holistic perspective on veganism and related designs. Still, detailed investigation into design ideas and the related practice(s) is needed to sharpen the ideas presented here.

Our results are limited by the fact that we interviewed vegans, who successfully managed to undergo a practice transition. Therefore, in future work, it will be interesting to focus on participants who are either still uncertain about their diet change or who attempted unsuccessfully to transform their practices., e.g., through the absence of technology. At this point, it is of particular interest to quantify the impact of ICT in future work. Furthermore, the absence of elderly people, who might have different artefact ecologies, and the small sample size, limits our work. The elderly group, given demographic change, should not be underestimated when aiming for sustainable transformation. Also, for the background of quantifying the impact of ICT for practice change, recruiting a representative and bigger sample should be addressed in future research.

In light of the urgent need to transform our (diet) practices [2,3], our work contributes to both theory and ICT design: Regarding theory building, our findings shed light on the transformation of consumer practices by making aware about the co-evolutionary process of using ICT artefacts in making consumer practices vegan and in general more sustainable. Our study uncovered common patterns of self-reflection, learning, and enculturation together with the adoption of new goods and infrastructures and how this transformation is accompanied by ICT. Regarding ICT design, we inform to broaden the scope of ICT to go beyond persuasion. We aim to inspire designers to develop interventions that support a shift towards more vegan and other sustainable consumption practices.

Author Contributions: Conceptualization, D.L. and M.E.; methodology, formal analysis, investigation, writing—original draft preparation, D.L., M.E., P.E. and G.S.; writing—review and editing, D.L. and M.E.; All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Twine, R. A Practice Theory Framework for Understanding Vegan Transition. *Anim. Stud. J.* **2017**, *6*, 192–224.
2. Goodland, R. Environmental sustainability in agriculture: Diet matters. *Ecol. Econ.* **1997**, *23*, 189–200. [[CrossRef](#)]
3. Tilman, D.; Clark, M. Global diets link environmental sustainability and human health. *Nature* **2014**, *515*, 518. [[CrossRef](#)] [[PubMed](#)]
4. Twine, R. Materially Constituting a Sustainable Food Transition: The Case of Vegan Eating Practice. *Sociology* **2018**, *52*, 166–181. [[CrossRef](#)]

5. Scarborough, P.; Appleby, P.N.; Mizdrak, A.; Briggs, A.D.M.; Travis, R.C.; Bradbury, K.E.; Key, T.J. Dietary greenhouse gas emissions of meat-eaters, fish-eaters, vegetarians and vegans in the UK. *Clim. Chang.* **2014**, *125*, 179–192. [[CrossRef](#)]
6. Mensink, G.; Barbosa, C.L.; Brettschneider, A.-K. Robert Koch-Institut Verbreitung der Vegetarischen Ernährungsweise in Deutschland. *J. Health Monit.* **2016**. [[CrossRef](#)]
7. Schiermeier, Q. Eat less meat: UN climate-change report calls for change to human diet. *Nature* **2019**, *572*, 291–292. [[CrossRef](#)]
8. Prost, S.; Crivellaro, C.; Haddon, A.; Comber, R. Food Democracy in the Making: Designing with Local Food Networks. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, Montreal, QC, Canada, 21–26 April 2018; ACM: New York, NY, USA, 2018; pp. 333:1–333:14.
9. Fogg, B.J. Persuasive technology: Using computers to change what we think and do. *Ubiquity* **2002**, *2002*, 5. [[CrossRef](#)]
10. Schwartz, T.; Deneff, S.; Stevens, G.; Ramirez, L.; Wulf, V. Cultivating energy literacy: Results from a longitudinal living lab study of a home energy management system. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Paris, France, 27 April–2 May 2013; ACM: New York, NY, USA, 2013; pp. 1193–1202.
11. Schwartz, T.; Stevens, G.; Jakobi, T.; Deneff, S.; Ramirez, L.; Wulf, V.; Randall, D. What people do with consumption feedback: A long-term living lab study of a home energy management system. *Interact. Comput.* **2015**, *27*, 551–576. [[CrossRef](#)]
12. Brynjarsdottir, H.; Håkansson, M.; Pierce, J.; Baumer, E.; DiSalvo, C.; Sengers, P. Sustainably unpersuaded: How persuasion narrows our vision of sustainability. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Austin, TX, USA, 5–10 May 2012; ACM: New York, NY, USA, 2012; pp. 947–956.
13. Dourish, P. HCI and environmental sustainability: The politics of design and the design of politics. In Proceedings of the 8th ACM Conference on Designing Interactive Systems, Aarhus, Denmark, 16–20 August 2010; ACM: New York, NY, USA, 2010; pp. 1–10.
14. Maitland, J.; Chalmers, M.; Siek, K.A. Persuasion not required Improving our understanding of the sociotechnical context of dietary behavioural change. In Proceedings of the 3rd International ICST Conference on Pervasive Computing Technologies for Healthcare, London, UK, 1–3 April 2009.
15. Schwartz, T.; Stevens, G.; Ramirez, L.; Wulf, V. Uncovering practices of making energy consumption accountable: A phenomenological inquiry. *ACM Trans. Comput. -Hum. Interact. (TOCHI)* **2013**, *20*, 12. [[CrossRef](#)]
16. Gram-Hanssen, K. Standby consumption in households analyzed with a practice theory approach. *J. Ind. Ecol.* **2010**, *14*, 150–165. [[CrossRef](#)]
17. Ganglbauer, E.; Fitzpatrick, G.; Comber, R. Negotiating Food Waste: Using a Practice Lens to Inform Design. *ACM Trans. Comput.-Hum. Interact.* **2013**, *20*, 11:1–11:25. [[CrossRef](#)]
18. Ganglbauer, E.; Fitzpatrick, G.; Subasi, Ö.; Güldenpfennig, F. Think Globally, Act Locally: A Case Study of a Free Food Sharing Community and Social Networking. In Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing, Baltimore, MD, USA, 15–19 February 2014; ACM: New York, NY, USA, 2014; pp. 911–921.
19. Katzeff, C.; Milestad, R.; Zapico, J.L.; Bohné, U. Encouraging Organic Food Consumption through Visualization of Personal Shopping Data. *Sustainability* **2020**, *12*, 3599. [[CrossRef](#)]
20. Potts, A.; Parry, J. Vegan Sexuality: Challenging Heteronormative Masculinity through Meat-free Sex. *Fem. Psychol.* **2010**, *20*, 53–72. [[CrossRef](#)]
21. Twine, R. Vegan Killjoys at the Table—Contesting Happiness and Negotiating Relationships with Food Practices. *Societies* **2014**, *4*, 623–639. [[CrossRef](#)]
22. Hedin, B.; Katzeff, C.; Eriksson, E.; Pargman, D. A Systematic Review of Digital Behaviour Change Interventions for More Sustainable Food Consumption. *Sustainability* **2019**, *11*, 2638. [[CrossRef](#)]
23. Hasselqvist, H.; Hesselgren, M.; Bogdan, C. Challenging the Car Norm: Opportunities for ICT to Support Sustainable Transportation Practices. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems—CHI '16, San Jose, CA, USA, 7–12 May 2016; ACM Press: New York, NY, USA, 2016; pp. 1300–1311.

24. Clear, A.K.; O’neill, K.; Friday, A.; Hazas, M. Bearing an Open “Pandora’s Box”: HCI for Reconciling Everyday Food and Sustainability. *ACM Trans. Comput.-Hum. Interact.* **2016**, *23*, 28:1–28:25. [[CrossRef](#)]
25. Kersche-Risch, P. Vegan diet: Motives, approach and duration. Initial results of a quantitative sociological study. *Ernahr. Umsch.* **2015**, 98–103. [[CrossRef](#)]
26. Shove, E.; Pantzar, M. Consumers, Producers and Practices: Understanding the invention and reinvention of Nordic walking. *J. Consum. Cult.* **2005**, *5*, 43–64. [[CrossRef](#)]
27. Shove, E.; Pantzar, M.; Watson, M. *The Dynamics of Social Practice: Everyday Life and How it Changes*; Sage: Thousand Oaks, CA, USA, 2012.
28. Jakobi, T.; Ogonowski, C.; Castelli, N.; Stevens, G.; Wulf, V. The Catch(es) with Smart Home: Experiences of a Living Lab Field Study. In Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems—CHI ’17, Denver, CO, USA, 6–11 May 2017; ACM Press: New York, NY, USA, 2017; pp. 1620–1633.
29. Stevens, G.; Pipek, V. Making use: Understanding, studying, and supporting appropriation. In *Socio Informatics—A Practice-Based Perspective on the Design and Use of IT Artefacts*; Oxford University Press: Oxford, UK, 2018; pp. 139–176.
30. Choi, J.H.; Linehan, C.; Comber, R.; McCarthy, J. Food for Thought: Designing for Critical Reflection on Food Practices. In Proceedings of the Designing Interactive Systems Conference, Newcastle Upon Tyne, UK, 11–15 June 2012; ACM: New York, NY, USA, 2012; pp. 793–794.
31. Ganglbauer, E.; Fitzpatrick, G.; Molzer, G. Creating Visibility: Understanding the Design Space for Food Waste. In Proceedings of the 11th International Conference on Mobile and Ubiquitous Multimedia, Ulm, Germany, 4–6 December 2012; ACM: New York, NY, USA, 2012; pp. 1:1–1:10.
32. Lyle, P.; Choi, J.H.; Foth, M. Growing Food in the City: Design Ideations for Urban Residential Gardeners. In Proceedings of the 7th International Conference on Communities and Technologies, Limerick, Ireland, 27–30 June 2015; ACM: New York, NY, USA, 2015; pp. 89–97.
33. Chamberlain, A.; Griffiths, C. Wild Food Practices: Understanding the Wider Implications for Design and HCI. In Proceedings of the 2013 ACM Conference on Pervasive and Ubiquitous Computing Adjunct Publication, Zurich, Switzerland, 8–12 September 2013; ACM: New York, NY, USA, 2013; pp. 575–584.
34. Reckwitz, A. Toward a theory of social practices: A development in culturalist theorizing. *Eur. J. Soc. Theory* **2002**, *5*, 243–263. [[CrossRef](#)]
35. Torkkeli, K.; Mäkelä, J.; Niva, M. Elements of practice in the analysis of auto-ethnographical cooking videos. *J. Consum. Cult.* **2018**, 1469540518764248. [[CrossRef](#)]
36. Kuijjer, L.; de Jong, A.; van Eijk, D. Practices as a unit of design: An exploration of theoretical guidelines in a study on bathing. *ACM Trans. Comput.-Hum. Interact.* **2008**, *20*, 1–22. [[CrossRef](#)]
37. Crivits, M.; Paredis, E. Designing an explanatory practice framework: Local food systems as a case. *J. Consum. Cult.* **2013**, *13*, 306–336. [[CrossRef](#)]
38. Håkansson, M.; Sengers, P. Beyond being green: Simple living families and ICT. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems—CHI ’13, Paris, France, 27 April–2 May 2013; ACM Press: New York, NY, USA, 2013; p. 2725.
39. Draxler, S.; Stevens, G.; Stein, M.; Boden, A.; Randall, D. Supporting the social context of technology appropriation: On a synthesis of sharing tools and tool knowledge. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Austin, TX, USA, 5–10 May 2012; p. 10.
40. Draxler, S.; Stevens, G. Supporting the Collaborative Appropriation of an Open Software Ecosystem. *Comput. Supported Coop. Work* **2011**, *20*, 403–448. [[CrossRef](#)]
41. Bødker, S.; Klokmose, C.N. Dynamics in artifact ecologies. In Proceedings of the 7th Nordic Conference on Human-Computer Interaction Making Sense through Design—NordCHI ’12, Copenhagen, Denmark, 14–17 October 2012; ACM Press: New York, NY, USA, 2012; p. 448.
42. Engeström, Y. Expansive Learning at Work: Toward an activity theoretical reconceptualization. *J. Educ. Work* **2001**, *14*, 133–156. [[CrossRef](#)]
43. Engeström, Y. Activity theory and individual and social transformation. *Perspect. Act. Theory* **1999**, *19*, 19–30.
44. Carroll, J. Completing design in use: Closing the appropriation cycle. *ECIS 2004 Proc.* **2004**, 44–55.
45. Pipek, V.; Kahler, H. Supporting Collaborative Tailoring. In *End User Development*; Lieberman, H., Paternò, F., Wulf, V., Eds.; Springer Netherlands: Dordrecht, The Netherlands, 2006; Volume 9, pp. 315–345. ISBN 978-1-4020-4220-1.

46. Pipek, V. Negotiating infrastructure: Supporting the appropriation of collaborative software. *Scand. J. Inf. Syst.* **2005**, submitted.
47. Wenger, E. Communities of practice: A brief introduction. Available online: <https://wenger-trayner.com/wp-content/uploads/2015/04/07-Brief-introduction-to-communities-of-practice.pdf> (accessed on 20 April 2020).
48. Johnson, C.M. A survey of current research on online communities of practice. *Internet High. Educ.* **2001**, *4*, 45–60. [[CrossRef](#)]
49. Ardichvili, A.; Maurer, M.; Li, W.; Wentling, T.; Stuedemann, R. Cultural influences on knowledge sharing through online communities of practice. *J. Knowl. Manag.* **2006**, *10*, 94–107. [[CrossRef](#)]
50. Sharratt, M.; Usoro, A. Understanding Knowledge-Sharing in Online Communities of Practice. *Electron. J. Knowl. Manag.* **2003**, *1*, 10.
51. Perignon, M.; Vieux, F.; Soler, L.-G.; Masset, G.; Darmon, N. Improving diet sustainability through evolution of food choices: Review of epidemiological studies on the environmental impact of diets. *Nutr. Rev.* **2017**, *75*, 2–17. [[CrossRef](#)] [[PubMed](#)]
52. Derqui, B.; Guterman, H.G.; Ghaffari, M.; Rodrigo, P. The Vegan Revolution: Opportunities and Differences across Countries. In *Proceedings of the International Conference on Advances in National Brand and Private Label Marketing*; Springer: Berlin/Heidelberg, Germany, 2020; pp. 90–96.
53. Vegan-Trend: Zahlen und Fakten zum Veggie-Markt—ProVeg Deutschland. Available online: <https://proveg.com/de/pflanzlicher-lebensstil/vegan-trend-zahlen-und-fakten-zum-veggie-markt/> (accessed on 14 June 2020).
54. Gerke, M.; Janssen, M. Vegan foods: Labelling practice. *Ernahr. Umsch.* **2017**, *64*, M139–M145.
55. Meisch, S. Knowing one’s food—Making food a public issue. In *Know Your Food*; Dumitras, D.E., Jitea, I.M., Aerts, S., Eds.; Wageningen Academic Publishers: Wageningen, The Netherlands, 2015; pp. 306–311, ISBN 978-90-8686-264-1.
56. Federal Ministry of Food and Agriculture. *Leitsätze für Vegane und Vegetarische Lebensmittel mit Ähnlichkeit zu Lebensmitteln Tierischen Ursprungs*; Federal Ministry of Food and Agriculture: Bonn, Germany, 2018.
57. Carreño, I.; Dolle, T. Tofu Steaks? Developments on the Naming and Marketing of Plant-based Foods in the Aftermath of the *TofuTown* Judgement. *Eur. J. Risk Regul.* **2018**, *9*, 575–584. [[CrossRef](#)]
58. Cole, M.; Morgan, K. Vegaphobia: Derogatory discourses of veganism and the reproduction of speciesism in UK national newspapers¹: Vegaphobia. *Br. J. Sociol.* **2011**, *62*, 134–153. [[CrossRef](#)]
59. Noy, C. Sampling Knowledge: The Hermeneutics of Snowball Sampling in Qualitative Research. *Int. J. Soc. Res. Methodol.* **2008**, *11*, 327–344. [[CrossRef](#)]
60. Robert Koch-Institut. Prevalence of persons following a vegetarian diet in Germany. *RKI-Bib1 (Robert Koch-Institut.)* **2016**. [[CrossRef](#)]
61. Braun, V.; Clarke, V. Using thematic analysis in psychology. *Qual. Res. Psychol.* **2006**, *3*, 77–101. [[CrossRef](#)]
62. King, N.; Cassell, C.; Symon, G. Using templates in the thematic analysis of text. *Essent. Guide Qual. Methods Organ. Res.* **2004**, *2*, 256–270.
63. Wikipedia: Pferdefleischskandal_in_Europa_2013. Available online: https://de.wikipedia.org/w/index.php?title=Pferdefleischskandal_in_Europa_2013&oldid=189015771 (accessed on 20 April 2020).
64. Key, T.J.; Appleby, P.N.; Rosell, M.S. Health effects of vegetarian and vegan diets. *Proc. Nutr. Soc.* **2006**, *65*, 35–41. [[CrossRef](#)]
65. Prochaska, J.O.; DiClemente, C.C. Transtheoretical therapy: Toward a more integrative model of change. *Psychother. Theory Res. Pract.* **1982**, *19*, 276. [[CrossRef](#)]
66. Jung, H.; Stolterman, E.; Ryan, W.; Thompson, T.; Siegel, M. Toward a Framework for Ecologies of Artifacts: How Are Digital Artifacts Interconnected within a Personal Life? In *Proceedings of the 5th Nordic Conference on Human-Computer Interaction: Building Bridges*, Lund, Sweden, 20–22 October 2008; pp. 201–210.
67. Leonard-Barton, D. Implementation as mutual adaptation of technology and organization. In *Managing Knowledge Assets, Creativity and Innovation*; World Scientific: Singapore, 2011; p. 18.
68. Becker, H.S. Becoming a Marijuana User. *Am. J. Sociol.* **1953**, *59*, 235–242. [[CrossRef](#)]
69. Zapico, J.L.; Katzeff, C.; Bohné, U.; Milestad, R. Eco-feedback Visualization for Closing the Gap of Organic Food Consumption. In *Proceedings of the 9th Nordic Conference on Human-Computer Interaction*, Gothenburg, Sweden, 23–27 October 2016; ACM: New York, NY, USA, 2016; pp. 75:1–75:9.
70. Pipek, V. From Tailoring to Appropriation Support: Negotiating Groupware Usage. Ph.D. Thesis, University of Oulu, Oulu, Finland, 2005.

71. Warde, A. *The Practice of Eating*; Polity Press: Malden, MA, USA, 2015; ISBN 978-0-7456-9170-1.
72. Ahearne, J.; De Certeau, M. *Michel de Certeau: Interpretation and Its Other*; Stanford University Press: Palo Alto, CA, USA, 1995.
73. Suchman, L. Working relations of technology production and use. *Comput. Supported Coop. Work* **1993**, *2*, 21–39. [[CrossRef](#)]
74. Suchman, L.A. Practice-Based Design of Information Systems: Notes from the Hyperdeveloped World. *Inf. Soc.* **2002**, *18*, 139–144. [[CrossRef](#)]
75. Cherrier, H. Anti-consumption discourses and consumer-resistant identities. *J. Bus. Res.* **2009**, *62*, 181–190. [[CrossRef](#)]
76. Holt, D.B.; Thompson, C.J. Man-of-Action Heroes: The Pursuit of Heroic Masculinity in Everyday Consumption. *J. Consum. Res.* **2004**, *31*, 16. [[CrossRef](#)]
77. Lea, E.J.; Crawford, D.; Worsley, A. Consumers' readiness to eat a plant-based diet. *Eur. J. Clin. Nutr.* **2006**, *60*, 342–351. [[CrossRef](#)]
78. Prost, S.; Vlachokyriakos, V.; Midgley, J.; Heron, G.; Meziant, K.; Crivellaro, C. Infrastructuring Food Democracy: The Formation of a Local Food Hub in the Context of Socio-Economic Deprivation. *Proc. ACM Hum.-Comput. Interact.* **2019**, *3*, 1–27. [[CrossRef](#)]
79. Trattner, C.; Elswiler, D. Food Recommender Systems: Important Contributions, Challenges and Future Research Directions. *arXiv* **2017**, arXiv:1711.02760.
80. Ahn, Y.-Y.; Ahnert, S.E.; Bagrow, J.P.; Barabási, A.-L. Flavor network and the principles of food pairing. *Sci. Rep.* **2011**, *1*, 196. [[CrossRef](#)]
81. Black, I.R.; Cherrier, H. Anti-consumption as part of living a sustainable lifestyle: Daily practices, contextual motivations and subjective values. *J. Consum. Behav.* **2010**, *9*, 437–453. [[CrossRef](#)]
82. Redante, R.C.; de Medeiros, J.F.; Vidor, G.; Cruz, C.M.L.; Ribeiro, J.L.D. Creative approaches and green product development: Using design thinking to promote stakeholders' engagement. *Sustain. Prod. Consum.* **2019**, *19*, 247–256. [[CrossRef](#)]



© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).