Physically Processing Imperfect Produce:

The impact of Prototypicality

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Abstract

Forty percent of edible produce is wasted because of consumers' aversion towards aesthetical imperfections related to size, shape and blemish for produce. This phenomenon has huge implications in terms of both environmental sustainability and food security, and calls for the development of interventions that could facilitate the sale of products which would otherwise go to waste. This research provides an explanation for why transforming the physical state of imperfect produce – i.e. by physically processing it and turning it into other products (e.g., juices) – is a successful strategy in this sense. More specifically, when imperfect produce is transformed, the new processed product (e.g., juice) belongs to a different conceptual category and thus is perceived as more prototypical and a good example of this new category. We show that higher perceptions of prototypicality in turn lead to more positive preferences. We test this effect in three experimental studies and show that this mechanism is robust across a range of possible transformations of imperfect produce (e.g., natural vs. artificial) and across different dependent variables (i.e., purchase intention, product choice, willingness to pay).

Our findings provide evidence for the effectiveness of a solution to be enacted by retailers and actors of the food sector and provide suggestions for public policy initiatives aimed at curbing food waste.

Keywords

Food waste, imperfect food, physical processing, prototypicality

1. Introduction

Standing atop a huge pile of perfectly safe but slightly "imperfect" bananas, Australian television presenter Craig Reucassel visually summarized one stark statistic: large shares of fruit and vegetables are wasted because of colour, size, weight or aesthetic imperfections (Lallo, 2017; Porter et al., 2018; ReFED, 2016). These products are generally defined as "suboptimal" or imperfect (De Hooge et al., 2017; Aschemann-Witzel et al., 2019; Aschemann-Witzel et al., 2020) and they are wasted because of retailers' unwillingness to sell on their shelves products that consumers would not buy (Gruber, Holweg, and Teller, 2016).

Results from prior literature provide evidence that consumers are reluctant to consume produce which is aesthetically imperfect (e.g., Grewal et al., 2019; Lombart et al., 2019). Specifically, consumers show lower purchase intentions toward fruits and vegetables with aesthetical imperfections than toward normally-shaped foods (e.g., Loebnitz and Grunert, 2015; Lombart et al., 2019) because of perceived low quality (Lombart et al., 2019), inferior taste perceptions (Cooremans and Geuens, 2019) and safety concerns (Yuan et al., 2019). At the same time, actions can be implemented to increase consumers' willingness to buy and consume these products; for example, anthropomorphising imperfect produce (Cooremans and Guens, 2019; Koo, Oh, and Patrick, 2019) or offering it with a substantial discount (Symmank, Zahn, and Rohm; 2018). Another strategy increasingly employed by companies around the world to recover produce that would otherwise go to waste, is the transformation of imperfect fruits and vegetables into new products such as juices, soups, or smoothies (Smithers, 2018). However, why consumers are more likely to purchase imperfect produce that has been transformed than imperfect produce in their original state is still open to question. The objective of the present research is to answer this question and provide evidence for the psychological mechanism explaining this phenomenon.

Building on research that shows that individuals prefer products that are congruent with their category schema, whereas deviant or unusual products are less positively evaluated (Maoz and Tybout, 2002; Veryzer and Hutchinson, 1998), we argue that consumers are reluctant to purchase imperfect produce because fruits and vegetables with aesthetical imperfections are perceived as less typical examples of their perceived category than normally-shaped produce. Furthermore, we argue that the physical transformation of imperfect produce (e.g., an imperfect orange) affects the way consumers categorize the product (Trudel and Argo, 2013), with the processed product perceived as belonging to and as being a good example of a new category of products (e.g., an orange juice). This in turn has a positive effect on consumers' purchase intention, consistently with evidence showing that when an object is representative (i.e., *prototypical)* of a category (Barsalou, 1985; Rosch, 1999) consumers report higher purchase intentions than for objects that are less representative of their category. Hence, we hypothesize that consumers are more likely to buy and choose imperfect produce that has been physically transformed than imperfect produce in its original state. Furthermore, we argue that this effect is driven by perceptions of prototypicality, such that imperfect produce that has been physically processed is perceived as more prototypical than imperfect produce in its original state, which in turn positively affects purchase intention. We tested our conceptualization through three experimental studies that provide robust evidence supporting the benefits of physically processing imperfect produce across different product categories (i.e., apple, apricot, orange) and transformations (e.g., bar, chips) and using different dependent variables (i.e., purchase intention, product choice, willingness to pay).

This research contributes to recent literature investigating ways to overcome consumers' aversion toward imperfect fruit and vegetables (e.g., Cooremans and Guens, 2019; Grewal et al., 2019; Koo, Oh, and Patrick, 2019). Furthermore, our results add to

literature on food imperfection (e.g., Lombart et al., 2019; Yuan et al., 2019) by providing further insights into *why* consumers are averse to imperfect produce, i.e., perceptions of *prototypicality*. Moreover, we contribute to literature on food waste as well as to research into how consumers' category schemas and categorization processes can affect perceptions and behaviour across product categories (e.g., Creusen and Schoormans, 2005; Meyers-Levy and Tybout, 1989; Trudel and Argo, 2013). Finally, our findings provide a theoretical explanation supporting the effectiveness of the practices recently adopted by retailers to sell imperfect produce by transforming it into new products. Based on this result, both marketers and policy makers could design awareness and communication campaigns focusing on the alternative uses of imperfect produce and on the ways in which this can be recovered.

The remainder of this article is organized as follows. First, we develop the conceptual background and research hypotheses by focusing on the importance of physical processing and prototypicality on consumers' evaluations. Second, we report the empirical evidence supporting our conceptualization. Finally, we present the theoretical and practical implications of our results and discuss both limitations and directions for further research.

2. Theoretical framework

2.1.Food imperfection and physical processing

Previous research in consumer behaviour underlined the effect of product aesthetics and appearance on consumers' perceptions and subsequent behaviours (e.g., Bloch, 1995; Hoegg and Alba, 2008; Veryzer, 1995), with evidences in terms of product liking (Buechel and Townsend, 2018) product quality (Page and Herr, 2002), functionality (Hagtvedt and Patrick, 2014; Hoegg and Alba, 2011), and performance (Hoegg, Alba, and Dahl, 2010). This effect is well-documented across a range of domains, from everyday products (e.g., napkins, toilet paper) (Buechel and Townsend, 2018; Wu et al., 2017) to financial (Townsend and

Shu, 2010) and industrial products (Yamamoto and Lambert, 1994). Specifically, the bulk of research supports the existence of a general premium garnered by products which are perceived as more visually appealing (Townsend and Sood, 2012), such that higher (vs. lower) aesthetics is generally preferred by consumers (Buechel and Townsend, 2018) and can even compensate for minor flaws in the product's functionality (Hagtvedt & Patrick, 2014).

These findings have been recently confirmed by a stream of research investigating the role that imperfection and suboptimality in appearance have on consumers' perception and purchase intention toward fresh produce (e.g., Grewal et al., 2019; Loebnitz and Grunert, 2015; Lombart et al., 2019), in a way that fruits and vegetables deviating from the normal or optimal standard (De Hooge et al., 2017) are associated with lower purchase intentions, compared to normally-shaped foods (e.g., Loebnitz and Grunert, 2015; Lombart et al., 2019). Indeed, unlike other categories of products, external appearance – e.g., size, colour, shape, blemish – is the main cue consumers can use to infer the inherent characteristics and quality of fresh produce (Grunert, Bredahl, and Brunsø, 2004) as fruits and vegetables are commonly sold without or in transparent packaging (Deng and Srinivasan 2013). Specifically, Loebnitz and Grunert (2015) found that purchase intentions decreased as shape abnormalities increased, along a continuum that goes from normally shaped foods to extremely abnormal ones. In a similar vein, Loebnitz, Schuitema, and Grunert (2015) showed that while there is no difference in purchase intentions between normal and moderately abnormal foods, consumers are less likely to buy extremely abnormally shaped food. Conversely, Lombart et al. (2019) showed that there is an upper, as well as a minimum, threshold beyond which produce is too "imperfect," and thus perceived as having poor quality, and below which produce is too "perfect", and thus perceived as too "industrial" and less tasty.

Prior research has suggested several reasons explaining why consumers are unwilling to choose imperfect fruits and vegetables. For instance, consumers perceive imperfect fruit

and vegetables as riskier, with natural shape abnormalities associated with genetically-modified food (Loebnitz and Grunert, 2018) and consumers being concerned about the safety of imperfect produce (Yuan et al., 2019). Consumers also view imperfect fruit and vegetables as more disgusting (Hingston and Noseworthy, 2020) and as having lower quality (Cooreman and Geuens, 2019) than products without aesthetical imperfections. Aversion towards these products appear to be so pronounced that merely imagining about consuming unattractive produce leads to altered self-perceptions and consumers viewing themselves in a more negative light (Grewal et al., 2019). As a result, recent research has proposed solutions and interventions aimed at overcoming consumers' reluctance to consume and purchase imperfect produce. On the one hand, Cooremans and Guens (2019) and Koo, Oh, and Patrick (2019) showed that anthropomorphising imperfect produce is successful in increasing product evaluation and purchase intention. On the other hand, Louis and Lombart (2018) showed that communication claims based on health, food taste, and food price for imperfect produce are perceived credible by consumers and, in turn, have an additional positive effect on the retailer's image. Similarly, Legendre et al. (2020) found that communication strategies aimed at promoting the consumption of imperfect produce positively impact the evaluation of the company (i.e., food service) offering these products.

Finally, it is worth noting that there are circumstances that can have a positive impact on consumers' likelihood of purchasing imperfect produce. For instance, consumers in a supermarket are more likely to buy food that is abnormally shaped (i.e., a bent cucumber) than food that is imperfect in terms of colour, because the latter is perceived as unattractive, unsafe to eat, and bad-tasting (e.g., an apple with a spot; De Hooge et al., 2017). Consumers also find the display and purchase of imperfect produce more natural in farmers' markets than in regular grocery stores (Yuan et al., 2019), and often need a considerable discount before they are willing to buy them, consistent with the general belief that imperfect produce

is “to be discarded” (De Hooge et al., 2017; Symmank, Zahn, and Rohm; 2018; Yuan et al., 2019).

Overall, these findings suggest that consumers have negative attitudes towards imperfect foods and that they would not be willing to buy them, providing evidence for the retailers’ decision not to offer them on their shelves (Bond et al., 2013; Gustavsson et al., 2011). Indeed, the effect of food imperfections on consumers’ perception and behaviour can be explained in terms of the well-known preference of individuals for products which belongs to a typical product category (Maoz and Tybout, 2002; Veryzer and Hutchinson, 1998). However, products – and especially food – can go through a number of physical changes that alter their core characteristics (Trudel and Argo, 2013). We argue that the physical transformation of imperfect produce in new products, such as juices or soups, will affect the way in which consumers categorize the product (Trudel and Argo, 2013). Specifically, the change in physical shape entailed in such transformation is such that it causes a shift in the category the product belongs to (Schoormans and Robben, 1997), with the new product perceived as a more typical member of the new category; affecting, in turn, consumers’ purchase intention (Yang and Raghubir, 2005; Trudel and Argo, 2013; Prada et al., 2017).

Thus, we hypothesize that altering the physical state of imperfect fruit and vegetables – i.e., by transforming fresh produce into products such as juices or soups – has a positive effect on consumers’ purchase intention towards these products. More specifically, we expect that purchase intention is higher for imperfect produce that has been physically processed than for imperfect produce in its original state; conversely, there is no difference in purchase intention between perfect products in their original state and perfect products that have been physically processed. Formally:

H_1: *The physical processing of the produce moderates the negative effect of imperfection on purchase intention.*

2.2. Mediating Role of Prototypicality

We argue that the positive effect which physically processing imperfect produce has on purchase intention is driven by perceptions of *prototypicality*, defined as the extent to which an object is representative of a category (Barsalou, 1985; Rosch, 1999). Category representativeness has a graded structure, whereby objects – and products – range on a continuum that starts with the most representative members of the category, goes through atypical members, and continues to non-members of the category (Barsalou, 1985). More specifically, prototypical objects are more easily classified by consumers, and as such, are the first instances that come to mind when thinking about a specific product category (Amaldoss and He, 2013; Nedungadi and Hutchinson, 1985). For instance, Coca-Cola is a prototypical exemplar of its category (Nedungadi and Hutchinson, 1985), so when a consumer thinks of colas, Coca-Cola is the first instance that comes to mind (Amaldoss and He, 2013). Similarly, when thinking about the category of "fruit", an apple with specific features in terms of shape and colour comes to mind (Scarpi, Pizzi, and Raggiotto, 2019).

While previous evidence shows that prototypical products are more likely to be included in the consumer's consideration set (Amaldoss and He, 2013; Nedungadi and Hutchinson, 1985), there are instances in which an atypical product is more likely to be successful. For instance, an atypical external appearance is beneficial for products for which prestige, exclusiveness, novelty or differentiation are important (Creusen and Schoormans, 2005). A non-prototypical appearance can communicate that the new product has features that members of the category do not possess, or can even be perceived as a member of its own individual class (Rosch et al., 1976).

Conversely, consumers tend to prefer prototypical products in low-involvement purchases (Creusen and Schoormans, 2005), namely when they do not consider the purchase

of the product important or interesting (Alba and Hutchinson, 1987). In these cases, the consumer's effort is minimal and prototypical products come easily to mind (Amaldoss and He, 2013). In this sense, food products such as staples (Ahmed et al., 2004), soft drinks (Holmes and Crocker, 1987; Torres and Briggs, 2007), meat (Lind, 2007; Zaichkowsky, 1987), and snacks (Dahlèn, Ekborn, and Mörner, 2000) have all been considered as low involvement products by prior research. Furthermore, food purchases are highly repetitive and have a habitual nature (Wood and Neal, 2009; Gardner, de Bruijn, & Lally, 2011), and are characterized by limited information search (Machín et al., 2020). In such cases of low involvement, when faced with the decision about what to buy consumers are more likely to choose prototypical products that are more easily retrieved from memory.

Based on this evidence, and on the assumption that produce is a low involvement product, it is possible to argue that it is preferred by consumers when it is prototypical of its category. Conversely, fresh produce with aesthetical imperfections in terms of colour, size, shape, and weight are considered less prototypical of their category – i.e., fruit and vegetables – because they are not easily recognized by consumers. However, the change in category membership occurring when food is processed – e.g., when an apple is processed into an apple juice – is associated with an increase in perceived prototypicality, as the processed product (apple juice) will be perceived equally prototypical and a good example of its category regardless of whether it is produced using aesthetically perfect or imperfect produce.

Furthermore, prior research has demonstrated that a higher perception of prototypicality is associated with higher purchase intention (e.g., Babin and Babin, 2001; Scarpi et al., 2019). Hence, we expect imperfect produce that has been physically processed to be perceived more prototypical than imperfect produce in its original state, which in turn leads to higher purchase intention. Formally:

H_2: *Perceptions of prototypicality mediate the positive effect of physically processing imperfect produce on consumers' purchase intention.*

3. Materials and Methods

We conducted three experimental studies in order to test our hypotheses. In each study, we operationalized produce imperfection using pictures of imperfect fruits in terms of either colour (apple, apricot, Study 1a) or shape (orange, Study 1a, Study 1b). In particular, Study 1a investigates the moderating effect of physically processing the imperfect produce on purchase intention (H_1). Study 1b extends the results of Study 1a by testing the effect that physically processing imperfect produce has on both product choice and consumers' willingness to pay. Specifically, using different products (i.e., apple, apricot, orange) and transformations (i.e., bar, chips, candies, juice) this study shows that consumers are more likely to choose imperfect produce that has been transformed than imperfect produce in its original state. Furthermore, we show that consumers are willing to pay the same price for physically processed products regardless of whether they have been produced with perfect or imperfect produce. Finally, Study 2 tests the proposed underlying mechanism of prototypicality proposed in H_2.

To reduce potential demand effects, no mentioning of either perfection or imperfection was used in any of the studies when the stimuli for the imperfect or perfect produce were presented. Furthermore, for both conditions in which a physically processed product was presented, a claim stated that the processed product (e.g., apple juice) had been produced using the fruit shown on the left side of the screen (perfect vs. imperfect). By doing so, we made sure that respondents were aware that the product had been produced using either a perfect or an imperfect fruit, thus ensuring that the product of origin was salient in both conditions in which the product had been physically processed. In this sense, this design

rules out an important potential alternative explanation for our hypothesized effect: lack of imperfection visibility. Indeed, the hypothesized increase in purchase intention, as a result of the physical processing of the product, could not be driven by making the imperfection less visible, as the picture of the imperfect produce was shown in both conditions including imperfect produce (non-physically processed and physically processed).

FIGURE 1 ABOUT HERE

3.1.Study 1a

This study was aimed at providing evidence for the effect hypothesized in $H_{1,}$ by testing the moderating effect of the physical transformation of the product, namely, that of the interaction between food imperfection and the physical processing of the product on consumers' purchase intention. We tested H_1 across a series of three different transformations of produce with the goal of providing a robust account of the hypothesized effect.

3.1.1. Participants design and procedure

Two hundred and fifty-three participants (39.9% female; M_{age} = 34.53, *SD* = 12.96) were recruited by a research assistant (not aware of the study purpose) through a snowball sampling procedure. Specifically, following a similar procedure adopted by Romani et al. (2018), the study was first administered to a sample of 25 undergraduate students who, in turn, were asked to recruit up to ten more people responsible for shopping in their household. This technique allowed us to reach a more representative and varied population for the phenomenon under investigation. A 2 (perfect vs. imperfect produce) x 4 (not physically processed vs. bar vs. chips vs. juice) between-subjects experimental design was used, with participants randomly assigned to one of eight experimental scenarios: the picture of a perfect

fruit (apple) that was either presented in its original state (no processing) or was accompanied by a picture of a processed product (apple bar vs. apple chips vs. apple juice); the picture of an imperfect fruit (apple suboptimal in its appearance) that was either presented in its original state (no processing) or was accompanied by a picture of a processed product (apple bar vs. apple chips vs. apple juice) (see Appendix A).

In each condition, participants indicated their likelihood of purchasing the product that was presented at the beginning of the study, using a scale adapted from White et al., (2016) ("very unlikely to buy this product/very likely to buy this product," "very unwilling to buy this product/very willing to buy this product," "very uninclined to buy this product/very inclined to buy this product,", on seven-point differential semantic scales; $\alpha = .96$, M = 4.87, *SD* = 1.49). Before providing demographic information, respondents also completed a manipulation check measure aimed at verifying that the imperfect versus the perfect product was perceived as intended ("Please, rate the extent to which you perceive the product shown at the beginning of the study as …" 1= "imperfect", 7 = "perfect").

3.1.2. Results and Discussion

The manipulation check was successful as individuals exposed to the picture of the imperfect product rated the product as more imperfect than did individuals having been shown the picture of the perfect product ($M_{perfect} = 5.30$, $SD = 1.15$; $M_{imperfect} = 4.25$, $SD = 1.41$; $F\ (1,251) = 42.402$; $p < .01$).

In order to test for the moderating effect of the physical processing of an imperfect product on purchase intention, we conducted a two-way ANOVA with imperfection and physical processing as factors and likelihood to purchase the product as dependent variable. As expected, results revealed a significant interaction effect between imperfection and physical processing ($F\ (1,245) = 3.49$, $p < .05$), with simple effects showing that for *imperfect* products there is a significant difference between the product in its original state

(M = 3.47, *SD* = 1.34), and the product when it has been processed into an apple bar (M = 4.80, *SD* = 1.73), apple chips (M = 4.44, *SD* = .96) or apple juice (M = 4.63, *SD* = 1.71; $F(3, 245) = 5.58$, $p < .01$). Contrarily, for *perfect* products there is no significant difference between the product in its original state (M = 5.05, *SD* = 1.48) and the product after it has been processed into an apple bar (M = 5.34, *SD* = 1.67), apple chips (M = 5.00, *SD* = .76) or apple juice (M = 5.62, *SD* = .90, $F(3,245) = 1.15$, $p = .33$). Furthermore, there is no difference between perfect products and imperfect products after they have been processed into either an apple bar ($M_{perfect} = 5.34$, *SD* = .22 vs. $M_{imperfect} = 4.80$, *SD* = .22, $F(1,245) = 2.98$, $p = .09$) or apple chips ($M_{perfect} = 5.00$, *SD* = .24 vs. $M_{imperfect} = 4.44$, *SD* = .24, $F(1, 245) = 2.75$, $p = .10$).

Overall, these results support H_1 and show that physically processing imperfect produce into other products (bar, chips, juice) is effective in increasing consumers' likelihood of purchasing the product. Furthermore, by testing this effect across a series of three possible transformations of the product, we provide robust evidence for the moderating effect of physically processing the product on the relationship between imperfection and purchase intention.

FIGURE 2 ABOUT HERE

3.2. Study 1b

The purpose of Study 1b was to provide further and more robust evidence for the effect hypothesized in H_1. First, Study 1b tests the effect of imperfection on the choice between a product in its original state and a product that has been physically processed. Second, this study extends results of Study 1a by testing the effect that physically processing imperfect produce has on consumers' willingness to pay for the product. Third, different types of products and different transformations were used to provide further and

more generalizable evidence for the positive effect that the physical transformation of imperfect produce has on consumers' preferences and behaviour. In this sense, this study uses dependent variables that more closely reflects real behaviour, thus overcoming the limitations of behavioural intention measures. Finally, data was collected on the online platform Prolific with the aim of circumventing potential biases associated with the use of snowball sampling procedures.

3.2.1. Participants, Design and Procedure

Study 1b employed a one-factor (perfect vs. imperfect produce) between-subjects design in which participants were given the option to choose between two products: an imperfect (vs. perfect) product in its original state, and a physically processed product (e.g., bar) produced using an imperfect (vs. perfect) fruit. We used different types of fruits and transformations, with six hundred UK residents (69.8% female; M_{age} = 34.42, *SD* = 11.92) recruited on Prolific, randomly assigned to one out of twelve scenarios in which they were asked to choose between either: an imperfect (vs. perfect) apple and an apple bar (vs. apple chips vs. apple candies vs. apple juice); an imperfect (vs. perfect) apricot and an apricot juice; an imperfect (vs. perfect) orange and an orange juice (see Appendix B). The presentation order of the choices in each condition was counterbalanced to avoid any order bias (Cutright, 2012). After making their choice, participants were asked to imagine that they had a maximum budget of £5 and to rate the extent to which they would be willing to pay for both the product (perfect vs. imperfect) in its original state and the physically processed product. Respondents also completed the manipulation check measure for imperfection (1 = imperfect, 7 = perfect) used in Study 1a. Finally, demographic information was collected.

3.2.2. Results and Discussion

The manipulation check for imperfection was successful, with respondents in the imperfect produce conditions perceiving the imperfect produce as significantly more imperfect than respondents in the perfect product conditions ($M_{perfect}$ = 5.33, *SD* = 1.25 vs. $M_{imperfect}$ = 2.30, *SD* = 1.45, *F (1, 598)* = 758.30, $p < .001$, see Table 1 for details across product types and transformations).

A chi-square test of independence was performed to examine the relation between imperfection (perfect vs. imperfect) and product choice (product in its original state vs. physically processed product). The relationship between these two variables was significant (χ^2 *(1, N = 600)* = 135.57, $p < .001$). Specifically, the proportion of participants choosing physically processed imperfect produce was higher than the proportion of participants choosing imperfect produce in its original state (χ^2 *(1, N = 299)* = 127.17, $p < .001$); conversely, the product in its original state was more likely to be chosen than the physically processed product when produce had no aesthetical imperfections (χ^2 *(1, N = 301)* = 24, $p < .001$) (see Figure 3). Results of chi-squares tests of independences conducted to test the effect of imperfection on product choices for the different types of products (i.e., apple, apricot, orange) and transformations (i.e., apple bar, apple chips, apple candies, apple juice, apricot juice, orange juice) are summarized in Table 1.

FIGURE 3 ABOUT HERE

TABLE 1 ABOUT HERE

Finally, results of two one-way ANOVAs considering consumer's willingness to pay as a dependent variable (from now on: WTP) show that when the product is in its original

state, consumers have a lower WTP for imperfect (M = .29, SD = .29) than perfect produce (M = .54, SD = .38, $F\ (1, 598)$ = 76.75, p < .001); contrarily, there is no difference in consumers' WTP for perfect and imperfect produce that has been physically processed ($M_{perfect}$ = 1.10, SD = .62 vs. $M_{imperfect}$ = 1.13, SD = .36, $F\ (1, 598)$ = .264, p = .61). Further details about differences in WTP across products and transformations are summarized in Table 2.

TABLE 2 ABOUT HERE

Overall, Study 1b extends results of Study 1a and provides more robust support for the positive effect of physically processing imperfect produce on consumers' behaviour. Specifically, we show that consumers are more likely to choose imperfect produce that has been physically processed than imperfect produce in its original state. Furthermore, we show that consumers are willing to pay the same price for a physically processed product regardless of whether it was produced using perfect or imperfect produce.

3.3. Study 2

Study 2 was aimed at testing the full model hypothesized in H_2 and thus at providing evidence for the proposed underlying mechanism of prototypicality for the effect of imperfection and physical processing of imperfect produce on purchase intention toward the product.

3.3.1. Participants, design and procedure

One hundred and ninety responses (M_{age} = 33.46, SD = 14.86, 48% female) were collected through a snowball sampling procedure similar to the one used in Study 1a,

ensuring that the pool of participants of this study differed from the one used in Study 1a[2]. We used a 2 (perfect vs. imperfect) x2 (not physically processed vs. physically processed) experimental design in which participants were randomly assigned to one out of four conditions: the picture of a perfect product in its original state, the picture of a perfect product accompanied by the picture of the physically processed version of the product shown on the left side of the screen, the picture of the imperfect product in its original state, and the picture of the imperfect product accompanied by the picture of the physically processed version of the product shown on the left side of the screen. In this case, an orange (perfect vs. imperfect) was used as the product of origin and an orange juice as the physically processed version (see Appendix C).

Purchase intention was measured using the same items as in Study 1a (α = .98, M = 3.87, SD = 1.98; adapted from White et al., 2016). Our proposed mediator – i.e., prototypicality – was measured by asking respondents to rate the extent to which the product shown in the picture was perceived to be "an extremely poor example/an extremely good example of its category", "atypical/typical" and "very unrepresentative/very representative" (adapted from Loken and Ward, 1990, on seven-point differential semantic scale (α = .88, M = 4.19, SD = 1.87). A manipulation check was administered to test for perceived differences between the perfect and imperfect product (1 = "imperfect"; 7 = "perfect").

3.3.2. Results and Discussion

The manipulation check for imperfection was successful, with respondents perceiving the imperfect produce as significantly more imperfect than did respondents having seen the perfect produce ($M_{perfect}$ = 4.94, SD = 1.63; $M_{imperfect}$ = 3.05, SD = 1.76; F= (1, 188) = 58.41, p < .001).

[2] The study was administered to a group of 18 undergraduate students (different from the ones recruited in Study 1a), who in turn were asked to recruit a maximum of 10 subjects responsible for shopping in their household.

In order to test for H_2, according to which the moderation effect of the physical transformation is explained by perceptions of prototypicality, we conducted a moderated-mediation analysis (Model 7 of PROCESS macro; Hayes, 2017), considering imperfection as independent variable (perfect product = 0, imperfect product = 1), whether the product was physically processed as moderator (0 = not physically processed, 1 = physically processed), and prototypicality as mediator. Results show that imperfection (b = -2.80, *t(186)* = -8.76, $p <$ .001) has a significant effect on prototypicality ($M_{perfect}$ = 5.13, *SD* = 1.55 vs. $M_{imperfect}$ = 3.29, *SD* = 1.69, *t(188)* = 7.80, $p <$.001). Furthermore, the interaction between imperfection and physical processing of the product is significant (b = 1.72, *t*(186) = 3.94 $p <$ .001), indicating that imperfect products that have been physically processed perceived more prototypical than imperfect products in their original state ($M_{original\_state}$ = 2.28, *SD* = 1.13; $M_{processed}$ = 4.09, *SD* = 1.64, *F(1, 95)* = 37.68, $p <$ .001) while for perfect products there is no evidence of differences in prototypicality between the product in its original state and the product after it has been physically processed ($M_{original\_state}$ = 5.08, *SD* = 1.73; $M_{processed}$ = 5.17, *SD* = 1.39, *t (91)* = 1.52, p = .79). In turn, prototypicality has a positive effect on purchase intention (b = .73, *t*(186) = 11.06, $p <$ .001), while the effect of imperfection on purchase intention is not significant (b= .02, *t*(186) = .09, p = .93). The index of moderated-mediation further supports these findings by showing that the indirect effect of imperfection on purchase intention through prototypicality is moderated by the physical processing of the product (b=1.25, SE = .33; 95% C.I.: .60; 1.92). Both conditional indirect effects are significant [95% C.I. -2.64, -1.49; 95% C.I. -1.27, -.35] and coherently with our expectations, the effect of imperfection on purchase intention is greater (b = -2.03, SE = .29) when the product is in its original state than when it is physically processed (-.78, SE = .23). Indeed, the direct effect of imperfection on purchase intention is not significant [95% C.I. -.46, .50].

Results of Study 2 provide support for the hypothesized theoretical mechanism (H_2) explaining the effect of food imperfection on consumers' purchase intention. Specifically, we have enough evidence to confirm our conceptualization, according to which, for *imperfect* produce, a physically processed version of the product is perceived as more prototypical than the product in its original physical state, thus increasing consumers' purchase intention.

4. Discussion

In this research we set out to investigate how physically processing imperfect produce affects consumers' likelihood of purchasing these products. Through three experimental studies results indicate that consumers show higher purchase intention toward and are more likely to choose imperfect produce that has been physically processed than imperfect produce in its original state. Furthermore, consumers are willing to pay the same price for physically processed products (e.g., juice, chips) regardless of whether they have been produced using perfect or imperfect produce. Specifically, we show that this effect is driven by perception of prototypicality, so that processing imperfect produce changes the category the product belongs to; in turn, the new product is perceived as more prototypical, with a positive effect on purchase intention. We provide evidence that this effect holds over a range of transformations (bar vs. chips vs. juice vs. candies) and categories of products (i.e., apple, apricot, orange).

4.1. Theoretical Implications

Our results add to recent literature on food imperfection (e.g., Lombart et al., 2019; Yuan et al., 2019) by providing evidence for the psychological mechanism – i.e., prototypicality – explaining why consumers show higher preference (in terms of purchase intention, choice and WTP) for imperfect produce that has been physically processed than for

imperfect produce in its original state. In this sense, whereas prior research has suggested risk perceptions (Loebnitz and Grunert, 2018), taste perception (Cooremans and Geuens, 2019), quality perception (Lombart et al., 2019) and safety concerns (Yuan et al., 2019) as reasons for consumers' low willingness to purchase and consume imperfect produce, we suggest that this phenomenon can be explained by consumers perceiving imperfect fruits and vegetables as non-prototypical and as a non-representative members of their product category (i.e., produce). However, our results show that the physical transformation of imperfect fruits and vegetables affects the way consumers categorize the product, such that a physically processed product is perceived as more prototypical than the product in its original state; this, in turn, positively affects purchase intention. In this sense, the contribution of our work to literature on consumers' perception of imperfect produce is two-fold. First, we add to works focusing on the drivers of consumers' negative perception of food imperfection (e.g., Grewal et al., 2019; Hingston and Noseworthy, 2020; Yuan et al., 2019) by providing evidence for the role played by perceptions of prototypicality as antecedent of consumers' preference toward imperfect fruits and vegetables. Second, we provide support for the effectiveness of a solution – physical transformation – that can be successfully implemented to promote the purchase of these products. In this sense, our work adds to current works focusing on the development of interventions aimed at overcoming the constraints and limitations of traditional strategies for selling imperfect produce based on lower prices (Aschemann-Witzel et al., 2017; Cooremans and Guens, 2019; Koo, Oh, and Patrick, 2019). Indeed, we show that consumers are more likely to buy and choose imperfect produce that has been physically processed than imperfect produce in its original state. Furthermore, we contribute to literature on prototypicality by showing that the principles of category representativeness (Barsalou, 1985) can explain consumers' evaluation of imperfect produce, while distortions in product shape (Creusen and Schoormans, 2005; Trudel and Argo, 2013; Veryzer and Hutchinson,

1998) positively influence consumers' response to food imperfection. In this sense, we add to this literature by showing that such principles can be successfully applied to a product category neglected by prior research.

Finally, we contribute to the recent wave of research on food waste by showing that the understanding of the psychological mechanisms explaining consumers' attitudes and reactions is paramount for the design and development of tools aimed at its minimization (e.g., Cooremans and Geuens, 2019; Grewal et al., 2019), in line with the call for more efforts to fight food waste at the consumer level (e.g., Graham-Rowe, Jessop and Sparks, 2014). In this sense, our work contributes to recent research underlying the role of retailers and marketers in promoting consumers' sustainable consumption choices and overcoming their negative perceptions of certain types of products (Hingston and Noseworthy, 2018; Pham and Mandel, 2019).

4.2. Practical Implications

Our results have relevant implications for companies operating in the food sector and for producers as well as for policy makers. For instance, manufacturers could profit by selling products such as juices, chips, and candies produced using fruit or vegetables with aesthetical imperfections, thus recovering and financially benefitting from produce that would otherwise go to waste. This strategy, in turn, can also positively affects consumers' perception of the manufacturers; indeed, prior research has shown that societal advertisements on imperfect fruit and vegetables have a positive effect on retailers' image and perceived social responsibility policy (Louis and Lombart, 2018). In this sense, manufactures could commercialize physically processed imperfect produce by using pictures of imperfect fruits or by using claims on the package detailing the origin of the product.

The economic and reputational benefits associated with the sale of physically processed imperfect produce could also act as a trigger for retailers to take more effective actions for the reduction of food waste. Given their key position in the global food system and in the supply chain (Burch and Lawrence, 2007; Swaffield, Evans, and Welch, 2018), it is paramount to engage retailers and devise effective solutions that ensure their contribution to the overall reduction of food waste (Swaffield, Evans, and Welch, 2018). Physically processing imperfect fruit and vegetables and sell the final products in stores could provide such a solution. In this sense, our findings suggest that it would be convenient for supermarkets to add juice bars to their stores in which to sell fresh juices and smoothies made with imperfect produce. Our work shows that, when asked to pick between imperfect produce in its original state and imperfect produce that has been physically processed, consumers are more likely to choose the latter. While some retailers are already buying less aesthetically appealing produce for prepared foods (Aubrey, 2006; Peters, 2019), our studies suggest that communicating to consumers that these products have been produced using imperfect fruit and vegetables would not be detrimental in terms of consumers' acceptance of these products. Alternatively, retailers could complement the sale of imperfect produce with materials aimed at providing consumers with suggestions and recommendations about how to process and use imperfect fruit and vegetables in their households. This could be done through in-store banners or leaflets, or through information provided on the company's website or social media channels. For instance, the Australian supermarket chain Harris Market recommends on its website recipes specifically tailored for its range of imperfect produce[3]. The results of our work are in line with this strategy and suggest the positive effects that such an initiative could have on consumers' choice.

[3] https://www.harrisfarm.com.au/collections/imperfect-fresh-juices

Second, our findings provide useful suggestions for policy makers aiming at raising awareness of food waste. For instance, while entities such as FAO are focusing on communicating the inner value and beauty of imperfect produce (FAO, 2018), our work suggests that a more practical way to push consumers toward the consumption of these products is by communicating to them how they could process them into new products. Policy makers could contribute in that sense by helping retailers realize the potential for profit and market opportunities of selling physically processed imperfect produce (EU Platform on Food Losses and Food Waste, 2019), which would ultimately affect consumers' choice in store. Furthermore, policy makers could develop educational materials aimed at providing useful suggestions in terms of the possibilities for successfully repurposing imperfect produce inside the household. These could be distributed in partnership with retailers offering imperfect produce on their shelves to maximize reach and impact. Similarly, policy makers could work alongside non-profit organizations fighting food waste to provide consumers with information and suggestions about the benefits of purchasing imperfect produce and their potential in terms of transformation in new products. Overall, our results are informative and could provide useful suggestions for actors working at different levels of the food supply chain.

5. Limitations and Avenues for Future Research

One limitation of our work is that we tested our predictions only with fruit. Future research could build on and expand our work verifying the effect of physically processing imperfect produce on consumers' perceptions by testing our underlying mechanism using vegetables (e.g., crooked cucumber) and different types of transformations (e.g., soups, salad). This would further expand the validity of our findings while at the same time help to identify potential boundary conditions for the effect hypothesized in this work. Furthermore,

whereas different types of physically processed versions of the product were employed (i.e., bar, juice, chips), the transformations we used are commonly found in retail stores. Hence, future research could test the extent to which uncommon transformations influence consumers' purchase intention. Given the proliferation of new ways of physically processing food, and the emergence of new technologies, we expect this to be a relevant topic for companies selling food products and for policy makers aiming to encourage the consumption of these products.

We did not consider the role of social norms. For instance, consumers who are more familiar or have had experience with imperfection in fresh produce, or with specific types of physically processed food, may react differently to imperfect products in their original state and imperfect products that have been physically processed. While this is beyond the scope of our work, future research could explore the effect that familiarity has on consumers' purchase intention and preferences toward physically processed imperfect produce. Moreover, while previous research converges on the idea that food is a low involvement product (e.g., Ahmed et al., 2004; Dahlèn et al., 2000) whose purchase has a habitual and repetitive nature, we did not explicitly test this assumption in our empirical work. Future research could test specific circumstances in which consumers are particularly involved in the purchase of produce, for instance when they are highly concerned about their health or when they are considering the purchase of produce for a special event (e.g., having guests at dinner). In particular, it would be interesting to investigate the effect of prototypicality in these circumstances and whether other mechanisms play a role in explaining consumers' preferences toward aesthetically perfect produce.

Finally, future research could investigate the extent to which the appearance of other categories of food – e.g., snacks – and physical distortions affect categorization and consumers' perception of prototypicality. Whereas prior studies have provided, for instance,

initial evidence for how the size of food affects categorization (Scott et al., 2008), this aspect is still neglected by current research. Building on this idea, for instance, future efforts could be devoted to the understanding of how physically altering the aesthetic appearance of food influences purchase intention, as well as the categorization of the product as healthy vs. unhealthy, or virtue vs. vice.

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Table 1.
Study 1b: summary of results.

	Apple (# choices)	Apple bar (# choices)	Test	Mean rating (SD) of imperfection (1 = imperfect, 7 = perfect)	Manipulation check
Perfect	34	17	χ^2 (1, N = 51) = 5.67, p = .017	5.02 (1.44)	F (1,99) = 212.26, p = .000
Imperfect	4	46	χ^2 (1, N = 50) = 35.28, p = .000	1.64 (.80)	
	Apple (# choices)	**Apple chips (# choices)**	**Test**	**Mean rating (SD)**	**Manipulation check**
Perfect	42	8	χ^2 (1, N = 50) = 23.12, p = .000	5.22 (1)	F (1,96) = 237, p = .000
Imperfect	5	43	χ^2 (1, N = 48) = 30.08, p = .000	1.92 (1.23)	
	Apple (# choices)	**Apple candies (# choices)**	**Test**	**Mean rating (SD)**	**Manipulation check**
Perfect	38	12	χ^2 (1, N = 50) = 13.52, p = .000	4.94 (1.19)	F (1,98) = 221.22, p = .000
Imperfect	8	42	χ^2 (1, N = 50) = 23.12, p = .000	1.68 (1)	
	Apple (# choices)	**Apple juice (# choices)**	**Test**	**Mean rating (SD)**	**Manipulation check**
Perfect	26	24	χ^2 (1, N = 50) = .080, p = .777	4.94 (1.42)	F (1,98) = 204.89, p = .000
Imperfect	4	46	χ^2 (1, N = 50) = 35.28, p = .000	1.58 (.86)	
	Apricot (# choices)	**Apricot juice (# choices)**	**Test**	**Mean rating (SD)**	**Manipulation check**
Perfect	29	21	χ^2 (1, N = 50) = 1.28, p = .258	6.08 (.85)	F (1,99) = 71.05, p = .000
Imperfect	19	32	χ^2 (1, N = 51) = 3.31, p = .069	4.10 (1.43)	
	Orange (# choices)	**Orange juice (# choices)**	**Test**	**Mean rating (SD)**	**Manipulation check**
Perfect	24	26	χ^2 (1, N = 50) = .080, p = .777	5.80 (1.01)	F (1,98) = 151.74, p = .000
Imperfect	12	38	χ^2 (1, N = 50) = 13.52, p = .000	2.82 (1.38)	

Table 2.
Study 1b: summary of results (willingness to pay).

	Perfect	Imperfect	Test
Apple[a]	.493 (.279)	.172 (.183)	F (1, 397) = 184.26, p = .000
Apple bar	.810 (.418)	.848 (.398)	F (1, 99) = .228, p = .634
Apple chips	.979 (.663)	1.05 (.536)	F (1, 96) = .299, p = .585
Apple candies	.980 (.539)	1.01 (.668)	F (1, 98) = .057, p = .812
Apple juice	1.08 (.567)	1.08 (.608)	F (1, 98) = .001, p = .973
Apricot	.600 (.300)	.553 (.374)	F (1, 99) = .495, p = .483
Apricot juice	1.58 (.601)	1.51 (.545)	F (1, 99) = .459, p = .500
Orange	.651 (.686)	.510 (.257)	F (1, 98) = .195, p = .166
Orange juice	1.20 (.616)	1.28 (.610)	F (1, 98) = .378, p = .540

[a]All conditions in which participants were shown an apple (perfect vs. imperfect) were aggregated

Figure 1. Overall theoretical framework.

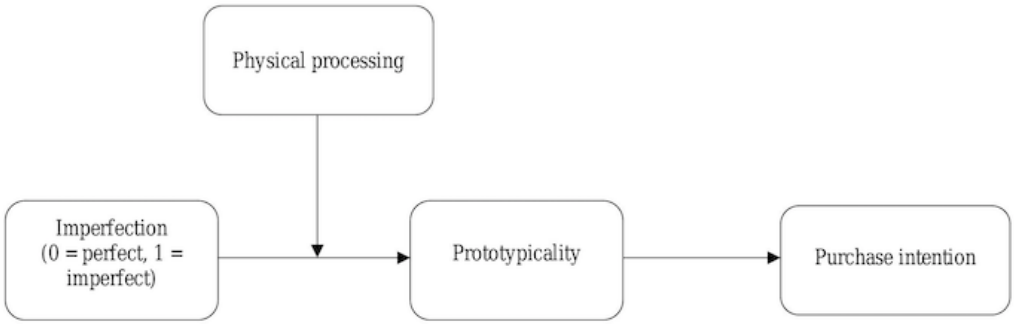


Figure 2. Interaction effect of food imperfection and physical processing on purchase intention (Study 1a).

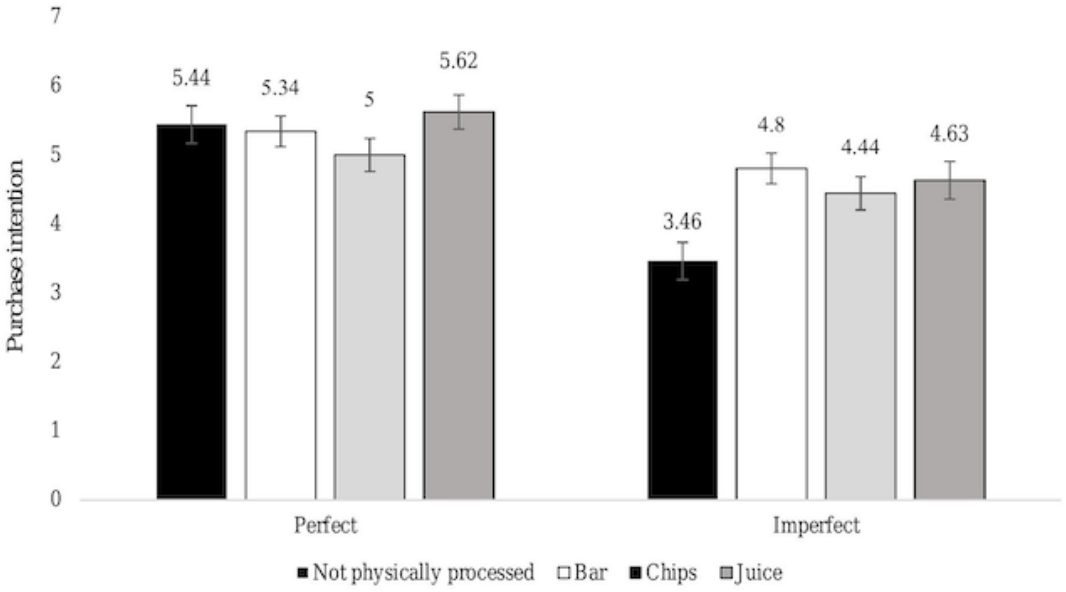
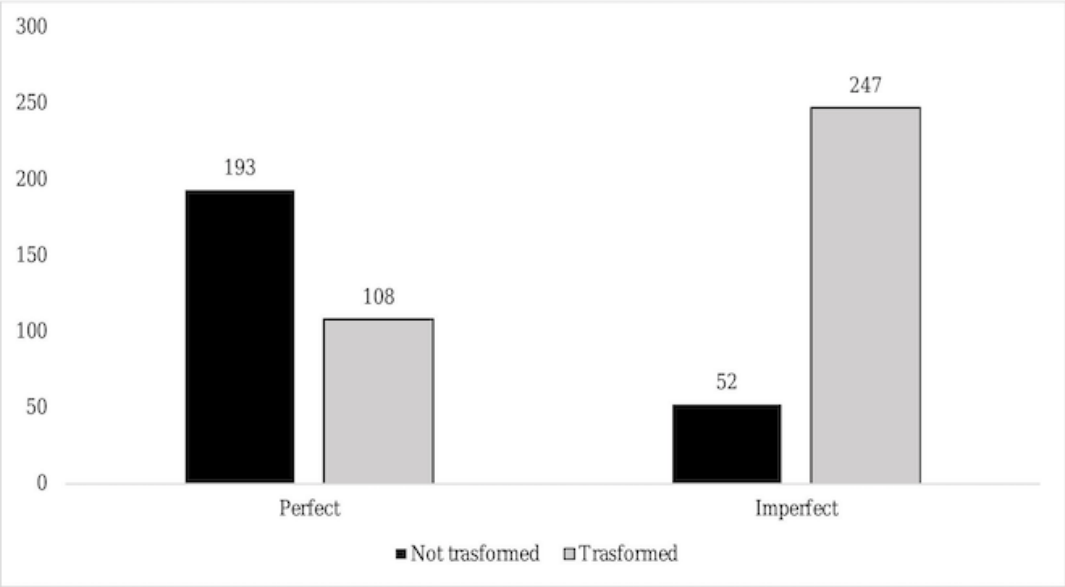


Figure 3. Summary of choices across conditions (Study 1b).



Appendix A.

Study 1		
	Perfect	Imperfect
Not physically processed	 Apple	 Apple
Bar	 Apple bar obtained from apple on the left	 Apple bar obtained from apple on the left
Chips	 Apple chips obtained from apple on the left	 Apple chips obtained from apple on the left
Juice	 Apple juice obtained from apple on the left	 Apple juice obtained from apple on the left

Appendix B.

Study 1b		
	Perfect	**Imperfect**
Apple bar	 Apple ○  Apple bar ○	 Apple ○  Apple bar ○
Apple chips	 Apple ○  Apple chips ○	 Apple ○  Apple chips ○
Apple candies	 Apple ○  Apple candies ○	 Apple ○  Apple candies ○
Apple juice	 Apple ○  Apple juice ○	 Apple ○  Apple juice ○
Apricot juice	 Apricot ○  Apricot juice ○	 Apricot ○  Apricot juice ○
Orange juice	 Orange ○  Orange juice ○	 Orange ○  Orange juice ○

Appendix C.

Study 2		
	Perfect	Imperfect
Not physically processed	 Orange	 Orange
Physically processed	 Orange juice obtained from orange on the left	 Orange juice obtained from orange on the left