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EMPIRICAL STUDY

Crosslinguistic Differences in Food Labels Do Not Yield Differences in Taste Perception

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Abstract: Research has shown that speakers of different languages may differ in their cognitive and perceptual processing of reality. A common denominator of this line of investigation has been its reliance on the sensory domain of vision. The aim of our study was to extend the scope to a new sense—taste. Using as a starting point crosslinguistic differences in the category boundaries of edible bulbs, we examined whether monolingual speakers of English and bilingual speakers of Norwegian and English were influenced by language-specific categories during tasting. The results showed no evidence of such effects, not even for the Norwegian participants in an entirely Norwegian context. This suggests that crosslinguistic differences in visual perception do not readily generalize to the domain of taste. We discuss the findings in terms of predictive processing, with particular reference to trigeminal stimulation (a central tasting component) and the interplay between chemosensory signals and top-down linguistic modulation.

Keywords linguistic relativity; verbal labels; taste perception

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An Accessible Summary of this article in nontechnical language is freely available in the Supporting Information online and at https://oasis-database.org.

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Introduction

Towards the end of the 19th century, Canadian psychologist William James (1890) published an essay in which he discussed the role of verbal labels, or words, for interpreting and categorizing reality. James suggested that by giving names to things, people highlight —or even create—their uniqueness and that, by extension, the perceived difference between two objects may be boosted by their having different names. In an oft cited passage, James discussed how he, during a walk, spotted some odd-looking snow on the ground and gave it the label "micaceous" (p. 512). Through this labelling, he suggested, the peculiarities of the snow were further highlighted and dragged away from other instances of more normal-looking snow. In another passage, James focused on the relationship between labels and taste, or, more specifically, the experience of drinking the red wines Burgundy and claret. These wines, he argued, are really quite similar, but the fact that they have different names seems to warp people's sensory experience of them such that they perceive them as more different in taste than they actually are.

More than 100 years later, the cognitive sciences have seen an ever-growing body of investigations into the function of labels in cognitive and perceptual processing, showing that the practice of giving names to things may indeed influence the way that people think about phenomena such as time (Athanasopoulos et al., 2017; e.g., Boroditsky & Gaby, 2010; Bylund & Athanasopoulos, 2017; Casasanto & Boroditsky, 2008; Núñez et al., 2012), space (e.g., Haun et al., 2011; Levinson, 1997; Majid et al., 2004), objects (e.g., Johanson & Papafragou, 2016; Lupyan & Casasanto, 2015; Lupyan & Ward, 2013), color (e.g., Brown & Lenneberg, 1954; Gilbert et al., 2006; Roberson et al., 2005; Thierry et al., 2009), and motion (e.g., Gennari et al., 2002; Montero-Melis et al., 2016; for general discussions, see Lupyan, 2012; Lupyan et al., 2020; Wolff & Holmes, 2011). A common denominator of this line of research has been its reliance on vision as the primary sensory modality as the experimental paradigms have been centered around categorical perception of visual stimuli.

Of course, vision is but one of the five human senses (as defined in the Aristotelian tradition; for alternative approaches, see Tuthill & Azim, 2018). Although there has also been research on language and audition,[1] the senses of touch, smell, and taste have to date remained at the periphery of research on language and perception—to the extent they have been researched at all (for exceptions, see de Araujo et al., 2005; Djordjevic et al., 2008; Grabenhorst et al., 2008; Herz & von Clef, 2001; Majid & Burenhult, 2014; Majid & Kruspe, 2018; Miller et al., 2018; Vanek et al., 2021). Historically, these senses have been considered as minor or more basic compared to vision and audition, both among philosophers (see, e.g., the writings of Immanuel Kant and Thomas Aquinas: Brook & Wuerth, 2023; Cross, 2011) as well as cognitive scientists—even by James himself in a later publication (James, 1890): Underlying this division is the view that vision and audition are more "intellectual" senses as they allow people to appraise distal objects, whereas touch, smell, and taste produce "mere bodily sensations" (Smith, 2015, p. 315). Although this view has become increasingly obsolete, the empirical bias towards vision in research on language and perception has persisted.

As a consequence, James' century-old speculations regarding the role of labels in people's perception of reality has remained only partially answered. Owing to the vast body of research on language and visual perception, researchers are in a position to confirm James' musings on snow: labels indeed create a visual pop-up effect, boosting objects or features into visual awareness (see Lupyan & Ward, 2013). However, because of the low incidence of research concerning the effects of language on taste, James' speculations on this matter have still been largely unexplored.

Against this backdrop, our study set out to contribute further evidence in the cognitive sciences on the under-researched human sense of taste. Specifically, we investigated to what extent crosslinguistic differences in the lexical typology of foods give rise to corresponding differences in gustatory perception.

Background Literature

Taste and Language

In the study of the chemosenses, taste is defined as the perceptions that are generated when ingested chemical components stimulate the receptor cells of the taste buds. The phenomenon that we examined in our study is technically speaking defined as *flavor*, because it also involves smell (from the oral cavity to the nose), touch (feeling the texture with the mouth), and stimulation of the trigeminal nerve (a cranial nerve that produces the sensation of coolness or heat in the mouth in relation to foods such as peppermint and mustard, respectively; Smith, 2015). However, similar to previous discussions on language and gustation (Speed & Majid, 2020), we will use taste as an umbrella term for both taste and flavor.

From a general point of view, research has shown an association between language and taste. For instance, neuroimaging findings have suggested that reading food- or taste-related words, such as "honey" or "salt," may trigger activation of primary and secondary cortical areas of taste (e.g., Barrós-Loscertales et al., 2012; for olfaction, see González et al., 2006). To the extent that these results hold across different experimental manipulations (for a critique of the experimental paradigm used in these studies, see Speed & Majid, 2020), it would suggest that the meaning of taste words is grounded in neural populations distributed across the areas of both language and gustation (see also Pulvermüller & Fadiga, 2010). The few studies that exist to date on language and taste have suggested that words may have the potential to modulate taste perception. A study by Yeomans et al. (2008) found that participants provided different ratings of smoked-salmon ice-cream depending on the label that they had received prior to the tasting: Participants who were told that they would eat ice-cream enjoyed the stimulus less and provided lower ratings for sweetness compared to those who were told that they would eat frozen savory mousse. Similar findings were obtained by Grabenhorst et al. (2008), who reported that monosodium glutamate was given different pleasantness ratings depending on whether it was described as “rich and delicious,” “boiled vegetable water,” or “monosodium glutamate.” A question regarding ratings of this kind is whether they indeed reflect gustatory perception or an affective response arising as a result of the mismatch between taste expectation and taste sensation. Woods et al. (2011) argued that the patterns of cortical activation (primary taste cortex, as revealed through fMRI) that occur while experiencing an unexpected taste (e.g., salt instead of sweetness) indicate that the response is perceptual rather than affective. Overall, this would suggest that language may act as a top-down modulator of taste sensation (Spence, 2015).

Lexical Typology of Foods

Languages across the world differ in how they categorize edibles. Through the use of devices such as compound nouns, some languages group certain edibles into the same lexical category, whereas in other languages the same edibles belong to different categories. For instance, in the Afrikaans language, oranges and lemons are lexically related, *lemoen* “orange” and *suurlemoen* “lemon” (literally sour/acidic orange), whereas in English, they are not lexically related (botanically speaking, though, they are both citric fruits). Although there has been some research on the semantics of ingestion verbs across different languages and phytonyms in general (e.g., Nakagawa, 2012; Panasenko, 2021), the semantics of edibles has not been well documented.

Our study focused on crosslinguistic differences in the lexical typology of edible bulbs (onion, garlic, leek, etc.), The botanical genus of *Allium*—which, among other bulbs, includes onion, garlic, and leek—displays relevant crosslinguistic variation in terms of lexical semantics. In the Germanic languages of the Nordic countries, onion and garlic belong to the same lexical category. In contrast to English, which has separate labels for garlic and onion, these languages use one term for both. In Swedish, for instance, onion is referred to as *lök* or *gul lök* "yellow onion," and garlic as *vitlök*, literally, "white onion," much in the same way an English speaker refers to red onion as a type of onion (coincidentally, the botanist Carl von Linnaeus, who established the *Allium* genus, was himself a native speaker of Swedish). The principle is the same for Danish and Norwegian. In the Nordic countries, consequences of this lexical category are visible naturalistically, or in "the wild" (Athanasopoulos & Bylund, 2020), throughout different text types. For instance, in discussions on food and health, advice is often given as to which "onion"/*Allium* is the richest in antioxidants, as per Example 1 from a Norwegian online magazine:

Example 1
Hvilken løk er sunnest - gul, rød, hvit eller sjalott?[2]
"Which 'onion'/ *Allium* is the healthiest - yellow, red, white, or shallot?"

In Example 1, *gul* "yellow" refers to *gul* "onion," literally, "yellow onion," *rød* "red" to *rødløk* "red onion," *hvit* "white" to *hvitløk* "garlic," literally, "white onion" and *sjalott* to *sjalottløk* "shallot," literally "shallot onion."

Similarly, Example 2 shows instructions from a Swedish plant nursery for how to grow one's own vegetables:

Example 2
Att odla lök är ofta väldigt enkelt[3]
"To grow your own 'onion'/ *Allium* is often very easy"

The instructions then go on to recommend the following "onions"/*Allia* to this end: white onion, red onion, shallot, and garlic (which, respectively, translate as *gul lök*, *rödlök*, *schalottenlök*, and *vitlök*). Food recipes is of course another text type where the "onion"/*Allium* super category becomes visible. For instance, Example 3 provides a Swedish recipe for onion soup where both onion and garlic are used and in which textual groupings based on *Allium* can be found:

Example 3
Skala och skiva lök och vitlök. (…) Lägg i löken och låt fräsa ca 5 min[4]
"Peel and slice onion and garlic. (…) Put the 'onion'/ *Allium* [in the pan] and fry for about 5 min"

In other words, in Example 3, *löken* refers to both the white onion and the garlic.

Just as cultural practices have been found to shape the conceptualization of food (Mazzuca & Majid, 2023), the examples above suggest that language-specific categories of edibles (e.g., "onion"/*Allium*) may influence the written conceptualization of food-related activities such as cooking, eating, and planting.

The Present Study

Although there is a rich body of research investigating crosslinguistic differences in perceptual and cognitive processing in the visual modality, little is known as to whether such differences also obtain in the sensory domain of taste. The existing research on language and gustatory perception has, to the best of our knowledge, only concerned within-language manipulations, whereby the influence of taste sensation is modulated by different labels. Although this approach has offered a neat way of assessing the top-down regulation of labels, it has left open the question of whether language-specific habitual categorization of foods has an impact on taste perception. Using as a starting point differences between English and Norwegian in the lexical categories of garlic and onion, our study investigated whether speakers of these languages judge the taste of these bulbs differently.

To this end, we administered to first language (L1) speakers of English, and L1 Norwegian–second language (L2) English bilinguals a taste task in which they were asked to rate the similarity of pairs of foods. The pairs could include any combination or repetition of garlic (*hvitløk*), white onion (henceforth onion [*løk*]), red onion (*rødløk*), and leek (commonly called *purre*). We included leek in order to limit the possibility that the participants might come to guess the covert language-based manipulation since leek is in a lexical category that is independent of garlic and onion in both languages. We hypothesized that, if linguistic categories influence perception such that having a different name for each food enhances the distinctiveness of their taste, then garlic-onion pairs should taste more similar for L1 Norwegian speakers than L1 English speakers.

There are two ways to test this possibility. First, one can simply compare mean similarity ratings for garlic–onion pairs between groups. Second, one can run the same comparison, arguably more accurately, while controlling for scores given to within-category pairs (onion–red onion). In this second way, one can better zoom in on an effect of category boundaries. We decided that both analysis types would be informative, but that the results from the second way should be treated as the more authoritative. In view of research suggesting that cognitive and perceptual processing in bilinguals may vary as a function of language of operation and exposure (e.g., Athanasopoulos et al., 2015; Bylund & Athanasopoulos, 2017; Miles et al., 2011; Montero-Melis et al., 2016), we added a manipulation of language context, such that we randomly allocated the

Table 1 Group information

Group	*n*	Age (years)	English age of acquisition (years)	English proficiency (self-report)	Length of stay in United Kingdom (months)
	F (M)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
English	25 (12)	23 (6)	–	5.0 (0.0)	–
Norwegian–English (L2 context)	19 (3)	22 (2)	6 (2)	4.6 (0.5)	19 (18)
Norwegian–English (L1 context)	21 (6)	21 (2)	7 (3)	4.5 (0.6)	15 (16)

Note. English proficiency was self-assessed on a scale from 0 to 5 (*native or native-like*). F = female; M = male; L2 = second language; L1 = first language.

Norwegian–English bilinguals to either a L1 Norwegian context group or a L2 English context group. If the effects of language context extend to the domain of taste, then it might be the case that the Norwegian–English bilinguals in the English language context pattern like L1 English speakers. Together, these two hypotheses would inform the language-and-perception debate by testing for the first time whether effects extend to a new sensory pathway and additionally answer the question of whether any such effect is modulated by the language context.

Method

Participants

We recruited 73 participants from a university in the United Kingdom. All the participants gave informed consent before commencing the task, and all received compensation for their time. The experiment received ethical approval from the University of Essex ethics board. All the participants were tested in the United Kingdom. We discarded the data from five participants due to experimenter error and technical faults (wrong order of food pairs administered or wrong pictures presented). One further participant failed to complete the task, and the experiment was halted for another participant owing to a report of an allergy. One participant was also excluded for being the only participant to perform the task on a given day. Owing to natural variation in samples of natural foods, we felt that, at a minimum, there should be one participant from at least two of the three groups to perform the task using the sample prepared on that day. The final sample size was therefore 65 participants, 25 of whom were L1 English speakers, 19 Norwegian–English bilinguals who performed the task in a L2 context, and 21 in a L1 context. Background information for each group can be found in Table 1. All the L1 Norwegian speakers had spent

Figure 1 Pre-prepared samples for tasting (red and white onion).

the majority of their lives in Norway and reported using Norwegian approximately 31 to 41 hours per week even while in the United Kingdom. The L1 English speakers indicated no knowledge of a L2 beyond a self-rated level of 3 out of 5, where 5 represented native- or native-like proficiency. The majority ($n = 15$) indicated no knowledge of a L2 at all (0 on the scale).

Materials and Procedure

Fresh white onion, red onion, leek, and garlic were peeled and finely chopped in a blender on the morning of each day of testing. The preparation in a blender was done to minimize sample differences in texture. All utensils were washed between preparations of each food type such that no cross-contamination was possible. The resultant samples were measured out in 0.3 g portions, as exemplified in Figure 1. The participants were instructed verbally that they were going to taste small quantities of real foods which were safe to swallow but could also be spat into a cup provided and that they would be blindfolded to prevent visual identification of the foods. Water and crackers were given to the participants as palate-cleansers in order to alleviate strong or unpleasant flavors. On the rare occasion that palate cleansers were requested between two samples of the same pair the participant repeated the first sample.

Participants were fed the samples by the experimenter. Each member of a pair was tasted consecutively and not mixed in the mouth. The participants then rated the similarity of the two tastes on a scale of 1 (*very similar*) to 9 (*very different*). The participants were instructed to focus on the "taste and the taste only" when making their judgments and to ignore other things such as the intensity, texture, smell, pleasantness, or unpleasantness of the samples. Although it is difficult to ensure that the participants indeed were able to follow this instruction, the instruction served as an attempt to channel their attention toward taste. The experimenter noted the responses, and no feedback was provided. At no point were the labels of the foods mentioned during or before the taste task. In this way, any influence of linguistic categories could not be scaffolded by explicit use of labels.

Each food was paired twice with each of the other foods, once in each order (e.g., garlic followed by white onion and white onion followed by garlic). Each food was also paired once with itself. There were therefore 16 pairs presented in a fixed order for all participants (see Appendix S1 in the Supporting Information online for the order). The same food was never presented twice in succession across different pairs.

The L1 English speakers and the Norwegian–English bilinguals assigned to a L2 context performed the task entirely in English with a native English-speaking experimenter (male) who had no knowledge of Norwegian. The remaining Norwegian–English bilinguals performed the experiment in an entirely Norwegian-language context with a L1 Norwegian-speaking experimenter (male). This latter experimenter was bilingual (Norwegian–English), but used Norwegian only throughout the experiment. All documentation (consent form, information sheet, and questionnaire) was also printed in the language of testing. All the participants were asked to complete an information sheet that asked questions about food and drink allergies. The experimenter stressed the importance of full disclosure of known allergies and intolerances, and in any cases where the foods used in the experiment were considered to be even a minor risk, the experiment was discontinued immediately. No participant reported any professional tasting experience.

After the final food pair was tasted, a participant's blindfold was removed, and the participant was presented with 16 pairs of pictures. As with the taste trials, the participants were asked to rate the similarity of the food pairs on the same scale. This additional task was included to test the possibility that the

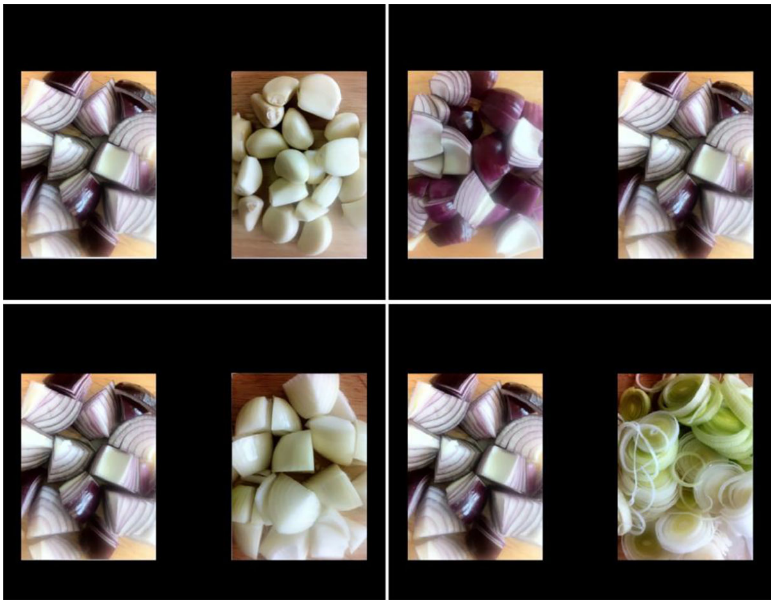

Figure 2 Example of all four possible picture pairings with red onion (left panel of each pair). Clockwise from top left: garlic, red onion, leek, onion.

categorical perception of the foods might obtain over two sensory pathways (vision and taste) simultaneously. The pairs of pictures precisely matched the order in which the taste trials were administered (though the participants were not made aware of this). If the participants queried the role of taste in this task they were instructed to focus on the visual aspect of the pictures. All the pictures were presented in full-color simultaneously side-by-side on a black background using an Apple MacBook Pro laptop computer with an 18 inch screen. The pictures showed the raw food close up on a chopping board, with the food reaching to all four borders of the frame (see Figure 2). The foods were in roughly sliced (leek), chopped (onions) and unpeeled form, or in the case of the garlic in peeled cloves. Where the same food pair was presented twice, one of the pictures showed the same food pieces in a different visual arrangement on the board. The experimenter noted the responses without providing feedback.

After the picture similarity task, the participants were blindfolded once more and asked to rate the intensity of the food sample and to guess what the sample was. Intensity ratings were made on a scale of 1 (*very weak*) to

Table 2 Similarity ratings

	Taste				Pictures			
Food contrast	Eng/Eng *M* (*SD*)	Nor/Eng *M* (*SD*)	Nor/Nor *M* (*SD*)	*p*	Eng/Eng *M* (*SD*)	Nor/Eng *M* (*SD*)	Nor/Nor *M* (*SD*)	*p*
GG	2.8 (2.3)	2.5 (1.8)	2.7 (1.7)	.929	1.6 (1.4)	1.3 (0.6)	1.3 (0.5)	.877
GL	7.9 (1.2)	7.3 (1.7)	7.5 (1.3)	.408	6.9 (1.8)	6.7 (2.2)	7.3 (1.5)	.798
GR	6.9 (1.5)	5.9 (1.7)	6.3 (1.4)	.167	6.9 (2.0)	6.5 (2.6)	6.8 (1.9)	.899
GW	6.4 (1.9)	6.1 (1.9)	6.8 (1.4)	.588	4.4 (2.4)	4.4 (2.0)	5.8 (1.9)	**.048**
LL	1.8 (1.3)	2.2 (1.5)	2.2 (0.9)	.160	1.6 (0.8)	1.5 (0.6)	1.8 (1.2)	.947
LR	4.3 (1.9)	3.7 (1.6)	3.7 (1.8)	.466	4.8 (2.6)	5.3 (2.3)	5.9 (2.3)	.254
LW	4.0 (1.7)	3.6 (1.3)	3.7 (1.4)	.726	4.6 (2.6)	4.8 (1.6)	5.6 (1.9)	.221
RR	2.8 (1.8)	3.3 (1.7)	2.7 (1.9)	.359	1.1 (0.4)	1.3 (0.6)	1.2 (0.5)	.834
RW	3.2 (1.4)	2.9 (1.6)	2.9 (1.6)	.595	3.2 (2.2)	3.4 (1.9)	3.7 (2.0)	.406
WW	3.1 (1.9)	2.9 (1.4)	3.2 (1.2)	.679	1.1 (0.3)	1.1 (0.3)	1.3 (0.7)	.482

Note. Lower scores indicate greater perceived similarity. See Appendix S1 in Supplemental Information online for confidence intervals for all means. Comparisons significantly different at alpha .05 are in bold. Eng = English; Nor = Norwegian; G = garlic; L = leek; R = (red) onion; W = (white) onion.

9 (*very strong*). The foods were presented in a fixed order for all the participants (garlic, onion, red onion, leek), and the participants gave the intensity rating first and the identification second before the next sample was tried. The experimenter recorded the responses, providing no feedback. Finally, the blindfold was removed once more, and the participants were presented once more with four of the pictures that they had seen in the picture similarity task, with one picture for each food used in the task. The pictures were presented in the same fixed order as in the previous taste identification task. The participants were asked to name the foods in their L1. The experimenter recorded the responses, providing no feedback.

Results

As we described in the introduction to the section The Present Study, we ran two analyses (alpha level was set at $p < .05$). The first concerned a between-group comparison of mean similarity ratings for each pair type. As these scores were not normally distributed, we performed nonparametric independent-samples Kruskal-Wallis tests with group (L1 English, Norwegian–English bilinguals in a L1 Norwegian context, Norwegian–English bilinguals in a L2 English context) as the between-subjects variable. As Table 2 shows, neither the participants' L1 nor the language of instruction played any role in similarity ratings for any combination of food pairs. The same was true for the picture task, with the exception of garlic–white onion pairs. Follow-up paired-samples Wilcoxon tests using the Bonferroni correction revealed no robust differences in the Norwegian–English bilinguals' judgements of garlic and white onion similarity (Norwegian context, $p = .09$; English context, $p = .11$). We found no difference between L1 English speakers and Norwegian–English bilinguals in a L2 English context ($p = 1$).

For our second (main) analysis, we subtracted the similarity ratings given to red onion–white onion pairs from ratings given to garlic–white onion pairs. Since these scores were normally distributed, we analyzed these data using a one-way ANOVA. The analysis found no evidence of a difference in these scores between three groups (L1 English: $M = 3.2$; Norwegian in English: $M = 3.2$; Norwegian in Norwegian: $M = 3.9$), $F(2, 62) = 0.602$, $p = .551$, $\eta_p^2 = .019$. Repeating the analysis while controlling for intensity ratings calculated in the same way also revealed no evidence of variation between the three groups ($p = .479$).

Null hypotheses are often considered more difficult to interpret than significant results. The normal distribution of these scores enabled us to conduct a test of the strength of the null hypothesis by using Bayesian tests to examine the probability of our data under the null hypothesis that categorical boundaries do not influence these scores versus the alternative hypothesis that they do. Consistent with recent guidelines concerning the classification of a null result with sufficient sensitivity, we set a threshold Bayes factor (BF_{10}) of less than 0.33, indicating that the null should be at least three times as likely as the alternative hypothesis given the data (Dienes, 2014). A Bayesian ANOVA found that the data were in fact five times more likely under the null hypothesis that there is no between-group difference ($BF_{10} = 0.2$). As the difference scores for the picture data were also normally distributed, we performed the same analyses (ANOVA and Bayesian) on these data. The test found no effect of group (L1 English: $M = 1.2$; Norwegian in English: $M = 1.0$; Norwegian in Norwegian: $M = 2.0$), $F(2, 62) = 0.655$, $p = .523$, $\eta_p^2 = .021$. Just as with the taste data analyses, a Bayesian ANOVA again found that the data were five times more likely under the null hypothesis ($BF_{10} = 0.208$). In sum, our data strongly supported the null hypothesis that language does not influence the categorical perception of taste.

Table 3 displays the results of the naming tasks. Crucially, Norwegian-speaking participants overwhelmingly named the pictures of the foods correctly according to the language of testing, as did English speakers. The sole

Table 3 Results of naming tasks

	Taste naming (% correct)				Picture naming (% correct)			
Actual food	Garlic	White onion	Red onion	Leek	Garlic	White onion	Red onion	Leek
Head noun	Garlic	Onion	Leek	Garlic	Onion	Leek		
English	56	60	52	16	76	92	96	28
Nor–Eng (L2)	53	47	40	16	95	95	95	32
Head noun	Løk		Purre		Løk		Purre	
Nor–Eng (L1)	72	76	48	5	86	100	100	15

Note. Percentage indicates proportion of correct naming responses as measured by head noun (e.g. any with head noun “onion” or for either onion or red onion in the native English speakers). Nor = Norwegian; Eng = English; Løk = onion; Purre = leek.

exception was the noncrucial leek stimulus. Results from the taste naming task were less accurate, as would be expected given the advantage of visual identification over taste.

Discussion

Our study investigated, for the first time, language use and taste perception from a crosslinguistic perspective. The results indicated that there were no differences between the language groups/language contexts in the ratings of the taste of garlic and onion: Even those L1 Norwegian participants who performed in an entirely Norwegian context did not behave in a way that would suggest language-specific category boundaries were active during tasting. Overall, this suggests that crosslinguistic differences in the lexical typology of edibles do not yield corresponding differences in taste perception. It is thus possible that previous findings on the influence of language-specific categories in the sensory domain of vision do not readily extend to taste. Although our study was unique in its crosslinguistic approach to labels and taste perception, it is important to consider the previous research by Grabenhorst et al. (2008) and Yeomans et al. (2008), who did observe an effect of labels. However, those studies were designed to create a gustatory expectation via label priming among speakers of the same language as opposed to taste perception among speakers of different languages. This means that our findings are not necessarily at odds with previous research—this may be particularly true seeing that previous research in this case consisted of only two studies, making it difficult to assess the consistency and variation in the influence of labels on gustatory experience.

It is, however, also worth considering the possibility that the influence of language-specific nomenclature on taste perception may vary as a function of edible characteristics. In predictive models of the human mind (e.g., Clark, 2013; Hohwy, 2013; Kanai et al., 2015), perception and cognition are construed as the outcome of an interplay between top-down predictions and bottom-up sensory signals. In the visual modality, language has been shown to be a potentially powerful top-down regulator (Lupyan & Clark, 2015), as evidenced specifically with regard to color perception (Gilbert et al., 2006; Thierry et al., 2009). Top-down predictions and bottom-up signals generally interact in such a way that the stronger the sensory signal is, the weaker is the influence of the top-down predictions on cognition and perception. Conversely, if the sensory signal is weak or ambiguous, top-down predictions play a greater role. Again, in visual modalities, it has been shown that stimuli that are difficult to discriminate or differentiate are likely to be perceived along the lines of linguistic categories rather than their actual physical properties (e.g., Bylund & Athanasopoulos, 2017; Winawer et al., 2007). The linguistic effects hitherto attested in the sensory domain of taste have been interpreted along similar lines in the sense that labels—along with cultural artefacts such as packaging and branding—may exert a cognitive influence on taste perception (Spence, 2015).

In our study, such top-down modulation did not obtain. A potential explanation of the findings reported here may be found in the characteristics of the sensory bottom-up signal. A distinct feature of *Allium* plants is their pungency and spicy aroma that are produced by organosulfur compounds. These compounds have been found to strongly stimulate the trigeminal nerve (Bautista et al., 2005) that, along with retronasal olfaction and mouth-feel, is a crucial component in taste perception. In the mammalian brain, the trigeminal stimulation triggered by garlic and onion activates the anterior and central insula, claustrum, cingulus, and facial area of the primary sensory cortex, all of which are associated with pain processing (Bautista et al., 2006; Roussos & Hirsch, 2014). With such powerful stimulants, it cannot be ruled out that the bottom-up signal, boosted through trigeminal stimulation, is of such strength that it overrides language-based predictions. In other words, the top-down influence of language-specific *Allium* labels would be too weak to warp taste perception.

If this interpretation is correct, it could have important implications for understanding the role of language in the sensory domain of taste. Specifically, it suggests that considerable trigeminal stimulation, be it through organosulfur compounds or other stimulants such as menthol, is a component that eliminates or minimizes the impact of language on taste perception. By extension, this interpretation opens up the possibility that language-specific terminology may be more likely to influence the perception of edibles that produce a weak or ambiguous sensory signal (as found in the olfactory domain: e.g., Herz & von Clef, 2001; Vanek et al., 2021).

In addition to the strength of the sensory signal, it is also worth considering that there may be more competing top-down predictions for edibles than for purely visual percepts such as colors.[5] Edibles have greater multisensorial representation—they taste, smell, look, feel, and even sound—than, for example, colors (which are typically restricted to the visual modality), one consequence being that edibles display a greater number of distinctions than monomodal percepts. The fact that edibles have multiple distinctions that go beyond their flavor means that cognitive influence in gustatory perception not only involves linguistic and encyclopedic knowledge but also, for instance, tactile, visual, and auditory knowledge.

In view of the discussion above, it becomes clear that pinpointing the stimulus characteristics that down-regulate the strength of language-based predictions and minimize competing cognitive influence constitute important steps towards identifying the conditions under which language is less—and more—likely to influence gustatory experience.

Conclusion

Although the effects of language on thought have primarily been investigated in the sensory domain of vision, a small number of studies have extended this line of research to the domains of touch, smell, and taste. The aim of our study was to contribute evidence on the effects of language on the perception of taste in our mouths, specifically exploring whether crosslinguistic differences in the lexical typology of edibles yield corresponding differences in taste perception. A tasting experiment yielded no such effects, as shown through both frequentist and Bayesian statistical analyses. This raises the possibility that the crosslinguistic differences documented in the domain of vision (with regards to phenomena such as time, space, motion, and color) simply do not generalize to the domain of taste. Conversely, there is also the possibility that the current null effect can be explained by accounts of predictive processing, according to which a strong sensory signal (as that produced by *Allium*) may outweigh cognitive influence. An important task for future research would be to manipulate experimental conditions (e.g., the strength of the sensory signal) to further elucidate the relationship between language-specificity and taste perception.

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Materials Exemption Statement

The stimuli used in our study were food and therefore could not be uploaded in an electronic format. The reader is referred to Figures 1 and 2 for a visual depiction of the stimuli.

Notes

1 From a linguistic-relativistic viewpoint, research on auditory perception may sometimes show the effects of language on language (Lucy, 1997). For instance, language-specific phonemes or phonotactic structures may prime speakers of that language to be more prone to (mis)perceive such phonemes or structures even when they are not present in speech (Flege, 1999).

2 kk.no (n.d.). *Her er løken du bør velge* [Here is the 'onion'/*Allium* you should choose]. Retrieved July 5, 2023, from https://www.kk.no/livstil/her-er-loken-du-bor-velge/67866589

3 blomsterlandet.se (n.d.), *Så lyckas du med dina sättlökar* [How to successfully plant your 'onion'/*Allium*]. Retrieved 5 July from https://www.blomsterlandet.se/tips-rad/tradgard/kokstradgarden/lilla-lokskolan-sa-lyckas-du-med-dina-sattlokar/

4 arla.se (n.d.), *Fransk löksoppa* [French onion soup]. Retrieved 5 July 2023 from https://www.arla.se/recept/fransk-loksoppa/

5 We are grateful to an anonymous reviewer for raising this point.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Acessible Summary

Appendix S1. Confidence Intervals for Comparisons (Taste and Pictures).