What's That on My Plate? Individual Differences in Visual Recognition of Prepared Food

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Abstract

We explored evidence for a domain-general contribution, domain-specific ability, and the influence of experience and personality on the visual recognition of prepared food – a previously unexplored domain. Four questions guide the current study (1) Does the domain-general visual ability “o” contribute to food recognition performance (2) Is there evidence for a domain-specific ability with food recognition (3) How does this domain-specific visual-ability relate to different kinds of experience with food and (4) How is food recognition performance related to personality? To answer these questions, we created two tasks that measure food recognition ability: the Food Recognition Match Task and the Food Recognition Oddball Task. Also, we measured o with two visual tasks: Novel Objects Memory Task and the Novel Objects Matching Task. We found a positive correlation between o and food recognition ability, indicating a domain-general contribution to food recognition. Moreover, performance on the two foods tasks was positively correlated even after controlling for the domain-general ability, suggesting a domain-specific ability in recognizing food. To answer the question of individual experience influencing the recognition of food, we created a novel survey to measure the constructs of general recognition interest, food interest, and preference for food taste/appearance and included a measurement for the Big Five factors of personality. While none of the survey constructs related to food recognition performance, we found that agreeableness positively correlated with performance, suggesting that an aspect of personality relates to food recognition.

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Our individual experiences shape the perception of people, places, and even objects. Some experts, such as car enthusiasts or birding hobbyists, have much more experience perceiving and categorizing their objects of expertise than the average person. Their perceptual experiences facilitate the identification of objects within their domain of expertise. Yet experience influences perception for everyone, not just those who are experts within their chosen field. Thus, studying the perception of the domain of food leads to interesting questions: Does a person's general ability to recognize objects predict how well they recognize prepared food? What kinds of experience with food influences our visual recognition of it? The domain of food has yet to be studied in the field of object recognition, so there is little research to explore for this domain. However, previous work has explored the influence of experiences, such as expertise, on performance in visual tasks in other domains.

Expertise and Face Recognition

Perceptual expertise influences both object and face recognition and is defined as the experience with objects in a natural setting outside of a laboratory (Wong et al., 2012). Experience is thought to affect visual recognition performance in a variety of different studies from musical notation to face perception (Chang, 2020; Ryan et al., 2016). In the current study, we aimed to explore the influence of expertise on food recognition and looked to previous research that investigated the effects of experience on face recognition.

Gender differences in facial recognition is varied in interest and exposure – two factors that may also predict food recognition performance. While studying interest in face recognition, Ryan et al. (2016) found that men can outperform women in a toy face category in which they have self-reported more experience, offering evidence for experience improving performance.

Prior to the Ryan et al. (2016) study, previous work found that women tend to perform better in face recognition tasks and, while this previously may have been attributed to gender differences, this study instead focused on a specific interest-based experience that influenced the participant's visual recognition. In our current study, based on findings from Ryan et al. (2016), I predicted that higher self-reported interest with viewing prepared foods may predict food recognition performance. Another factor that influenced performance on face recognition task while studying gender differences is exposure to faces. Sunday et al. (2019) found that women from small hometowns outperformed men from small hometowns, but such results were not replicated by people in large hometowns. The researchers gave a possible explanation for the improvement of men who live in large hometowns by noting that there is a difference between social competencies between men who live in urban and rural areas. The differences of growing up in either small hometowns or large hometowns could have a lasting impact on personality and affect how much people interact with others, so this may affect face recognition ability. Related to the current food study, other factors may influence prepared food recognition, such as the personality of the participant. With the Big Five factors of personality, I predicted that a participant's Openness (Imagination/Intellect) positively predicts their performance in the food recognition tasks because a participant's openness to new foods may increase their exposure to different types of food.

In the domain of food, cultural background influences a person's exposure to different types of food, and previous research in face recognition found that performance was influenced by cultural and social judgements (Wong et al., 2018; Schwarts & Yovel, 2019). Studying faces as concepts as opposed to percepts improved performance in face recognition tasks (Schwarts & Yovel, 2019). Also, people tend to judge whether two faces are a couple based on social-cognitive judgements of the faces' perceived personality (Wong et al, 2018). In relation to the domain of food, this leads to questions of how perception of food differs depending on cultural and social judgements. In the current study, the participants are from the United States and the stimuli include a mixture of different cultural foods. Performance on the visual tasks and experience with food could relate to the person's openness to new experiences such as tasting different cultural foods.

Expertise and Object Recognition

Experience also applies to other domains – musical notation, radiology, and echocardiography – and influences performance on visual tasks. As such, we considered previous research on expertise and visual recognition to inform our prediction that experience may correlate with food recognition performance. For example, expertise in musical notation predicted the distractor familiarity effect (Chang, 2020). Distractor familiarity effect is the term used to describe how a participants' search for a prespecified target among familiar and unfamiliar distractors becomes more efficient as participants are more familiar with the distractors. Expertise positively correlated with the magnitude of the distractor familiarity effect. In a different task, expertise applied to radiology. Self-reported radiological experience was the greatest predictor of performance on the VCRT (Sunday et al., 2018). In all tasks, radiologists performed better than novices, showing that having more experience in a field can predict better performance in visual tasks. Like testing radiologist's experience, echocardiographers performed better than novices in domain-general visual ability tasks (Carrigan et al., 2020). Also, echocardiographers performed better than naïve participants when controlling for "exposure" – the number of cases per week performed on average and per year. The results thus provide some evidence for a domain-general perceptual expertise. As an explanation for this result, those with relatively high visual perceptual abilities may self-select into the echocardiographer, or similar careers that require more visual skills.

Between all three studies, experts' performance on visual tasks were compared to those of naïve participants (Carrigan et al., 2020; Chang, 2020; Sunday et al., 2018). Their experience accumulated throughout their careers as a musician, radiologist, or echocardiographer. By measuring the visual task performance of those already within their fields, researchers found naturally occurring individual differences for these domains. Each study compared the performance of experts with naïve participants, and the research suggests that expertise improves visual ability.

Performance is a combination of domain-general ability and experience in a specific domain. (Carrigan et al., 2020; Sunday et al., 2018). Whether the study takes place in the perception of lung nodules or musical notes, individual differences in experience and in general ability potentially plays a role in object recognition skill. Studying the individual differences based on reported experience with a visual domain sheds light on the effects of expertise on performance in visual tasks for other domains, such as the rich domain of food.

Domain-general and Domain-specific Ability in Visual Tasks

Domain-general ability of object recognition, measured by the latent construct known as o, is measured by visual skills in multiple categories including cars, birds, and an assortment of different items. Visual skills are relatively independent from general intelligence (Richler et al., 2019; Shakeshift & Plomin, 2015; Wilmer et al., 2010). The domain-general visual ability is thus considered separate from other cognitive skills (Gauthier et al., In Press). Overall, the domain-general visual ability is a new concept that has potential to predict how well people can learn visually from experience in different domains. Researchers have created tasks using novel objects, such as Greebles and Ziggerins, to measure how well the participant recognizes objects without the influence of previous experience with the objects (Sunday et al., 2021). We predicted that the domain-general ability contributes to food performance because those who generally recognize objects better would perform well in most visual tasks.

While domain-general ability encompasses multiple categories, domain-specific ability is the measured visual skill for a single category after controlling for domain general visual ability. Gauthier et al. (2014) found that object recognition performance for any visual category is the combination of the individual's domain general ability and category- specific experience. The researchers created an experience survey involving domain-general questions, omnibus category-specific self-ratings, and category-specific self-ratings (Gauthier et al., 2014). The study measured the participants' self-reported experience and performance with object recognition in eight different categories. Self-reported experience and performance on the face and object recognition depended on the participant's experience with the objects. Although experience did not predict performance, it moderated the relationship with face recognition performance as being more like object performance with increased self-reported experience. Experience was thus concluded to moderate a participant's performance on tasks while face and object recognition are supported by a domain-general ability. In sum, our domain general ability affects performance in any visual task (Gauthier, 2018). Experience is specific to a single visual category.

Rationale and Research Questions

Four questions guide the current study (1) Does the domain-general visual ability "O" contribute to food recognition performance (2) Is there evidence for a domain-specific ability with food recognition (3) How does this domain-specific visual-ability relate to different kinds of experience with food and (4) How is food recognition performance related to personality? The goal of the study is to explore how experience and interest with food predict domain-specific abilities in recognition of food and investigate a domain-general ability contribution to food recognition. It is possible that only domain-general abilities may account for recognition of food. I hypothesize that there is a domain-general contribution to food recognition, a domain-specific ability for food recognition, that self-reported experience positively correlates with that specific ability, and that openness predicts food recognition performance.

Method

Participants

Participants are students in psychology courses that participated in experiments through the SONA platform at Vanderbilt University. Each received course credit for their participation. Seventy-seven students (51 female and 26 male) completed the study. The ages ranged from 18 to 22 years old.

Materials

Participants used their own computers. By self-report, any participant with a diagnosed or suspected eating disorder were excluded from the study to avoid causing unnecessary stress. Experience with viewing images of prepared food was measured by the “Experience with Viewing Images of Prepared Food Questionnaire”. The Big Five factors of personality were measured by the mini IPIP constructed by Donnellan et al. (2016). The ability to recognize images of food was measured by performance on two visual tasks: the Food Recognition Match task and Food Recognition Oddball task. The participant also completed two tasks measuring the domain-general ability o.

Experience with Viewing Images of Prepared Food Questionnaire

Experience with recognition of prepared foods was measured by a survey containing several different sections: domain-general questions, modified domain-specific questions, taste questions, and food appearance questions.

The domain-general questions are adopted from Gauthier et al. (2014) measure of experience with object recognition. The questions are as follows: (1) Generally speaking, how easily do you learn to recognize objects visually? (1: much less easily than average; 7: much more easily than average). (2) Generally speaking, how strong is your interest in classifying objects in their various subcategories (e.g., learning about different kinds of insects, plants, shoes, tools, etc.)? (1: not strong at all; 7:very strong). (3) Generally speaking, relative to the average person, how much of your time involves recognizing things visually? (1: much less time than average; 7: much more time than average).

The domain-specific questions are focused on the category of food. The food interest questions are as follows: (1) If you were asked to write an essay about different kinds of food, how extensive and detailed do you think your essay would be? (1: very short and simple; 7: very long and detailed) (2) If you saw a specific food dish in a TV show, how sure are you that you could recognize that item among similar images if you were tested the next day? (1: not sure at all; 7: absolutely sure). (3) How important is the domain of food to you, relative to all the other things you are interested in? (1: one of the least important; 7: one of the most important). (4) How often do you read text (books, magazines, or online) that contain information about food? (1: almost never; 3:~once a month; 5:~once a day; 7: almost every day). (5) Compared to other people, how varied is your diet on a day-to-day basis? (1: as little variety as possible; 7: as varied as possible). (6) How often do you try new foods? (1; almost never; 7: as often as possible).

The importance of taste questions includes the following (1) How likely are you to choose to wait longer or pay a little more for your food to taste better? (not likely at all; very likely). (2) How often do you talk about the taste of food when you talk to someone else? (1: almost never, 7: extremely often). (3) If you wrote a review about a restaurant visit, how likely would you be to mention the taste of food, as opposed to other aspects of your visit? (not very likely; extremely likely).

The importance of food appearance questions includes the following (1) How important is the visual appearance of food to you? (1: not important; 7: very important). (2) How likely are you to choose to wait longer or pay a little more for your food to look better? (not very likely; extremely likely). (3) How often do you talk about the appearance of food when you talk to someone else? (almost never; extremely often). (4) If you wrote a review about a restaurant visit, how likely would you be to mention the appearance of food, as opposed to other aspects of your visit? (not very likely; extremely likely). (5) How often do you take pictures of food to share with others? (almost never; extremely often).

The Mini IPIP Scale

To measure the Big Five factors of personality of the participants, we used the Mini IPIP scale developed by Donnellan et al. (2006). It is a 20-item short form that includes four statements to measure the five traits: intellect/imagination (openness), conscientiousness, extraversion, agreeableness, and neuroticism. The participants indicated how well each statement described them on a scale from 1 to 5 (1: not very well; 5: very well).

To measure openness, the statements were: (1) Have a vivid imagination. (2) Am not interested in abstract ideas (reverse coded). (3) Have difficulty understanding abstract ideas (reverse coded). (4) Do not have a good imagination (reverse coded).

To measure conscientiousness, the statements were: (1) Get chores done right away. (2) Often forget to put things back in their proper place (reverse coded). (3) Like order. (4) Make a mess of things (reverse coded).

To measure extraversion, the statements were: (1) Am the life of the party. (2) Don’t talk a lot (reverse coded). (3) Talk to a lot of different people at parties. (4) Keep in the background (reverse coded).

To measure agreeableness, the statements were: (1) Sympathize with others’ feelings. (2) Am not interested in other people’s problems (reverse coded). (3) Feel others’ emotions. (4) Am not really interested in others (reverse coded).

Lastly, to measure neuroticism: (1) Have frequent mood swings. (2) Am relaxed most of the time (reverse coded). (3) Get upset easily. (4) Seldom feel blue (reverse coded).

Visual Tasks of Food Recognition

The two visual food tasks, Match and Oddball task, are included to measure different aspects of food recognition as opposed to testing only memory or another potential ability.

Food Recognition Match Task

The food recognition match task included 60 trials. As depicted in Figure 1, the studied image appeared by itself first for 1000 milliseconds. Then, the participant viewed a set of three images of food. From this set, the participant picked the image that is most visually similar to the previously studied image without a time limit to respond. The correct image may include the prepared food at a different angle or in a different setting (such as presented on a plate or in a bowl). All studied images are images of prepared foods including breakfast, lunch, dinner, snacks, desserts, and beverages.

Figure 1 – Food Recognition Match Task with both the studied image and the set of 3 images.

For each studied image, there are two distractors. The distractors are matched to the studied image based on ingredients, plate colors, presence of utensils, and background colors. However, the distractors categorically differ from the image. For example, an image of salmon will have two distractors: tilapia and chicken. Although these distractors may have similar garnishes or plating, they are different dishes.

Food Recognition Oddball Task

In the food recognition oddball task, the participants viewed four images of prepared food. The oddball task included 60 trials. Three of these images are the same food. The participants selected the image that is unlike the other images. Each participant had no time limit to respond. The categories of food in this task is similar to the Food Recognition Match task. Figure 2 gives an example of a single trial. For this task, I collected 240 images of food from online searches of different food dishes.

Figure 2 – The Food Recognition Oddball Task. The correct answer here is the first image.

Visual Tasks of General Object Recognition

We measured the latent construct o using two different tasks: the Novel Objects Memory Test – Greebles and the Novel Objects Matching Task. These two differed in both task and category of objects used.

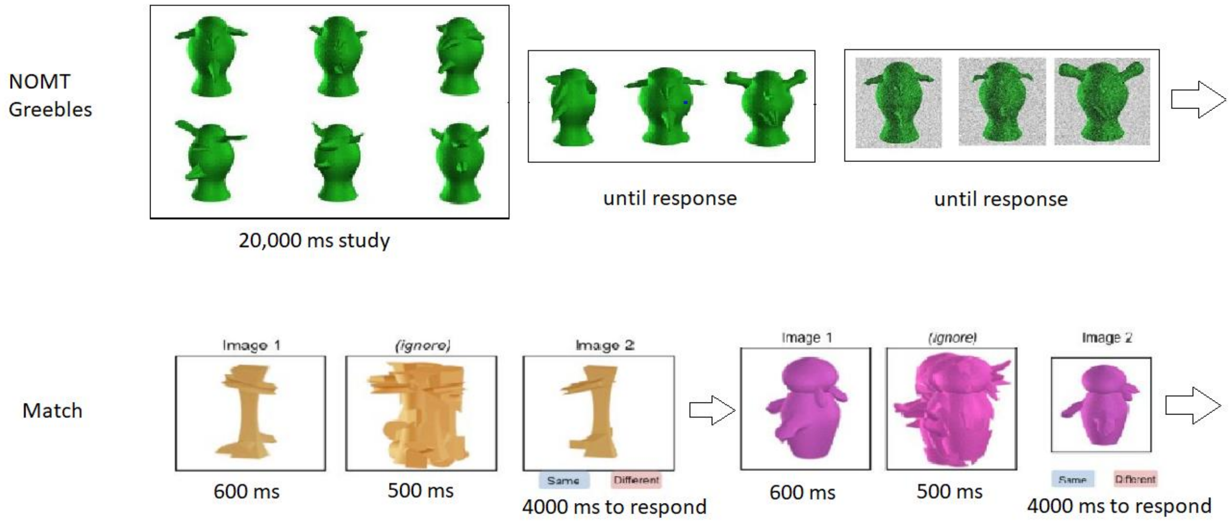


Figure 3 – The Domain General Ability Tasks measuring latent construct "o"

Novel Objects Memory Test – Greebles

In this study, we used the Novel Objects Memory Test with greebles (Richler & Guathier, 2017). Greebles, as a novel object, were used because participants had no prior experience with these objects. In this experiment, there were 48 trials of this visual task. During the study section of the task, the participant studied six different stimuli to remember throughout the entire task for 20 seconds. During the test section of the task, participants viewed three different Greebles and had to select the image that was previously studied. Participants had an unlimited amount of time to respond.

Novel Objects Matching Task

The Novel Objects Match Task also measured the participant's domain-general ability with 71 trials. The participant studies an image of a novel object (such as the ziggerins) for 600 milliseconds, the image is then distorted by a category-specific mask for 500 milliseconds, and then a second image appears. The participant must recognize whether the second object is the same as the first, independent of size or viewpoint. The participants were limited to 4000 milliseconds to respond. The participants did not receive feedback on the trials.

Procedure

The participants viewed the study on their own computer screens and participated online. Since each participant is completing the study remotely, attention checks are included in the survey and four visual tasks. Each participant first answered the survey measuring experience with viewing images of prepared foods and responded to the mini IPIP. Then, the participant completed the four visual tasks in the following order: food recognition match task, novel objects memory test greebles, food recognition oddball task, and lastly the novel objects match task.

Results

We measured general interest, food interest, interest in food taste, interest in food appearance, and the Big Five factors of personality. The survey includes novel questions for the food interest, food taste, and food appearance constructs. To analyze the survey, we measured the reliability of each intended measure. In sum, each survey construct had an acceptable reliability (Table 1).

Table 1. Mean, standard deviation, and reliability of each survey construct.

Survey Construct	**Mean**	***SD***	**Reliability (Cronbach's α)**
General Interest (3*)	4.38	.90	.59
Food Interest (6)	4.34	.98	.74
Food Taste (3)	5.29	1.03	.63
Food Appearance (5)	3.90	1.32	.85
Extraversion (4)	11.27	3.35	.77
Agreeableness (4)	14.39	2.57	.70
Conscientiousness (4)	11.65	2.84	.58
Neuroticism (4)	9.53	2.94	.64
Imagination (4)	10.53	1.06	.69

Note *Indicates the number of survey questions used for each construct.

We also analyzed the reliability of and correlation between the aggregate of two tasks for food recognition ability and general object recognition ability. The food recognition ability tasks included both the food recognition match and the food recognition oddball task. The aggregate food recognition ability had a high correlation and reliability (Table 2). General object recognition ability was measured with two tasks: the novel objects memory test and the novel objects matching task (Table 2). We expected the two food measures to have a strong correlation because they are two different types of tasks that use the same category of images – prepared food dishes. In contrast, the two o tasks differ in both the task and the kind of images used, so the correlation between the tasks is lower than the correlation between the food tasks. However, we are not interested in using objects of the same category to measure the general construct o, so we expected a lower correlation between the two tasks measuring the general recognition ability o.

Table 2. Correlation and reliability of the food recognition and general object recognition ability.

Aggregate Tasks	**Correlation (*r*)**	**Reliability (Cronbach's α)**
Food Recognition Ability	.62	.86
General Recognition Ability o	.34	.83

After analyzing the reliability of our measures, we also explored how food recognition ability could be related to individual differences in experience with food. In the survey, several questions were used to measure the participant's interest in food, taste of food, and appearance of food. After measuring these experiences with food, we also measured the Big Five personality traits of each participant to ask whether any of the traits correlated with performance on food recognition tasks. The correlation was significant for agreeableness and food recognition ability (r=.33, p=.003) and the effect was moderate when considering attenuation by measurement error (r=.43) (Table 3).

By analyzing the correlations, we also answer the question of domain-general ability's contribution to food recognition performance. There is a positive correlation between the domain-general visual ability o and food recognition ability, indicating a domain-general contribution to food recognition (r=.33, p=.003) and the effect was moderate in size when considering attenuation by measurement error (r=.39).

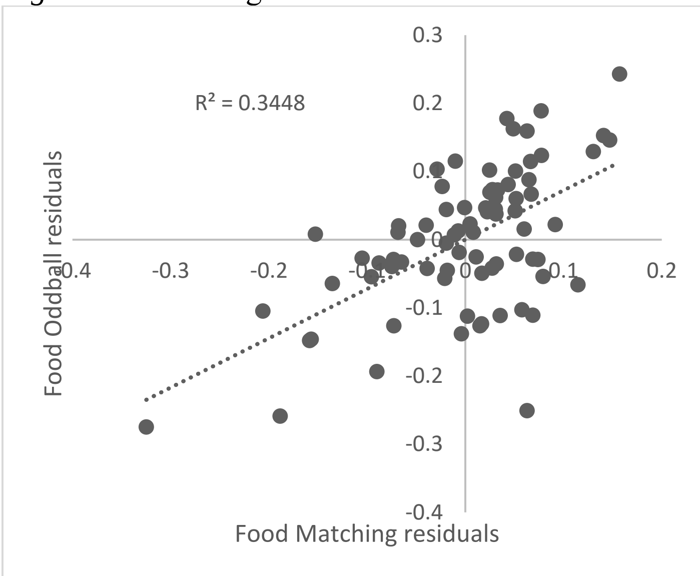
After finding a domain-general contribution to food recognition performance, we explored whether we could detect a domain-specific contribution. A linear regression analysis reveals that the two food tasks positively correlated with each other after controlling for o (r=.59, p <.001) (Figure 1). Also, after controlling for o, we wanted to ask how the surveyed constructs – general interest, food interest, food taste, food appearance, and Big Five personality traits – relate to domain-specific food ability (food ability controlling for "O"). Agreeableness significantly correlates with the food residual scores (r=.31, p=.003) and after disattenuation (r=.40) (Table 3).

Table 3. Correlational matrix with correction for attenuation in bold text

Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1. General Interest											
2. Food Interest	.33*			.							
	.51										
3. Food Taste	.13	.37*									
	.22	**.55**									
4. Food Appearance	.10	.34*	.52*								
	.14	**.44**	**.71**								
5. Extraversion	.00	.26*	.19	.15							
	.00	**.35**	**.27**	**.19**							
6. Agreeableness	.00	.05	.11	.04	.37*						
	.00	**.07**	**.16**	**.05**	**.50**						
7. Conscientiousness	.08	.25*	.03	.31*	.02	-.06					
	.14	**.39**	**.05**	**.44**	**.03**	**-.09**					
8. Neuroticism	-.22*	-.26*	-.18	-.11	.05	.04	-.17				
	-.36	**-.37**	**-.29**	**-.14**	**.07**	**.05**	**-.28**				
9. Imagination	.25*	.18	-.06	.08	-.16	.11	.06	.06			
	.40	**.25**	**-.09**	**.11**	**-.22**	**.16**	**.09**	**.09**			
10. "O"	.11	-.04	-.09	-.22	-.10	.11	-.15	.03	.24*		
	.15	**-.06**	**-.12**	**-.27**	**-.13**	**.15**	**-.22**	**.04**	**.31**		
11. Food Recognition	-.03	-.03	-.15	-.13	.02	.33*	-.13	.12	.15	.33*	
Ability	**-.04**	**-.03**	**-.21**	**-.16**	**.02**	**.43**	**-.18**	**.16**	**.19**	**.39**	
12. Food Residual	-.07	-.01	-.13	-.06	.05	.31*	-.08	.11	.07	-	-
Scores	**-.09**	**-.02**	**-.18**	**-.07**	**.07**	**.40**	**-.12**	**.15**	**.09**	**-**	**-**

Note * p<.05

Figure 1. Linear regression of the food oddball and food match task after controlling for “O”.



Discussion

In the current study, we aimed to answer four questions by creating novel food survey constructs and food recognition tasks. We found that the food interest, taste, and appearance measurements had high reliability. Also, the novel tasks – food matching and food oddball tasks – had high reliability. With the creation of these tasks, future studies can use them to measure domain-specific food recognition ability and relate it to potential influences such as cultural experience with food and other aspects of experience with food.

First, we asked whether domain-general visual ability “o” contributes to food recognition performance. Considering that o is a latent construct that measures a general ability to recognize objects, we predicted that there would be a domain-general contribution to food recognition. The positive correlation between the domain-general visual ability o and food recognition ability indicates a domain-general contribution to food recognition. Considering this, prepared food is related to other object domains because o correlates with food recognition performance. Images of prepared food may be the most variable category related to o. Previous research has shown that o predicts performance with familiar categories such as birds or cars, but prepared foods vary more on the structure of the object in that there is not a set configuration or number of parts included in this specific category (Richler et al., 2017). Thus, the results of this study extend the relevance of o to a more variable category of visual stimuli – prepared food images.

Next, we asked whether there is a domain-specific ability for the visual recognition of prepared food. We found that the two food tasks correlate with each other even after controlling for o. This result indicates that the novel food recognition tasks measure a domain-specific ability for the visual recognition of prepared food. We recognize different prepared food dishes based on a combination of different visual elements on a plate or other container. With the great variety of stimuli involved in a single prepared food dish, prepared food is a more “scene-like” object and the scene-like variation of food might differentiate this domain from other categories. Many other studied visual categories are much less variable in their visual features; for instance, the average of several images of other familiar objects such as birds or planes would still average to recognizably look like a bird or plane. If several images of prepared food are averaged together, the averaged image will be unrecognizable, yet the category of prepared food still coheres as a visual domain.

Also, we sought to answer the question of whether any of the food survey constructs of interest, taste, appearance predict food recognition ability. The survey questions, although reliable, did not measure a food experience that predicted the domain-specific recognition ability. However, other questions about experience with food such as food neophobia may relate to food recognition ability (Nezlek & Forestell, 2019). Food neophobia is the fear of new foods – a concept that limits exposure to different types of food. Further studies should seek to include different survey questions to measure different experiences with food. In the domain of object recognition, studying individual differences offers an interesting insight into how experiences potentially influence perception.

Lastly, we explored the influence of personality on food recognition performance. We found that agreeableness positively correlates with food recognition ability. This result is different from the initial intuition that the openness trait may relate to how open people are to new foods. Previous research has recognized that agreeableness correlates with lower consumption of meat and higher intake of fruits and vegetables (Keller & Siegrist, 2015; Tiainen et al., 2013), and high scores on the health aware diet dimension (Mõttus et al., 2013). Keller & Siegrist (2015) suggest that agreeableness may correlate with less consumption of meat because those with the personality trait consider the ethical concerns of eating animals. Those with a higher agreeableness score may thus spend more time considering their diets related to their ethics and nutrition. As a result, people with high agreeableness scores may have more experience recognizing food to determine if it aligns with their ethical values. However, further studies could explore this by including different questions about food preferences – such as ethics and health considerations – and relate this to the agreeableness trait of the Big Five personality.

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