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What makes foods and flavours fit? Consumer perception of (un)usual product combinations

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ABSTRACT

Some foods and flavours go better together than others, but the success of novel food combinations is difficult to predict. The current study investigated to what extent perceptual, conceptual and affective pairing principles influence consumer evaluations of usual and unusual product combinations. Dutch consumers (N = 177) evaluated two sweet-tasting food products (vanilla ice cream, chocolate custard) combined with three flavour products (coffee, soy sauce, fish sauce) in terms of congruence, liking and sensory qualities. Product combinations occurred in three conditions (between-subjects): flavour products were either mixed with the carrier foods beforehand (Premix) or presented separately from the carriers, and were either accompanied with a flavour description (Label) or not (No-Label). Results showed that consumer evaluations were influenced by a combination of perceptual (*balance of intensity*), conceptual (*norms*) and affective (*surprise*) pairing principles. Moreover, usual (coffee) combinations were appreciated more, and unusual (soy/fish sauce) combinations less, if flavour products were identified, but flavour identification effects were mediated by the moment of identification (before *vs.* after tasting). Findings highlight the cognitive nature of food pairing principles, and the power of language in predicting successful food pairings in particular.

1. Introduction

Certain food combinations 'work' (e.g., strawberries and cream), whereas others do not go together well (e.g., red wine and seafood). Although it is widely agreed *that* certain food pairings are more successful than others, it is as of yet unclear *why* this is the case (cf. Møller, 2013). Molecular approaches to food pairing predict the success of food combinations from their number of overlapping chemical components (cf. Heston Blumenthal's *Food Pairing Theory*; Blumenthal, 2002; Blumenthal, 2008), but despite the popularity of such approaches among chefs (see e.g. Coucquyt et al., 2020), scientific evidence supporting this assumption is lacking (see e.g., de Klepper, 2011). It is argued that successful food pairing is, for a large part, a cognitive matter, as preferences for foods and food combinations are learned, and often culturally determined (for discussion, see e.g., Ahn, Ahnert, Bagrow, & Barabási, 2011; Arellano-Covarrubias, Gómez-Corona, Varela, & Escalona-Buendía, 2019; Galmarini, 2020; Møller, 2013; Spence, 2017, 2020; Spence, Wang, & Youssef, 2017). In a qualitative study with wine and beer experts, Eschevins et al. (2019) identified eigtheen principles underlying succesful food and beverage pairing, which they categorized into perceptual, conceptual and affective principles. Perceptual pairing principles are based on food-instrinsic properties, i.e. the sensory characteristics of the combined foods/beverages (and hence linked to sensory and perceptual systems; cf. Cardello, 2007). Conceptual and affective pairing principles rely on food-extrinsic properties, i.e. properties that are related to, but not physically part of the foods/beverages, as well as on individual preferences, both of which relate to previous experiences stored in memory (and thus linked to cognitive mechanisms, cf. Cardello, 2007). In particular the conceptual 'norms' principle relies on tradition (culinary culture) and custom (familiarity): a combination of foods is more likely judged a good match if it can be linked to existing associations with this combination. By contrast, the affective principle of 'surprise' relies on deviations from the norm. This principle can be strategically used to create an unexpected taste experience (which, from the consumer's perspective, may be more or less desirable; see e.g. Spence & Piqueras-Fiszman, 2014). The experts in Eschevins et al.

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(2019) mentioned predominantly perceptual pairing principles when pairing foods with wine/beer, but the impact of conceptual and affective principles on the commercial success of food-food and food-beverage pairings should not be underestimated – as it is ultimately the consumer who determines acceptance (Galmarini, 2020).

The current study investigates how perceptual, conceptual and affective pairing principles interact in consumer evaluations of food-food pairings. To this end, two sweet-tasting foods ('carriers'; chocolate custard and vanilla ice cream) were mixed with three condiments/flavourings ('flavours': coffee, soy sauce and fish sauce) to form usual and unusual combinations. The sensory profile of coffee forms both a usual and pleasant fit with sweet foods like vanilla ice cream and chocolate custard, as evidenced by the variety of commercially available products in which these flavours are combined. Based on both perceptual and conceptual pairing principles, coffee combinations are expected to be positively evaluated by consumers. Sweet-tasting foods mixed with fish sauce are unusual combinations. As far as we know, fish sauce is never combined with sweet foods in any (non-experimental) cuisine or marketed food product; moreover, (according to the authors' taste) its sensory profile forms an unpleasant fit with both of the carriers (in perceptual pairing terms, lacking balance of intensity; Eschevins et al., 2019). Based on both perceptual and conceptual pairing principles, fish sauce combinations with both sweet foods are therefore expected to be negatively evaluated by consumers. Examples of sweet-tasting foods mixed with soy sauce do not exist in Western culinary cultures, but such pairings are found in Asian culinary cultures (where soy sauce is sometimes used in cookies, cakes and desserts). The sensory profile of soy sauce forms an unusual, but pleasant fit with vanilla ice cream and chocolate custard. In perceptual pairing terms, it could be described as enhancing the sensory properties of the carrier foods (bearing resemblance with salted caramel/butterscotch and salted chocolate bars/snacks, respectively). For soy sauce combinations, perceptual and conceptual pairing principles are thus in conflict for Western consumers (and potentially trigger the affective principle of surprise), raising the question of how such combinations will be evaluated. We additionally investigated to what extent consumer evaluations of the product combinations related to the familiarity (operationalized as consumption frequency) and hedonic appraisal of the individual products in the combinations, as well as the more general tendency to avoid novel foods (*food neophobia*; Pliner & Hobden, 1992).

To further specify how conceptual and affective pairing principles influence consumer evaluations of (un)usual product combinations, we investigated when such experience-based pairing principles come into play. Prior research has extensively shown that previous food experiences (as stored in memory) can be triggered by all kinds of information (*cues*) in the environment, to shape expectations about, and subsequent perception of, a food's sensory and hedonic qualities (for reviews, see, e.g., Okamoto & Dan, 2013; Piqueras-Fiszman & Spence, 2015; Skaczkowski et al., 2016; Cardello & Meiselman, 2018). Such cues ban be food-intrinsic, e.g, visual (e.g., Delwiche, 2012), olfactory (e.g., Smeets & Dijksterhuis, 2014), auditory (e.g., Zampini & Spence, 2005), or tactile (e.g., Pramudya & Seo, 2019), as well as food-extrinsic, e.g., food descriptions and labelling (e.g., Yeomans et al., 2008; Woods et al., 2011; Liem et al., 2012), brand names (e.g., Cavanagh & Forestell, 2013), product packaging (e.g., Ng et al., 2013), shape (e.g., Spence & Ngo, 2012) or the consumption environment (e.g., van Bergen et al., 2021). Here, we investigate to what extent conceptual and affective pairing principles are triggered by food-intrinsic and food-extrinsic cues to shape consumer expectations about (and subsequent evaluations of) their combined taste. To this end, the visual, olfactory and linguistic information provided about the flavour products in the combinations was systematically varied across consumers. It is thereby hypothesized that expectations about the product combinations will be more certain as more flavour cues are available (cf. Ludden et al., 2008). To specify how such cue-based expectations affect the subsequent taste experience, consumer expectations were made explicit by having participants evaluate each combination twice (before and after tasting).

2. Method

2.1. Participants

One hundred and seventy-seven consumers participated in the experiment. Participants were recruited from the Food Research consumer database of Wageningen University & Research, after screening with an online survey (EyeQuestion Software, Logic8 B.V., the Netherlands) on the following criteria: 18 years or older; being healthy (self-reported); not following a vegetarian or vegan diet; having no allergies or intolerances for any of the product ingredients used in the study. Participants were randomly assigned to one of three groups. In the first group (Label group: N = 57, 44 female, mean age 45.0, SD 16.8) flavour products were accompanied with a product description, and were presented separately from carrier products (to be combined by the participants themselves). In the second group (No-Label group: N = 63, 50 female, mean age 46.0, SD 13.7) flavour products were also presented separately from the carrier products, but without a product description. The third group (Premix group: N = 57, 46 female, mean age 43.4, SD 16.3) was presented with premixed product combinations (without a description). Groups did not differ in terms of age ($F(2, 174) = 0.43$, $p = .65$) or gender ($X^2(2) = 0.22$, $p = .90$). All participants provided written informed consent prior to the start of the experimental session, and received ten euros for their participation.

2.2. Test samples

Carrier and flavour samples were combined in various amounts and pretested by the authors to select combinations that yielded the most balanced (or least unblanced, in the case of fish sauce) taste. Carrier samples consisted of 15 ± 0.5 g of vanilla ice cream (house brand Albert Heijn, the Netherlands) and 20 ± 0.5 g of chocolate custard (brand Mona, FrieslandCampina, the Netherlands), which were served in black plastic cups. Flavour samples consisted of 0.5 ml of soy sauce (brand Kikkoman, Japan), 0.55 ml of fish sauce (brand Suree, Thailand), and 0.55 ml of coffee (brand Maas, the Netherlands). Flavour samples were served in small semi-transparent plastic vials, allowing consumers in the Label and No-Label groups to extract intrinsic flavour product information (dark-brown liquids) to form expectations about the to-be-tasted combinations. At the same time, visual distinctions between the flavour samples were minimized by adding black and brown food colouring (PME trade, London, UK) to the coffee and fish sauce samples (which were slightly lighter in colour than soy sauce). This allowed us to investigate to what extent consumers could differentiate between flavour products based on other food-instrinic (i.e., olfactory) information. For the Premix group, flavour samples were mixed through the carrier samples beforehand, by which the visual and olfactory properties of the flavour products were masked by the carriers (and hence served as less reliable cues; Ernst & Bülthoff, 2004).

All food products were purchased from supermarkets in the Netherlands (except for coffee, which was supplied by Maas); the Dutch Food Safety Authority (*Nederlandse Voedsel- en Warenautoriteit*) ensures that food products sold in the Netherlands are safe for consumption. Samples were prepared the day before the experimental sessions. Ice cream carriers and premixed ice cream combinations were stored in a freezer at −20 °C; chocolate custard carriers, premixed chocolate custard combinations and flavour samples were stored in a refrigerator at 4–7 °C (according to the hygiene regulations set by Wageningen University & Research).

2.3. Procedure

The study was executed in November 2019 in the sensory testing facilities of Wageningen University & Research (three days; one day per group; five sessions per day). Upon arrival, participants were verbally informed about the study procedure and seated in individual booths. They first tasted the plain carriers (which were described as vanilla ice cream and chocolate custard to all participants) and evaluated these in terms of liking (VAS, anchors ranging from *not at all* to *very much*) and perceived intensity of five sensory attributes (sweet, salty, bitter, creamy, chocolate/vanilla flavour; VAS, *not at all - very intense*). They were told they would be evaluating the same carriers combined with different flavour products in the remainder of the session.

In the first round, the six carrier-flavour combinations were presented in a pseudo-randomized order, such that half of the participants first received all chocolate custard combinations followed by all vanilla ice cream combinations (and vice versa for the other half); within carriers, the order of flavour products was fully randomized. Samples were accompanied with a sentence identifying the flavour product in the Label group (e.g. "This is vanilla ice cream with coffee") but not in the other groups (e.g. "This is the first product combination"). Participants were instructed to completely empty the vial into the cup and mix the products (or, in the Premix group, to stir the premixed combination through). They were asked not to taste, but to evaluate the product combinations in terms of expected congruence (VAS, *very bad fit - very good fit*), liking and sensory profile (same attributes as for the plain carriers). A two-minute break was included before proceeding to the second round, where all product combinations were presented again (in a different order). Participants were instructed to mix (stir) the products and then taste at least a spoonful of the combination. They answered the same questions about the samples as before, now basing their responses on the taste experience. Participants in the No-Label and Premix groups were additionally asked to guess which flavour product they had tasted in each combination. In between samples, participants cleansed their palettes with still or sparkling water.

At the end of the session, participants filled in the Food Neophobia scale (Pliner & Hobden, 1992) and indicated how often they consumed each of the products used in the study (1: *less than once per year*; 2: *1–2 times per year*; 3: *3–4 times per year*; 4: *1–2 times per month*; 5: *1–2 times per week;* 6: *three times per week or more*). They were verbally debriefed about the goal of the experiment and left. A full experimental session took 60 min on average.

2.4. Analysis

For ease of interpretation of the figures, horizontal positions on the VAS scales were converted to scores ranging from −50 (*very bad fit / do not like at all / not at all intense*) to + 50 (*very good fit / like very much / very intense*). Congruence, liking, and sensory attribute scores after tasting were compared across product combinations and groups by means of 3 (Flavour, within-subjects) × 2 (Carrier, within-subjects) × 3 (Group, between-subjects) ANOVAs. Greenhouse-Geisser corrections were applied in case of sphericity violations; *p*-values below 0.05 were considered significant. F-statistics, p-values and effect sizes (partial eta-squared) are reported. Significant effects were followed up with paired (within-subjects factors) or independent (between-sujects factors) t-tests; p-values (Bonferroni-corrected in case of multiple comparisons) are reported. Evaluations before tasting were added for illustration purposes; only descriptive statistics are reported (difference scores). Associations between liking/congruence scores and carrier/flavour consumption frequency, carrier liking and food neophobia were assessed per flavour combination using Spearman correlation analyses. Significant correlations (adjusted p-value 0.5/15 = 0.003) are reported.

All analyses were conducted using R version 4.0.5 (R core team, 2021) and the `rstatix` (Kassambara, 2021) and `corx` (Conigrave, 2020) packages.

3. Results

3.1. Evaluations of product combinations

Fig. 1 shows the mean congruence, liking and sensory attribute scores for each carrier-flavour combination after tasting (averaged over groups). The figure shows that for all combinations, congruence and liking scores were highly similar, and varied more across flavours than between carriers: coffee combinations were preferred over soy sauce combinations, which in turn were preferred over fish sauce combinations. As for sensory evaluations, perceived saltiness also varied considerably across flavours, but scores went in the opposite direction to congruence and liking scores. Sweetness and vanilla/chocolate (carrier flavour) scores varied across both flavours and carriers, but differences were attenuated relative to saltiness scores. Bitterness and creaminess scores varied more across carriers than between flavours.

For congruence and liking, a strong main effect of Flavour (congruence: $F(1.9,329.74) = 616$, $p < .001$, $\eta_p^2 = 0.78$; liking: $F(2,348) = 543$, $p < .001$, $\eta_p^2 = 0.76$) confirmed that coffee combinations were perceived as more congruent and liked better than combinations with soy sauce (p's < 0.001), which in turn were more congruent and liked better than combinations with fish sauce (p's < 0.001). Moreover, a main effect of Carrier (congruence: $F(1,174) = 36.2$, $p < .001$, $\eta_p^2 = 0.17$; liking: $F(1,174) = 37.1$, $p < .001$, $\eta_p^2 = 0.18$) indicated that combinations with vanilla ice cream were more congruent and liked better than combinations with chocolate custard. A significant Flavour × Carrier interaction effect was also found (congruence: $F(2,348) = 14.6$, $p < .001$, $\eta_p^2 = 0.08$; liking: $F(2,348) = 12.4$, $p < .001$, $\eta_p^2 = 0.07$). Paired *t*-tests per flavour showed that coffee was more congruent (diff. 10.7, $p < .001$) and liked better (diff. 10.5, $p < .001$) when combined with vanilla ice cream relative to chocolate custard; similar differences were found for soy sauce (congruence: diff. 8.7, $p < .001$; liking: diff. 9.8, $p < .001$). Combinations with fish sauce were perceived as equally incongruent and disliked regardless of the carrier (p's $\geq .46$).

For sensory evaluations, analyses showed a main effect of Flavour for all attributes (all $F \geq 7.96$, $p < .001$, $\eta_p^2 \geq 0.04$), which was strongest for saltiness ($F(2,348) = 407$, $p < .001$, $\eta_p^2 = 0.70$). Combinations with coffee tasted less salty (diff. −30.7), sweeter (diff. 9.9), had a more intense vanilla/chocolate (carrier) flavour (diff. 10.6), and tasted more creamy (diff. 5.2) and more bitter (diff. 5.5) than combinations with soy sauce (p's < 0.001), which in turn tasted less salty (diff. −13.2), sweeter (diff. 11.1), had a more intense vanilla/chocolate flavour (diff. 12.0), and tasted more creamy (diff. 6.1) and less bitter (diff. −4.6) than fish sauce combinations (p's < 0.001). In addition, a main effect of Carrier was found for all attributes (all $F \geq 34.2$, $p < .001$, $\eta_p^2 \geq 0.16$) except for saltiness ($p = .54$), such that chocolate custard combinations tasted more bitter (diff. 16.7), less sweet (diff. 16.6), less creamy (diff. 12.8), and more like chocolate (diff. 8.5) than combinations with vanilla ice cream (tasted like vanilla) (p's < 0.001). Lastly, a significant Flavour × Carrier interaction effect was found for creaminess, sweetness and bitterness (all $F \geq 4.36$, $p \leq 0.013$, $\eta_p^2 \geq 0.02$). Pairwise flavour comparisons per carrier showed that creaminess, sweetness and bitterness intensity differed across flavours in all combinations (p's < 0.001), but differences were enhanced in vanilla ice cream relative to chocolate custard combinations. This suggests that chocolate custard masked the sensory properties of the flavour products more than vanilla ice cream.

Correlation analyses (Fig. 2) showed that liking and congruence of carrier-flavour combinations were positively related with individual flavour and (to a lesser extent) carrier product consumption frequency, but only for coffee combinations. A positive association with carrier liking was found for coffee and soy sauce combinations, but not for fish sauce combinations. These findings suggest that the impact of individual products in a combination on consumer evaluations is constrained by perceptual pairing principles, such that product-specific experiences are overruled in case of a perceptual mismatch.

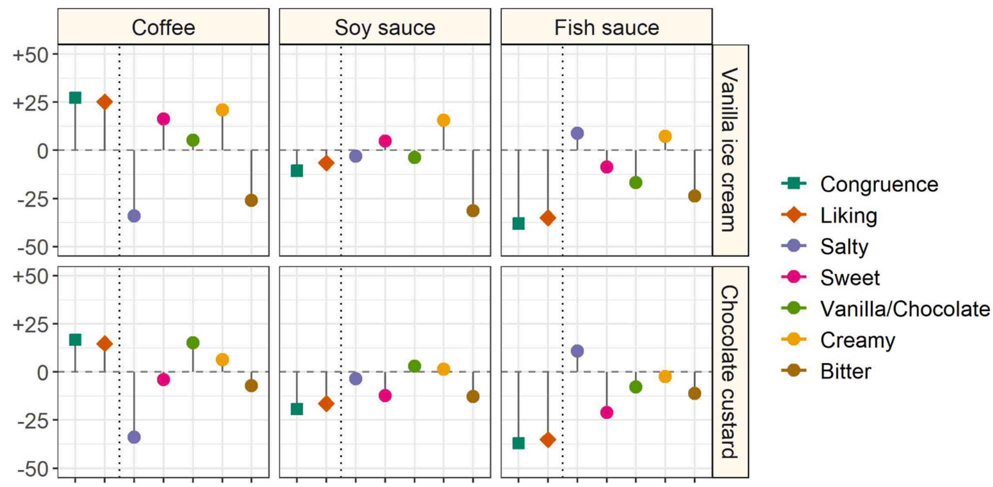

Fig. 1. Mean congruence (squares), liking (diamonds) and sensory attribute scores (circles) per carrier-flavour combination (averaged over groups). Positive scores indicate better fit / better liking / stronger intensity; negative scores represent worse fit / worse liking / weaker intensity.

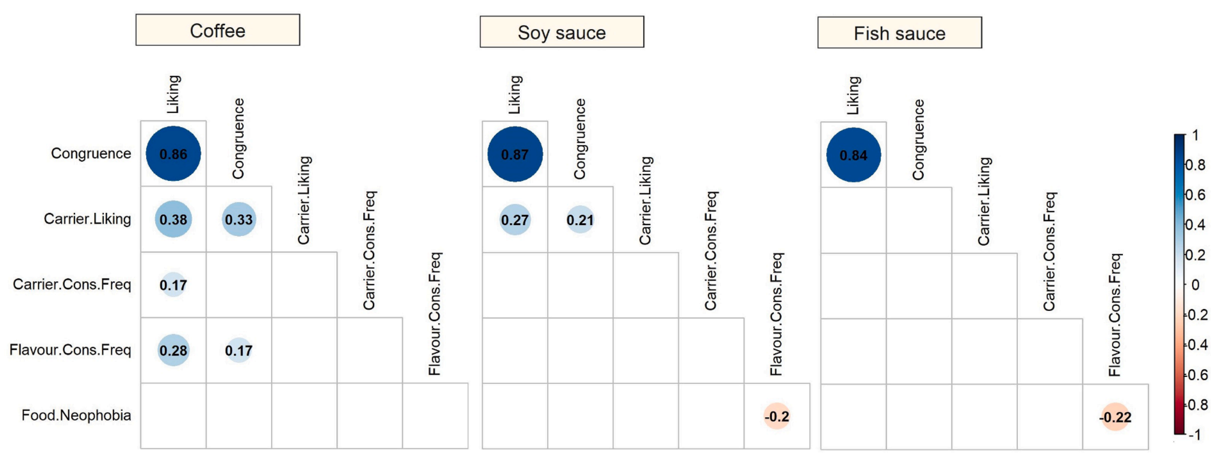

Fig. 2. Correlation matrices of congruence and liking scores with carrier liking, carrier/flavour consumption frequency and food neophobia per flavour combination.

3.2. Flavour cue effects

Fig. 3 shows the expected and perceived congruence (top) and liking (bottom) of each carrier-flavour combination per group. As shown in the figure, expectations about the congruence and hedonic quality of carrier-flavour combinations prior to tasting differed considerably across groups, such that expectations were more extreme (i.e., further away from 0) as participants had more flavour cues to rely on. In the Label group, perceived congruence and liking deviated little from the expectation ($|\Delta| \leq 6$), except for ice cream-soy sauce combinations, which were perceived as more congruent ($\Delta = +14.3$) and liked better ($\Delta = +17.2$) than expected. By contrast, the largest negative deviations from the expectation were seen in the Premix group, especially for chocolate custard combined with fish sauce (congruence: $\Delta = -32.2$; liking: $\Delta = -34.0$) and soy sauce (congruence: $\Delta = -27.0$; liking: $\Delta = -26.6$) (Fig. 3).

After tasting, group differences were substantially reduced, but a significant Flavour × Group interaction for congruence scores ($F(3.79, 329.74) = 5.20$, $p < .001$, $\eta_p^2 = 0.06$) indicated that cue-based expectations prior to tasting affected the subsequent taste experience. Participants in the Label group perceived coffee combinations as more congruent relative to the Premix group (diff 7.2, $p = .023$), and as marginally more congruent relative to the No-Label group (diff 5.6, $p = .058$). By contrast, fish sauce combinations were perceived as less congruent by the Label group relative to the No-Label (diff. −7.6, $p = .008$) and Premix group (diff. −5.7, $p = .048$). A similar trend was found for soy sauce combinations (Label *vs.* No-Label: diff. −10.1; Label *vs.* Premix: diff. −8.4), but differences were not significant ($p = .067$ and $p = .071$, respectively). No evidence was found for a Carrier × Group ($p = .06$) or a Flavour × Carrier × Group interaction effect ($p = .35$). These results thus suggest that language cues before tasting affect the perceived congruence of product combinations upon tasting.

For liking scores, a significant Flavour × Group interaction was also found ($F(4,348) = 2.72$, $p = .029$, $\eta_p^2 = 0.03$), again indicating that cue-based expectations prior to tasting affected the subsequent taste experience. The figure suggests that in the Premix group, the unexpected perceptual mismatch led to a stronger dislike of soy and fish sauce combinations (or produced negative affect, cf. Cardello, 2007), but differences were not significant (p's $\geq .057$). Analyses provided no evidence for a Carrier × Group ($p = .14$) nor for a Flavour × Carrier × Group interaction effect ($p = .25$).

Sensory expectations also showed considerable variation depending on the flavour cues provided beforehand (especially regarding saltiness), but no evidence was found for a Flavour × Group interaction effect for any attribute after tasting (p's ≥ 0.090). However, a Carrier × Group interaction was found for sweetness ($F(2,174) = 6.55$, $p = .002$, $\eta_p^2 = 0.07$) and creaminess ($F(2,174) = 4.51$, $p = .012$, $\eta_p^2 = 0.05$). Paired *t*-tests per group showed that all groups perceived combinations with vanilla ice cream as sweeter and more creamy than chocolate custard combinations (p's < 0.001), but differences were enhanced in the Label

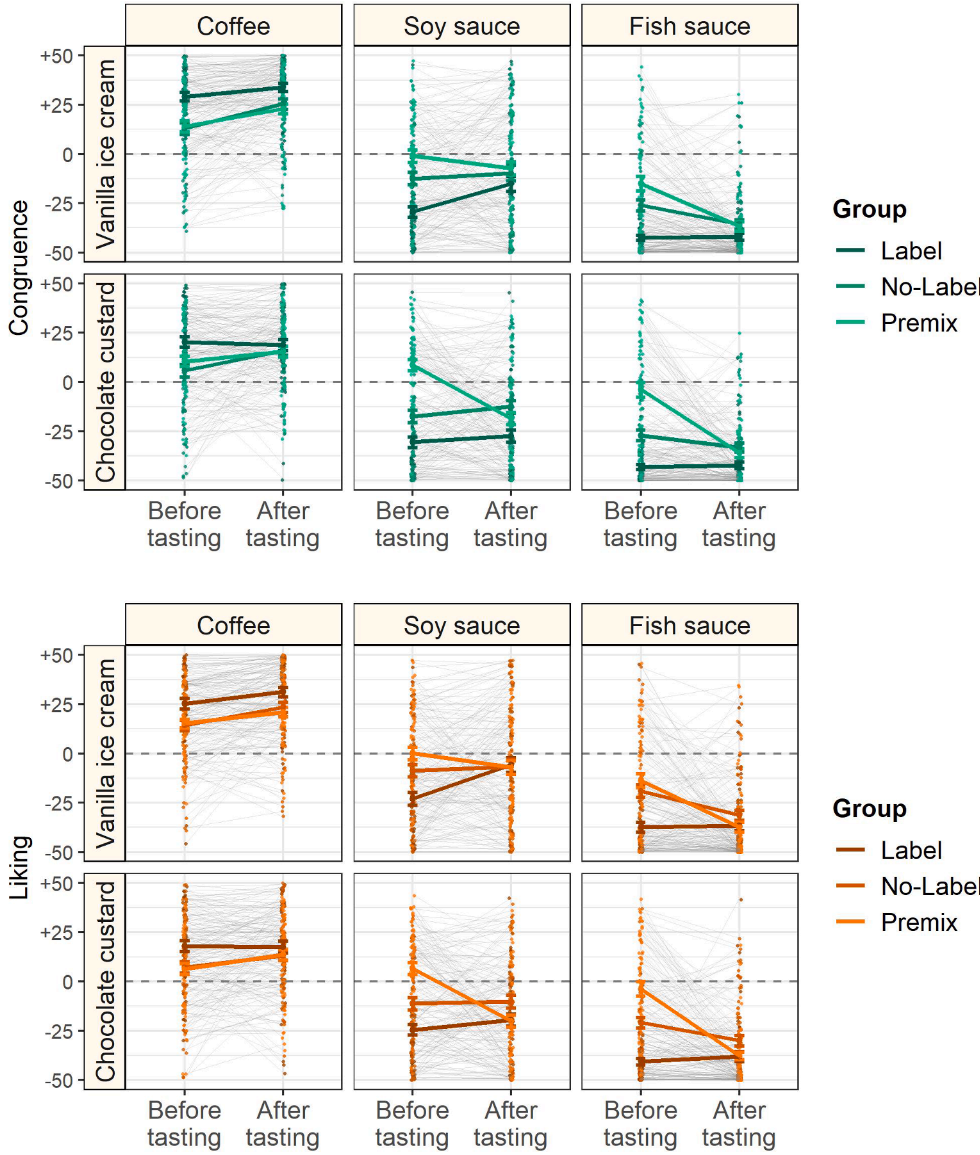

Fig. 3. Congruence (top) and liking (bottom) scores for each carrier-flavour combination before and after tasting per information group. Positive scores indicate better fit liking, negative scores indicate worse fit / liking. Thin grey lines represent individuals; think colored lines represent the mean. Error bars indicate ± SEM.

group (sweet: diff. 21.7; creamy: diff. 16.9), relative to the No-Label group (sweet: diff. 18.2; creamy: 13.6) and the Premix group (sweet: 10.8; creamy: 8.0), respectively. These results suggests that, with fewer flavour product cues to rely on, consumers attended more to the sensory properties of the (unknown) flavours than to those of the (known) carriers during tasting. Analyses for all sensory attribute evaluations and corresponding figures are provided in the supplement.

3.3. *Re-analysis: Perception by flavour identification*

Primary analyses revealed that usual (coffee) combinations were evaluated most positively, and unusual (soy sauce and fish sauce) combinations most negatively by participants in the Label group, who were provided with the flavour descriptions beforehand. Even without this language cue, however, participants in the No-Label and Premix groups may have known (or guessed) the flavour products in the combinations, either from the product-instrinsic (visual/olfactory) cues prior to tasting, or from the additional (gustatory) information that became available upon tasting. This possibility was explored by examining participants' responses when prompted to guess the flavour products in the combinations. As shown in Table 1, coffee was identified more often than soy sauce, which in turn was identified more often than fish sauce, in line with the familiarity of these products in the western world (and consumption frequency in our sample, which did not differ across groups). Also, flavours were identified more often in vanilla ice cream combinations than in chocolate custard combinations, confirming that chocolate custard masked the sensory properties of the flavour products more than vanilla ice cream. When comparing flavour identifiers *vs.* incorrect guessers across groups, analyses per combination showed that the proportion of soy sauce identifiers was significantly higher in the No-Label group than in the Premix group (ice cream: $X^2(1) = 18.5$, $p < .001$; chocolate custard: $X^2(1) = 25.3$, $p < .001$), which suggests that presenting soy sauce separately from the carriers before tasting facilitated flavour identification. For coffee and fish sauce, the proportion of flavour identifiers was also higher in the No-Label group than in the Premix group, but differences were smaller (and not significant, p's $> .25$).

To explore whether the more extreme congruence and liking scores in the Label group could be explained in terms of flavour identification, participants in the No-Label and Premix groups were re-categorized as

Table 1
Number (%) of participants in the No-Label and Premix group who identified the flavour in the product combinations.

	Coffee		Soy sauce		Fish sauce	
	Vanilla ice cream	*Chocolate custard*	*Vanilla ice cream*	*Chocolate custard*	*Vanilla ice cream*	*Chocolate custard*
N (%) flavour identifiers	71 (59)	56 (47)	39 (32)	36 (30)	28 (23)	20 (17)
No-Label group (N = 63)	36 (57)	33 (52)	32 (51)	32 (51)	17 (27)	12 (19)
Premix group (N = 57)	35 (61)	23 (40)	7 (12)	4 (7)	11 (19)	8 (14)

flavour identifers *vs*. non-identifiers. For each combination, evaluations were compared between flavour identifiers and non-identifiers on the one hand, and between flavour identifiers and pre-informed participants (the Label group) on the other. Results (Table 2) show that for unusual flavour combinations, flavour identifiers indeed patterned with the Label group rather than with non-identifiers. Soy sauce and fish sauce identifiers perceived the combinations as less congruent and less liked relative to non-identifiers (although differences were only marginally significant for soy sauce-chocolate custard combinations), whereas their evaulations did not differ from the Label group. Fish sauce-ice cream combinations tasted more salty and less like vanilla to fish sauce identifiers when compared with non-identifiers (even when compared with the Label group). These results provide suggestive evidence that perception of unusual product combinations is affected by product identification, beit via extrinsic (language) or intrinsic (sensory) cues.

For usual combinations, group comparisons showed a different result. Coffee identifiers patterned with non-identifers rather than with pre-informed participants, especially for coffee- ice cream combinations. The Label group perceived coffee-ice cream combinations as more congruent and more creamy, and liked the combinations better than participants who were not provided with the language cue, irrespective of whether they identified coffee. Coffee identifiers did differ from non-identifiers with respect to perceived bitterness and vanilla flavour intensity (coffee identifiers perceiving coffee-ice cream combinations as more bitter and having a less intense vanilla flavour), but this did not impact their congruence and liking evaluations. This finding suggests that flavour identification led to more positive evaluations of usual product combinations, but only if flavour products were identified before tasting.

4. Discussion

This study investigated to what extent perceptual, conceptual and affective pairing principles (Eschevins et al., 2019) influence consumer evaluations of food-food pairings. To this end, consumers tasted six (un) usual product combinations – two sweet-tasting carrier foods (vanilla ice cream and chocolate custard) combined with three flavour products (coffee, soy sauce, and fish sauce) – in terms of congruence, liking and sensory attributes. To further specify when and how experience-based pairing principles come into play, information about the flavour products in the to-be-tasted combinations was systematically varied across consumers.

Findings showed that (usual) coffee combinations were overall perceived as more congruent and liked better than (unusual) soy sauce and fish sauce combinations, and soy sauce combinations were perceived as more congruent and liked better than combinations with fish sauce. Carrier effects were limited to coffee and soy sauce combinations, which were liked better when combined with vanilla ice cream than with chocolate custard. Similarly, correlation analyses showed that carrier liking positively contributed to evalutations of coffee and soy sauce combinations, but not fish sauce combinations. Sensory analyses revealed that the product combinations differed most in perceived saltiness, which varied across flavour products regardless of the carrier they were combined with. Other perceived sensory differences between flavour products were smaller and/or mediated by the carriers, suggesting that perceived saltiness contributed most to the congruence and liking of the product combinations. These findings confirm that successful food pairing relies strongly on perceptual principles, i.e. the sensory properties of the foods in the pair have to be balanced (Eschevins et al., 2019; see also Spence, 2020).

Findings also showed that consumer evaluations differed according to the information provided before tasting. Specifically, participants

Table 2
Mean differences in congruence, liking and sensory attribute evaluations between (a) flavour-identifiers *vs*. non-identifiers and (b) flavour-identifiers *vs*. pre-informed participants (Label group). Significant differences in bold. Asterisks indicate significance level (adjusted p-values 0.05/2 = 0.025).

	Coffee		Soy sauce		Fish sauce	
	Vanilla ice cream	*Chocolate custard*	*Vanilla ice cream*	*Chocolate custard*	*Vanilla ice cream*	*Chocolate custard*
Congruence						
Identifiers vs. non-identifiers	+0.5	+5.5	**−20.5****	−10.1	**−10.9***	**−12.8****
Identifiers vs. Label group	**−9.4****	−0.2	−7.3	+5.0	−2.7	−3.0
Liking						
Identifiers vs. non-identifiers	+0.5	−0.4	**−13.5***	−8.6	**−9.8***	**−12.4***
Identifiers vs. Label group	**−8.7***	−4.2	−10.2	−1.3	−5.0	−5.9
Salty						
Identifiers vs. non-identifiers	−5.1	−6.3	+10.4	**+13.1***	**+15.4****	+7.7
Identifiers vs. Label group	+2.7	−3.2	+4.6	+3.6	**+17.8****	+8.9
Sweet						
Identifiers vs. non-identifiers	−0.8	+4.2	−6.4	−4.0	−11.9	+1.1
Identifiers vs. Label group	−4.7	**+9.2***	−3.3	+1.4	−12.0	+1.7
Creamy						
Identifiers vs. non-identifiers	−4.9	0.6	−2.8	−0.6	+1.0	−1.3
Identifiers vs. Label group	**−10.2****	−0.4	−5.2	+1.2	−1.7	+2.2
Vanilla/Chocolate						
Identifiers vs. non-identifiers	**−10.7***	−7.2	−8.3	+0.5	**−11.1***	−1.3
Identifiers vs. Label group	−4.7	−4.8	−9.5	+2.1	**−12.4***	−2.8
Bitter						
Identifiers vs. non-identifiers	**+9.9***	+8.1	+3.3	+1.4	−0.3	−4.5
Identifiers vs. Label group	+0.9	−4.6	−0.9	−5.0	+1.0	−6.1

who were given flavour product descriptions were more positive about usual combinations, and more negative about unusual combinations, when compared with participants who could only rely on food-intrinsic cues. Based on a re-analysis of these results, we accounted for this finding in terms of flavour identification: consumer evaluations of unusual combinations were more negative once the flavour products were identified, either externally (i.e. via the language cue) or internally (i.e. by participants themselves through food-intrinsic cues). Relating this to the conceptual 'norms' principle, that is, a combination of two products is less likely considered a match if there are no pre-existing associations with this combination (Eschevins et al., 2019), our findings suggest that product identification is a prequisite for triggering this norms principle and affecting consumer evaluations of unusual combinations.

It seems probable that the norms principle also underlied the more positive evaluations of coffee combinations attested in the Label group. Since these are usual combinations, associations with coffee combinations likely did exist: once these pre-existing associations were triggered by the flavour description, this positively affected consumer evaluations. In contrast with unusual combinations, however, we did not find the same effect in participants who identified coffee themselves (via sensory cues), which we speculatively relate to the moment of identification. Whereas flavour identification preceded tasting in the Label group, it likely followed tasting in the other groups (and for those who already guessed they would be tasting coffee beforehand, the actual taste experience likely led to more certainty). This would imply that pre-existing associations with (usual) product combinations must be activated before tasting to shape expectations about the subsequent taste experience – but additional research is needed to confirm this assumption.

Following the same logic, product identification should also be a prerequisite for triggering the affective 'surprise' principle, as this principle relies on deviations from the norm (Eschevins et al., 2019). If this assumption is correct, the surprise principle could explain why soy sauce-ice cream combinations were more congruent and liked better than expected to participants in the Label group (but not the other groups). Note, however, that after tasting, evaluations of soy sauce combinations did not significantly differ between groups. In fact, the re-analysis showed that soy sauce combinations were *less* congruent and liked *worse* by soy sauce identifiers than by non-identifiers. This suggests that the surprise principle interacted with other (perceptual and/or conceptual) pairing principles to influence consumer evaluations.

Sensory evaluations were also found to be affected by flavour information. First, participants who were not provided with the flavour descriptions attended more to the sensory properties of the (unknown) flavours than the (known) carriers in the combinations – perhaps attempting to identify these products – while participants who already knew which flavour products they were tasting could focus more on the combined taste. Second, sensory evaluations were affected by flavour identification, to the extent that flavour identifiers perceived the sensory properties of the flavour products (saltiness, bitterness) as more intense, and those of carrier products (vanilla/chocolate flavour) as less intense, when compared with non-identifiers. In the case of fish sauce-ice cream combinations, evaluations from fish sauce identifiers were even more extreme than those of the Label group (in the case of fish sauce-ice cream combinations). This can be interpreted as an instance of *contrast*, that is, consumers maximizing the discrepancy between the expected and experienced taste (Schifferstein et al., 1999; for a similar finding, see Yeomans et al., 2008). This finding again suggests that the moment of product identification mediates its effect on consumer evaluations: where product identification after tasting can *induce* contrast effects (i.e. evoke an expectation disconfirmation), product identification before tasting may *reduce* contrast effects (i.e. prevent an expectation disconfirmation). Together, findings from the sensory evaluations highlight the cognitive nature of perceptual pairing principles (see also Spence, 2020): whether two foods are considered a perceptual match is not determined by their sensory properties *per se*, but by their *expected* sensory properties (based on prior experience).

Taken together, our findings suggest that cognitive food pairing principles are triggered only once foods are put into words, which demonstrates the power of language in shaping food expectations. What makes language such a strong cue? In visual perception research, language cues have been found to outrank non-linguistic cues in facilitating various perceptual tasks. For instance, it has been shown that participants recognize a picture of a dog faster after hearing the word 'dog' relative to hearing a barking sound (Lupyan & Thompson-Schill, 2012). This so-called 'label-advantage' is accounted for by the idea that words have the ability to generalize over particular instances (the word 'dog' refers to any dog), whereas non-linguistic sensory cues are necessarily bound to more specific exemplars (e.g., a high-pitch, less loud, bark will be produced by a small dog). As such, language cues can activate a broader set of related memory representations to shape expectations about what will be encountered next. The label advantage hypothesis has been put forward to account for language effects in the visual domain, but applying it to other forms of (multi)sensory processing seems a valuable extension (for discussion, see Lupyan & Bergen, 2016).

Although cue-based expectations prior to tasting were largely overruled by the actual taste experience, the importance of these expectations should not be underestimated, given that the majority of everyday food choices is made in the absence of tasting. The expectation that two flavours do not to go together may prevent consumers from ever buying products in which these flavours are combined. For the successful commercial introduction of a novel flavour combination (such as sweet foods paired with soy sauce in the western market), focusing on perceptual pairing principles may be a way to help overcome this conceptual barrier (for instance by providing taste samples). From the finding that such combinations were more negatively perceived by soy sauce identifiers, one could conclude that explicitly naming the individual flavours in a novel combination is better avoided. However, if we consider how food experiences are integrated and stored in memory, this conclusion may be premature. From a (neuro)cognitive perspective, sensory perception is considered an active, anticipatory process (a.k.a. *predictive processing* or *predictive coding*; e.g. Friston, 2005; den Ouden et al., 2012; Clark, 2013). Our brains create an internal model of the outside world (based on prior experiences), and use this model to generate expectations about what we are about to see, hear, smell, taste, and feel. Generating expectations facilitates processing of incoming sensory input (i.e. saves cognitive resources), provided that expectations are met. Any mismatch between the expected and the actual sensory input (or *prediction error)* is used by the brain to adapt its internal model, thereby minimizing processing costs in the future. This may also apply to hedonic expectations: if a novel combination of two (identified) products disconfirms a negative (conceptual or perceptual) expectation, expectations about any next encounter with that combination may be positively adapted - unlike a combination of unidentified products (which do not trigger expectations abour their combined taste). As such, we predict that product disclosure may ultimately positively contribute to consumer acceptance of unusual product combinations - a hypothesis that could be for instance be tested by having consumers try such (named) combinations repeatedly.

5. Conclusion

The current study demonstrated the complexity of successful food pairing, which follows from an interplay of perceptual, conceptual and affective principles (Eschevins et al., 2019). Findings showed that sensory and hedonic evaluations of (un)usual product combinations were influenced by pre-existing perceptual and conceptual beliefs, as triggered by product identification (be it via product-extrinsic or product-intrinsic cues). Findings moreover suggest that product identification effects on consumer evaluations of product combinations are mediated by the moment of identification. In sum, findings highlight the cognitive nature of not only conceptual and affective, but also perceptual pairing principles, and the power of language in predicting successful food pairings in particular.

Ethical statement

Participants were informed about the general goal of the study and provided written informed consent prior to the start of the test session. They were able to withdraw from the study at any time without giving a reason. They were informed that all data will be de-identified and only reported in aggregate. At the end of the session, they were debriefed about the specific goal of the experiment (i.e. the prior information manipulation). All products tested were safe for consumption. Participants were financially compensated for their participation (10 euros).

CRediT authorship contribution statement

G. van Bergen: Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Visualization. **S. Ushiama:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing. **D. Kaneko:** Conceptualization, Methodology, Writing – review & editing. **G.B. Dijksterhuis:** Conceptualization, Methodology, Writing – review & editing. **R.A. de Wijk:** Conceptualization, Methodology, Writing – review & editing. **M.H. Vingerhoeds:** Conceptualization, Methodology, Writing – review & editing, Supervision.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: SU and DK are both employees of Kikkoman Europe R&D Laboratory B. V. A possible conflict of interest was prevented by following the WUR-integrity code (URL: https://www.wur.nl/en/About-Wageningen/Integrity-and-privacy/Scientific-integrity.htm). Products from different suppliers were included in the study.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodqual.2022.104680.

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