



Research report

Fast and frugal food choices: Uncovering individual decision heuristics

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Abstract

Research on food decision making is often based on the assumption that people take many different aspects into account and weight and add them according to their personally assessed importance. Yet there is a growing body of research suggesting that people's decisions can often be better described by simple heuristics—rules of thumb that people use to make choices based on only a few important pieces of information. To test empirically whether a simple heuristic is able to account for individual food decisions, we ran a computerized experiment in which participants ($N = 50$) repeatedly chose between pairs of 20 lunch dishes that were sampled from a local food court. A questionnaire assessed individual importance weights as well as evaluation ratings of each lunch dish on nine different factors. Our results show that a simple lexicographic heuristic that only considers each participant's most important factors is as good at predicting participants' food choices as a weighted additive model that takes all factors into account. This result questions the adequacy of weighted additive models as sole descriptions of human decision making in the food domain and provides evidence that food choices may instead be based on simple heuristics.

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Keywords: Simple heuristics; Weighted additive model; Food choice; Lexicographic; Decision making; Transitivity**Introduction**

In Western societies the variety of food to choose from is ever increasing (Schwartz, 2004) and people make around 200 food decisions a day (Wansink, 2006). Previous research has identified many different influences on food choice, including cultural, social, situational, physiological, and cognitive aspects (Furst, Connors, Bisogni, Sobal, & Winter Falk, 1996; Martins & Pliner, 2005; Mela, 1999). Although all these features may have an important impact on food choices, the picture is not complete without knowing how all this information gets integrated into an actual food choice made by an individual person. To illustrate, imagine an everyday situation in which a person has to decide between two lunch dishes. Given all possible information about the content of the foods, the individual values of the diner, the social and cultural context, and so

on, what would be the best way to process that information and predict which dish the person will choose?

In this paper we give an answer to the question of how food attributes and attitudes turn into actual selection behaviour by showing that everyday food decisions can be understood and predicted based on a surprisingly small amount of information and very simple rules of thumb. Starting from a brief review of previous research on food decision making we argue that our findings are very different from what is commonly assumed (but rarely tested) to be the cognitive process underlying food choice.

Factors influencing food choices

One way to categorize the factors¹ underlying deliberate food choices is to distinguish food-internal aspects from food-external aspects (Furst et al., 1996). Food-internal aspects relate to the properties of the food itself, for

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¹The terms 'factor', 'dimension', 'attribute', 'aspect', and 'cue' have been used more-or-less interchangeably in the literature (Shanteau, 1992). They all refer to the source of information being used to make a decision.

example, its taste, nutrient content, or texture. Food-external aspects relate to both the physical environment in which the choice takes place and also to individual preferences, attitudes, motives, and information. Often, the two aspects go hand-in-hand because what ultimately matters is how an individual *perceives* the food-internal aspects (Aikman & Stephen, 2005; Shepherd, 1989).

Among the most commonly investigated factors in the food literature are taste or sensory appeal, health-related issues, ethical concerns, convenience, price, and weight control considerations. People have also been shown to seek emotional comfort, mood improvement, familiarity, and novelty when choosing food (Biloukha & Utermohlen, 2000; Candel, 2001; Connors, Bisogni, Sobal, & Devine, 2001; Eertmans, Victoir, Vansant, & Van den Bergh, 2005; Green, Draper, & Dowler, 2003; Jaeger, 2006; Sjoden, 1996; Kurzenhäuser, 2006; Marquis, 2005; Martins & Pliner, 1998; Roininen et al., 2001; Roininen, Lähteenmäki, & Tuorila, 1999; Steptoe, Pollard & Wardle, 1995; Zandstra, de Graaf, & Van Staveren, 2001). There are individual differences in the importance of these different attributes depending on age, gender, race, lifestyle, socio-economic status, cultural background, and education (Glanz, Basil, Maibach, Goldberg, & Snyder, 1998; Lindeman & Sirelius, 2001; Pilgrim, 1957; Prescott, Young, O'Neill, Yau, & Stevens, 2002). Yet for the majority of people, aspects of taste and sensory appeal seem to be the most important factors underlying food choice, followed by concerns about health, weight control, nutritional value, and cost (Rozin & Zellner, 1985; Stafleu, de Graaf, van Staveren & Schroots, 1991).

The food choice questionnaire

One instrument commonly used to measure individual food attitudes is the food choice questionnaire, or FCQ (Steptoe et al., 1995). The FCQ captures the individual importance of nine factors that are measured based on a total of 36 survey items. These factors are concerns about *health*, concerns about *price and costs*, *convenience* of preparation and purchase, *mood* improvement and stress reduction, *sensory appeal*, such as taste, smell, and texture, *natural content* and the absence of additives, *weight control*, *familiarity*, and *ethical concerns* about the food origin and packaging. Most of these factors are similar to dimensions described by other researchers (above). Among the FCQ factors, sensory appeal, health, convenience, and price are commonly rated as the most important while natural content, weight control, familiarity, ethical concern, mood, and convenience are endorsed less strongly (Eertmans et al., 2005).

Relationship between food attitudes and behaviour

There is sound empirical evidence that the subjective importance that individuals attach to their food attitudes relates to their dietary intake. For instance, British college

students who care about natural food content, weight control, and health report eating healthier food than the average student, while those who value convenience report eating more potato chips (Pollard, Steptoe, & Wardle, 1998). Relationships between self-reported dietary behaviour and food attitudes were also established by Mooney and Walbourn (2001), who found that the avoidance of certain foods can be explained by concerns about weight, health, ethics, and unnatural ingredients. Roininen et al. (2001) as well as Zandstra et al. (2001) found that people who care about their health were more likely to pick a healthy snack while people who indicate a preference for sweet food also report a higher consumption of sweet and high-fat snacks. This approach of correlating food-related attitudes with consumption behaviour shows that attitudes are indeed related to what people eat on an individual level, but it does not reveal the process that leads from personal attitudes and motives to actual choices.

Need for a process model of food choice

The need for a more precise account of the mechanisms involved in food choice has been raised by Stafleu et al. (1991) and is also acknowledged by Steptoe et al. (1995), who point out that the FCQ “is concerned with the factors that are perceived as relevant to food choice, and these factors do not necessarily reflect *actual dietary selection behaviour*” (p. 282, italics added). We aim to close the gap between what people rate as important and how they actually make their individual food decisions. We cannot fully understand food choice until the process of choice has been spelled out.

Implicit models of food choice

Previous food choice research has seldom addressed the mechanisms of making choices but does nonetheless make implicit assumptions about how these mechanisms operate. By deciding to measure correlations between multiple factors and food choices, the underlying assumption is that all the factors matter at least somewhat and that people differ in how much importance they assign to each. If an individual regards several aspects as important, he or she will probably experience conflict between two or more aspects on some foods. For example, for British students, convenience often conflicts with healthiness (Marquis, 2005), and both aspects may only be achieved at a high price. Luomala, Laaksonen, and Leipämaa (2004) list other food-related value conflicts including novelty vs. familiarity (the omnivore's paradox) and health vs. taste. How decision makers solve these trade-offs has not yet been well explored in the food literature (Connors et al., 2001).

According to Furst et al.'s (1996) conceptual model of the food choice process, motives such as monetary considerations, health, and nutrition beliefs exert their effect on food choice through the negotiation of values by

the individual. Yet the authors do not specify the process by which these values are turned into an actual choice.

Explicit models of food choice: weighting and adding

In their model of food cognition, Rappoport, Peters, Downey, McCann, and Huff-Corzine (1993, p. 35) state that “the decision to eat a particular food will depend upon how that food scales on *each of the three criteria*” (pleasure, health, and convenience; italics added). This model assumes that various aspects of an alternative are added up, possibly with each aspect scaled differently according to its importance, to form an overall value or utility. This assumption is a component of multiattribute utility theory (Keeney & Raiffa, 1976) and the corresponding choice process is commonly referred to as a weighted additive mechanism (WADD). Specifically, WADD posits that people search for multiple factors associated with each choice alternative, positive or negative, then weight each factor according to its subjective importance or valence, and finally add them together for each alternative and choose from the alternatives based on the size of each sum. WADD is widely explored in research on decision making and it is often viewed as a gold standard for preferential choice (Payne, Bettman, & Johnson, 1993). Historically, it can be traced back to early work on probability theory and expected value by Daniel Bernoulli in the 18th century (Gigerenzer, 2005a).

In their review of food choice models, Stafleu et al. (1991) show that the understanding of decision making as a process of weighting and adding is widespread within the food choice literature. As a recent example, in one of their models of food choice, Eertmans et al. (2005, p. 715) explicitly assume that daily food intake is influenced “through the weighting of various food choice motives” such as sensory appeal, health, price, and convenience. Methodologically, this approach is usually implemented by estimating a weighted sum of all potentially relevant factors on food consumption. For example, Glanz et al. (1998) predicted individual self-reported consumption of fruits, fast foods, cheese, and breakfast cereals based on individual importance ratings of taste, nutritional value, cost, convenience, and weight control by using a general linear model (WADD).

Heuristic models of food choice

WADD mechanisms require time to assess all the relevant attributes and to combine them into an overall judgment of each choice alternative. Because of these requirements, previous research on judgment and decision making has seriously questioned whether WADD is a reasonable model of human decision making in many common circumstances (Dawes, 1979; Einhorn & Hogarth, 1975). In its stead, the research tradition of so-called simple heuristics (Gigerenzer, Todd, & the ABC Research Group, 1999) proposes decision mechanisms that overcome both of

these challenges. The simple heuristics perspective suggests (1) that people are often frugal in terms of the information they assess for a choice, and (2) that instead of aggregating many pieces of information by weighting and adding, people base their choices on a much simpler yet still effective decision rule. The key assumptions of this “fast and frugal” heuristics approach are that decision makers have limited time and computational resources (exhibiting what Herbert Simon called “bounded rationality”), and that rather than trying to determine “the best” option, they search for something that is “good enough” (Schwartz, 2004; Simon, 1955).

There is considerable evidence that people’s decision-making processes can indeed often be characterized as rules of thumb that work reasonably well in many situations (Bröder, 2000, 2003; Gigerenzer & Goldstein, 1996; Payne et al., 1993). With regard to food decisions in particular, Roering, Boush, and Shipp (1986, p. 78), as far back as 20 years ago, assumed that “consumers employ heuristics (empirical rules of thumb) to facilitate making a satisfactory choice with minimum effort”. As an example, Roering et al. describe a consumer who is on a strict weight reduction diet and bases eating decisions mainly on the caloric content of the food, whereas for a consumer who is not on a diet this information might go unnoticed.

The lexicographic decision heuristic

This example is a prime illustration of the application of a type of simple heuristic called a lexicographic (or LEX—Bettman, 1979) decision rule. LEX predicts that people base their decisions on just one reason by choosing whichever option has the highest value on the attribute that is regarded as most important (e.g., pick the food that is most convenient). If two or more options are equal on that attribute, the second-most important attribute is considered as a tie breaker (e.g., if two foods are equally convenient, pick the cheaper one). The process continues until an alternative is chosen, just like a LEX procedure for alphabetizing two words.

LEX predicts that people do not make trade-offs between different attributes and that they do not bother to assess many attributes but rather focus on the most important ones and choose the option that best satisfies their highest ranked distinctive attribute. With regard to the predicted outcome, LEX could be described as a special case of the WADD model with extremely skewed weights. Yet LEX qualitatively differs from WADD because it assumes a sequential information-sampling process that stops as soon as a discriminating attribute is found, whereas WADD always integrates all available information. People have been found to use LEX-type decision mechanisms in situations where information is costly, time is pressing, or the cost of making mistakes is low (Gigerenzer et al., 1999; Payne et al., 1993); nonetheless, surprisingly often this type of mechanism can make decisions about as well as WADD.

Example of the difference between LEX and WADD

As an example of the difference between the operation of LEX and WADD in a food choice context, imagine a decision maker who cares a lot about health (5 on a scale of 1–5) and slightly less about convenience (4). Our decision maker must decide between two dishes A and B. She perceives Dish A as very healthy (5 on a scale of 1–5) but not so convenient to prepare (3 out of 5), and she perceives Dish B as slightly less healthy (4) but much more convenient (5). According to WADD, the decision maker will choose Dish B because the weighted sum of its attributes ($5 \times 5 + 4 \times 3$) is higher than that of Dish A ($5 \times 4 + 4 \times 5$). But if the decision maker uses LEX, Dish A will be chosen because it is better on the more important attribute, health, and the difference in convenience would not be considered.

Alternative heuristics

Many other choice models have been described in the decision-making literature that could be potential candidates for how people make food choices. The models differ in how much information they take into account and how this information is integrated into a single choice. For instance, the so-called unit weight model follows WADD but with all attributes given equal weights, tallying goes further by replacing all attribute values with 1 if they are desirable and -1 if they are undesirable, and the minimalist heuristic is like LEX but with attributes checked in a random order instead of based on their importance (Bröder & Gaissmaier, in press; Gigerenzer et al., 1999). However, here we concentrate on comparing WADD and LEX as two representatives of radically different approaches to decision making, to see how well each can account for the food choices people make.

Hypothesis

Most approaches to understanding how people make food choices are either implicitly or explicitly based on the assumption that people weight and integrate many attributes of and attitudes towards the foods they consider eating. In contrast, as just summarized, recent research on judgment and decision making suggests that in many real-world situations people make choices based on only a few important pieces of information processed in a quick manner by simple decision heuristics. Given that people make many food choices on a daily basis under conditions of limited time and information, we hypothesize that typical food choices can be explained and predicted as the outcome of simple heuristic decision mechanisms such as LEX.

Methods

To test our hypothesis, we set up a computer-based experiment in which participants repeatedly chose between

20 different lunch dishes in a complete paired comparison task. The study was run in the laboratory of the Max Planck Institute for Human Development in Berlin, Germany, using dishes from a local mall food court. Participants also gave importance ratings for several food-related motives based on a modified version of the FCQ. Individually perceived food-internal attributes were measured by asking participants how much they thought each dish satisfied each of the motives measured by the FCQ. These three parts—a repeated choice task between pairs of dishes, a measurement of individual motives, and an evaluation of the individual food-internal attributes—will be described in more detail below. The whole experiment including instructions was computerized and displayed on a 17-inch colour monitor. Participants could give their answers by using the mouse or the keyboard and all data including the choices, the food choice motives, and the perceived internal attributes were collected via computer input. The experiment was programmed in C# based on the Microsoft .NET 2.0 framework.

The food stimuli

Previous research suggests that people conceptualize a food dish holistically rather than in terms of its components (Rappoport et al., 1993). Therefore, we chose complete lunch dishes as stimuli for our experiment. To ensure high external validity, we sampled 30 popular take-away lunch dishes from the food court of the Potsdamer Platz Arkaden, a large shopping mall in downtown Berlin. We obtained descriptions of three popular lunch dishes ranging in price between €0.60 and €5.79 from 10 different fast food restaurants in the food court. Next, to make sure that the snacks actually differed along the nine FCQ dimensions, we conducted a pre-test in which we described the dishes based on name, price, ingredients, and the type of restaurant that sold the dish and asked 30 participants whom we recruited from local universities (mean age = 25.7 years, $SD = 3.8$) to rate these 30 dishes on each of the 38 modified FCQ items (see food-related motives section). Based on this data, we calculated the Euclidian distance between each pair of dishes on the nine FCQ dimensions. From the initial 30 dishes, we then selected a subset of 20 such that the average between-pair distance within the subset was maximized. As there are more than 30 million possible subsets, this analysis was carried out in Matlab 7.0. Finally, we took a photograph of each of the 20 selected dishes from the food court to get a more realistic representation of the stimuli for the actual experiment. The Appendix A lists all 20 dishes.

Choice task

In the main experiment, participants were asked to choose one dish from each of all possible pairs of these 20 dishes in a complete paired comparison task (David, 1963). Participants were instructed to imagine that they were

hungry and in the Potsdamer Platz Arkaden food court at lunch time with a maximum budget of €10 to spend on a take-away dish. They were further instructed to choose the one dish of the two presented in each pair that they would prefer to buy and eat for lunch.

For n objects, there are $n(n-1)/2$ possible pairs, so in total, each participant made 190 decisions between pairs of dishes. The dishes were presented side-by-side on a computer screen; each side consisted of a colour photo together with the dish's name, the price in euros, and the type and name of the restaurant that sold it. The order of pairs was randomized between participants as was the side on the screen (left/right) on which a dish would appear. After selecting a dish, participants had to press a "continue" button on the screen to see the next pair of dishes. For each pair, the time between when the dishes were displayed and the continue button was pressed was recorded as a measure of decision time. Prior to the actual pairwise choices, participants were presented with a picture and a description of each individual dish so that they got an idea of what the 20 options were.

The food-related motives

To assess the importance each participant attached to a wide range of motives related to dietary choices we used a modified version of the FCQ (Steptoe et al., 1995) described in the Introduction. The FCQ scales have been shown to be reliable, internally consistent, and stable for individuals over time (Steptoe et al., 1995). The original FCQ assesses food-related attitudes with regard to food consumption in general and it does not stipulate a specific situation or consumption context. Accordingly, all items in the original FCQ are initiated with the following sentence: "It is important to me that the food I eat on a typical day...". Because according to the principle of compatibility (Ajzen, 1996) attitudes are better predictors of behaviour if both are measured at the same level of generality, we rephrased the introductory sentence of the FCQ such that the wording specifically referred to the context of lunch dishes: "It is important to me that a lunch dish that I purchase and eat on an average day...".

The five original FCQ items that measure "convenience" relate to food that is bought and prepared at home, which does not match our situation of choosing readily prepared dishes at a food court. We therefore replaced these original items with the following new scale of convenience: "can be prepared by the restaurant in a short amount of time"; "can be eaten quickly"; "can be consumed easily"; "can be carried easily"; "is suitable for consumption on the go".

To further adapt the FCQ scales to a context of prepared lunch dishes, we also added the following two items to the scale measuring ethical concern: "is being sold by companies that are committed to environmental protection" and "contains ingredients that meet special quality standards such as 'certified organic' labels". The other 31 FCQ items remained unchanged. To allow for more

gradation in the answers, we extended the answer scale from a 4-point scale in the original FCQ to a 5-point scale. Similar to the original FCQ, we labelled the endpoints of the scale as "not at all important" (score = 1) and "very important" (score = 5). The middle of the scale was labelled as "neither important nor unimportant" (score = 3); the scale values 2 and 4 were not labelled. We created a German version of the modified FCQ through translation by a German native speaker who was fluent in English and back translation by a native English speaker who was fluent in German (Table 1). Cases of

Table 1
List of modified FCQ items and their German translation

Scale	English	German
Natural content	Contains no additives	keine Zusatzstoffe enthält
	Contains natural ingredients	natürliche Zutaten enthält
	Contains no artificial ingredients	keine künstlichen Zutaten enthält
Ethical concerns	Comes from countries I approve of politically	aus Ländern kommt, deren Politik ich akzeptiere
	Has the country of origin clearly marked	deutlich gekennzeichnet ist hinsichtlich seines Herkunftslandes
	Is packaged in an environmentally friendly way	umweltfreundlich verpackt ist
	Is being sold by companies that are committed to environmental protection	von Läden bzw. Firmen verkauft wird, die sich für den Umweltschutz engagieren
Weight control	Contains ingredients that meet special quality standards, e.g., 'certified organic' labels	Zutaten enthält, die spezielle Qualitätsrichtlinien erfüllen (z.B. Biosiegel)
	Is low in calories	wenig Kalorien enthält
Mood	Is low in fat	einen geringen Fettgehalt hat
	Helps me control my weight	mir hilft, mein Gewicht zu kontrollieren
	Cheers me up	mich aufheitert
	Helps me cope with stress	mir dabei hilft, Stress zu bewältigen
Convenience	Keeps me awake/alert	mich wach/munter hält
	Helps me relax	mir dabei hilft, zu entspannen
	Makes me feel good	dazu führt, dass ich mich wohl fühle
	Helps me cope with life	mir dabei hilft, mein Leben zu bewältigen
Sensory appeal	Can be consumed easily	einfach zu verzehren ist
	Can be prepared by the restaurant in a short amount of time	in kurzer Zeit von dem Imbiss-Laden zubereitet werden kann
	Can be eaten quickly	schnell zu essen ist
	Can be carried easily	leicht zu transportieren ist
	Is suitable for consumption 'on the go'	sich zum Essen für unterwegs eignet
Sensory appeal	Tastes good	gut schmeckt
	Smells nice	gut riecht

Table 1 (continued)

Scale	English	German
	Has a pleasant texture	im Mund eine angenehme Konsistenz hat
	Looks nice	gut aussieht
Price	Is not expensive	nicht teuer ist
	Is good value for money	ein gutes Preis-Leistungs-Verhältnis aufweist
	Is cheap	billig ist
Familiarity	Is familiar	mir vertraut ist
	Is like the food I ate when I was a child	ähnlich der Nahrung ist, die ich als Kind gegessen habe
	Is what I usually eat	das ist, was ich gewöhnlich esse
Health	Is high in fibre and roughage	reich an Ballaststoffen ist
	Is nutritious	nahrhaft ist
	Contains a lot of vitamins and minerals	viele Vitamine und Mineralien enthält
	Is high in protein	reich an Proteinen ist
	Keeps me healthy	mich gesund hält
	Is good for my skin/teeth/hair/nails, etc.	gut für meine Haut/Zähne/Haare/Nägel etc. ist

incongruence were resolved based on discussions in a group of three scientists of whom one was a native English speaker and two were native German.

Control for order effects

Answering questions about food-related attitudes could sensitize people to consider more or different aspects than they usually would. To control for this, we randomly assigned the participants to two different experimental conditions. In one condition, participants were first asked about their individual motives (the modified FCQ) and then made choices among pairs of dishes. In the other condition, participants started off by choosing among the dishes and afterwards answered questions about their individual motives. In both groups, the evaluation of the dishes followed the choice task.

Perceived food-internal attributes

As has been pointed out by Sijtsema, Linnemann, van Gaasbeek, Dagevos, and Jongen (2002) as well as Aikman, Min, and Graham (2006), objective food characteristics can be quite different from what is perceived by an individual. While the mechanisms underlying food perception are important to understand on their own (Antonides & Van Raaij, 1998), it is the subjective impression that eventually lays the foundation for a decision. Therefore, rather than evaluating the food-internal attributes of the dishes based on objective or external criteria such as nutritional values or expert ratings, we were interested in the participants' individual subjective perceptions of the dishes. To measure the extent to which the 20 dishes

fulfilled participants' food-related motives, we had participants rate each dish on the 38 FCQ items. The rating scale ranged from 1 ("This statement doesn't apply at all to this dish") to 5 ("This statement completely applies to this dish"). To control for order effects, the order of dishes was randomized between participants.

Participants

A total of 60 participants were recruited through the subject pool of the Max Planck Institute in Berlin. At the time of the experiment, 41 were students at one of the local universities and the others had recently graduated from there. Prior to the data analysis seven participants were excluded because they were strict vegetarians, and another three were excluded because they had a medical condition that forced them to follow a special diet. Of the remaining 50 participants, 21 were male, 26 were female, and three did not report their gender. Participants were between 19 and 35 years old (mean age = 25 years) and their body mass index ranged between 17.3 and 31.6 (mean = 22.5). On average, it took 61 min ($SD = 14$ min) to read the instructions and to complete the experiment. Participants received €10 for their participation.

Consciousness of the decision

In analyzing people's strategies when choosing food, we make no assumptions about whether the process is conscious. It has been shown repeatedly that people often have little conscious insight into their own mental processes (Greenwald, 1992; Hammond, 1996; Nisbett & Wilson, 1977). Wansink (2006) reports numerous incidents in which people's food decisions can be well understood by situational influences, such as the size of their plate, even though they are not aware of that influence or even strongly deny it.

Results

Individual importance of FCQ factors

To increase reliability and minimize measurement error, all analyses were conducted on the factor level of the modified German version of the FCQ (Churchill, 1979)—the 38 individual items were averaged to create nine factors. The most important factors for choosing a lunch dish across all 50 participants were price ($M = 3.9$, $SD = 0.7$), sensory appeal ($M = 3.9$, $SD = 0.7$), and convenience ($M = 3.6$, $SD = 0.7$), followed by health ($M = 3.0$, $SD = 0.8$), weight control ($M = 2.9$, $SD = 1.0$), natural content ($M = 2.8$, $SD = 1.0$), mood ($M = 2.6$; $SD = 0.8$), familiarity ($M = 2.3$, $SD = 0.8$), and ethical concerns ($M = 2.2$, $SD = 0.8$). Yet what eventually matters for testing the decision strategies are the importance differences within participants. The data indicate a considerable degree of individual differences hidden behind

these average ratings—for instance, even though price is the most important factor on average, on an individual level only 16 of the 50 participants actually rated price as their most important factor.

Each of the nine scales of our modified German version of the FCQ had an acceptable internal consistency, with Cronbach's $\alpha \geq 0.59$ (Table 2). The average of these scales, $\alpha = 0.75$, is comparable to that reported for the original FCQ, $\alpha = 0.78$, by Steptoe et al. (1995).

Ratings of the dishes on the FCQ factors

The 38 subjective attribute ratings that participants made for each dish were also combined into nine factors in the same ways as for the motive importance ratings. Individuals differed considerably in their ratings of the dishes on the FCQ factors. The differences were highest for the evaluation of taste (average standard deviation = 1.0 over all dishes) and lowest for the evaluation of convenience (average standard deviation = 0.7).

On average over all participants, most of the attribute ratings for each dish were positively correlated. For example, most participants who perceived a dish as healthy also perceived it as high in natural content ($r = 0.68$), good for weight control ($r = 0.66$), and mood enhancing ($r = 0.49$). Small negative correlations only occur between the convenience and the price of a dish on one hand and its health, natural content, and weight control on the other.

Manipulation check of the choice task

To make sure that participants did not choose randomly between the dishes, we tested how often each participant violated transitivity. Transitivity denotes that within a triplet of three dishes, {A, B, C}, anyone who prefers Dish A over Dish B and Dish B over Dish C should also prefer Dish A over Dish C. Transitivity within a triplet is violated

whenever a so-called “circle” occurs (Kendall & Smith, 1940). A circle can either be the combination $A > B > C > A$, or $A > C > B > A$ (where $>$ denotes “is preferred over”). If individuals were choosing randomly 25% of all possible triplets would violate transitivity (Roering et al., 1986). For our experiment, a small algorithm implemented in Matlab 7.0 revealed that the average number of intransitive triplets across all participants was only 1.7% ($SD = 1.3\%$) and no single participant generated more than 5.8% intransitive triplets. Further analyses showed that most violations of transitivity occurred between dishes that were similar in their choice rankings. The choice ranking was based on how often a dish was chosen across all 190 decisions by each participant during the choice task and can be regarded as an approximation of the overall attractiveness of each dish for that individual. Thus, similarly attractive dishes were more likely to be involved in intransitive decisions.

Test of decision strategies: WADD

Our main interest is in comparing how well different decision mechanisms can account for how people make food choices. The decision model that most food research implicitly assumes, the weighted-additive or WADD model, takes into account all nine perceived attribute values of the two dishes on offer and weights the attribute values with the participant's associated importance ratings of the nine food-related values assessed with the FCQ. This model implements the food-choice process proposed by Glanz et al. (1998), Eertmans et al. (2005), and others (see Stafleu et al., 1991 for a review of food-choice models).

For our data, we implemented the WADD model for each participant by creating a vector a_i ($1 \leq a_i \leq 5$; $1 \leq i \leq 9$) that contained the individual importance ratings, a , of the nine FCQ scales, i . Next, we created a matrix, v_{ik} ($1 \leq v_{ik} \leq 5$; $1 \leq i \leq 9$; $1 \leq k \leq 20$), that contained the subjective attribute values, v , as perceived by the participant for each of the 20 dishes, k , on all nine FCQ scales, i . Based on this, we calculated the overall preferences of the participant for each dish, p_k , as the sum of the attribute importance ratings multiplied by the attribute values:

$$p_k = \sum_{i=1}^9 a_i v_{ik} \quad (1)$$

Given these preferences, the choice rule is then straightforward: Always choose the dish with the highest overall preference value, p_k . If two dishes have equal preference values, choose randomly.

Based on this model implementation we calculated individual preference values for each dish and made an individual prediction for each participant on each of the 190 decisions. To assess the model fit, we compared the model prediction to the actual decisions made in the choice task. As each of the 50 participants made 190 decisions, there are a total of 9500 decisions that can be used to test

Table 2
Scale reliabilities for original and modified food choice questionnaire (FCQ)

Scale	Cronbach's α	
	Modified German version of the FCQ	Original FCQ (Steptoe et al., 1995)
Natural content	0.92	0.84
Ethical concerns ^a	0.86	0.70
Weight control	0.83	0.79
Mood	0.79	0.83
Convenience ^a	0.74	0.81
Sensory appeal	0.62	0.70
Price	0.61	0.82
Familiarity	0.59	0.70
Health	0.81	0.87

^aThe items for ethical concerns and convenience in the modified German version were different from those in the original FCQ.

the performance of the model. Out of these decisions, the WADD model correctly predicted 6975 or 73%, where chance would be 50%. The median percentage of correct predictions across all 50 participants was 75%.

Test of decision strategies: LEX

The LEX strategy only uses a very limited amount of information—a single distinguishing attribute—and so does not allow trade-offs to be made across the attributes. To apply LEX individually for each participant the nine attributes were rank ordered by each participant's importance ratings, and then for each pair of dishes it was predicted that the dish that was superior on the most important attribute would be chosen by this participant. If two dishes were perceived by the participant as equal on that top attribute, then the decision was based on the next most important attribute, and so on until a decision could be made. When two or more FCQ factors were rated as equally important, their rank was randomly assigned.

Even though LEX only bases its decision on one piece of information, it correctly predicted 6814 or 72% of all participant decisions in the experiment, almost as much as WADD. The median percentage of correct predictions across all 50 participants was 75%, as high as WADD. And yet for each decision LEX only had to consider 1.1 attributes on average before finding one that discriminated between the two dishes, in comparison to WADD's use of all nine attributes. In 89% of all predictions, LEX made a decision based on the first most important attribute, and a further 9% of all decisions were made based on the second attribute; overall, one of the nine attributes always discriminated, and so the LEX mechanism never had to make a random choice.

Order effects of the experimental tasks

To test whether it made a difference if participants were asked about their individual motives (the modified FCQ) before or after they chose from the pairs of dishes we compared the predictabilities of the two models separately for each condition in a 2×2 (order of task vs. decision model) analysis of variance. If filling out the FCQ led participants to consider more attributes than they usually would, the WADD model should be relatively better than LEX in the "FCQ-first" condition compared to the "choice-first" condition. Yet the corresponding interaction effect does not reach significance and nor does the main effects of task order. Thus, the task order does not seem to have influenced participants' choices.

Identification of the strategies based on decision times

The fewer attributes that one must consider in making a choice between dishes, the faster that choice can be (cf. Bröder & Gaissmaier, in press). Therefore, it could be hypothesized that, on average, correct decisions by LEX

should take less time than correct decisions by WADD. To test for such converging evidence on the use of the strategies, we compared the time to make a decision for all pairs in which LEX but not WADD made correct predictions with the decision times of all pairs in which WADD made correct predictions but LEX did not. All decision times longer than two standard deviations from the mean of each participant were considered outliers and excluded from further analyses. On average 4% of all decision time measures were identified as outliers.

The average time to decide between two dishes and to move on to the next pair was 2.7 s ($SD = 1.4$ s). In total, there are 1028 decisions in which LEX but not WADD made correct predictions and 1197 decisions in which WADD but not LEX correctly predicted the outcome. To account for individual differences, we normalized the decision times individually for each participant with a z transformation before we compared the mean decision times between the two conditions. Based on this procedure, even with our large statistical power we did not find any decision time difference between the two conditions, $t(2,215) = 0.45$; $p(2\text{-tailed}) = 0.33$.

Whatever the reason for this lack of effect, it is not due to low validity in the decision time measure: we found that decision times do relate to a different aspect of the choice, namely, the similarity in the actual attractiveness between two dishes. As mentioned above, for each participant the attractiveness of a dish was based on how often that dish was chosen across all 190 decisions during the choice task. In line with the results of Bröder and Gaissmaier, decision times get longer the closer in attractiveness two dishes are. The Pearson correlation between decision time and attractiveness similarity (measured as the inverse of the difference in how often each dish was chosen) is $r = 0.34$.

Discussion

In our experiment we compared how well different cognitive process models predict choices between pairs of lunch dishes. The results show that a LEX heuristic that decides based on a single good reason and does not integrate information makes predictions almost as well as a complex process of weighting and adding all available information (WADD). This result questions the widely held belief that when choosing food, people take into account many different aspects and weight them according to their importance. Yet if we judge by our experiment, it is as likely that people chose food based on a much simpler process, selecting whichever option fulfilled their most important need.

Evidence for simple decision heuristics in related studies

Our findings are in line with a growing body of research on human decision making showing that in a wide range of situations people base their decisions on a few yet important pieces of information (Gigerenzer, 2005b;

Shanteau, 1992; Shepard, 1967). Along the same lines, in a qualitative study on individual food choice processes, Connors et al. (2001, p. 192) found that one strategy people use to deal with complex food choices is “to keep it real simple”. In their paper they also report that people avoided difficult trade-offs by prioritizing some aspects while dismissing others. Further supporting our findings, some participants in Connors et al.’s study even reported making choices based solely on the most important attribute. This result is consistent with other choice domains as well. Studying which features are considered necessities and luxuries in human mate choice, Li, Bailey, Kenrick, and Linsenmeier (2002) found that people rate many different aspects as being important. However, when people were faced with the prospect of trading off aspects against each other to choose a mate, they largely avoided such trade-offs by identifying a few very important characteristics (necessities) and treating most of the other aspects as insignificant (luxuries).

Why do heuristics work in food choice?

People may not integrate information because they want to avoid emotion-laden value conflicts and trade-offs, or they may simply lack the time or computational ability to do so. But regardless of what people actually do, it has often been argued from a normative rationality perspective that people *should* integrate information in order to make better decisions (Hammond, 1996). Yet a heuristic that uses only a fraction of the available information without integrating it can indeed be as good as a complex rule that integrates all available information—that is, it can be ecologically rational—provided that the heuristic is applied in the right type of information environment (Gigerenzer et al., 1999; Todd, Gigerenzer, & the ABC Research Group, in press). One type of environment in which simple heuristics can be as good as complex models is a decision set with highly correlated attributes.

Positive correlation between attributes

As outlined above, most attributes of the dishes in our experiment were positively correlated. Thus, often times, a dish that was superior to another on one attribute would also be superior on other attributes. In these cases, it did not matter if the decision was based on one attribute or on all of them, because they all pointed in the same direction. Because we used a representative sample of lunch dishes from a natural environment, there is good reason to believe that positive attribute correlations are more the rule than the exception in food choices (Biloukha & Utermohlen, 2000, for instance, report a positive correlation between the perception of healthfulness and tastiness). These positive correlations could be due to the general idea that in many real-world situations, information is redundant (Hammond, 1996), but it could also be due to a halo effect in which people judge food very holistically and this holistic

judgment then drives both the choice and the evaluation on the different FCQ scales. Positive correlations could also be explained through the theory of “completing perceptions” (Sijtsema, et al., 2002), which says that people infer one attribute from another—for example, if a dish is known to have natural contents, it is *assumed* to be healthy as well. The construction of subjective positive attribute correlations could also be thought of as an unconscious coping strategy to avoid difficult trade-offs in the first place (Lazarus & Folkman, 1984).

It could be argued that an environment in which positive correlations are present is not suitable for testing the difference between our two choice models because both would typically make the same predictions. But even if we only compare the decisions for which LEX and WADD make different predictions (which can be seen as a proxy for a decision set with negative attribute correlations) WADD still does not generally outperform LEX. From the perspective of an adaptive decision maker (Payne et al., 1993), the argument should, in fact, be the other way around: if the environment is structured such that one cue is as good as any other, why waste time and energy to add them all up?

Which is the right model?

It is certainly possible that the information-processing mechanisms underlying preferential choice may look very different from the models that we tested (Birnbaum, 2006). But if several models predict the same outcome, common practice suggests to choose the most parsimonious (Popper, 1992; Martignon & Hoffrage, 1999). Consequently, based on our results we do not see much reason to believe that people’s daily food decisions are made by the weighting and adding of several aspects. We propose instead that many daily food decisions are based on simple rules of thumb that aim to satisfy people’s most important preferences without the need to make trade-offs.

Predictive performance of the choice models

The models we tested correctly predicted over 70% of all pairwise choices. While this is clearly better than guessing (50%), it is also clear that a lot of choices still remain unexplained. There are several reasons why the models do not predict a higher percentage of the decisions. First, we showed by analyzing the transitivity in choices that people’s decisions are not always consistent, which sets the upper limit of what can possibly be explained to slightly below 100% (Rieskamp, Bussemeyer, & Mellers, 2006). Also, by using a representative sample of only lunch dishes, we increased the similarity between the options, which makes choices and predictions more difficult. Accordingly, when the models are tested exclusively on the choices people made between attractive and unattractive dishes, the percentage of correct predictions increases considerably.

Validity of the FCQ

As with every other behavioural measure, the reliability of the FCQ is not perfect, and this adds noise to our choice predictions. Also, the cross-cultural generalizability of the FCQ scales has recently been questioned by Eertmans and her colleagues (Eertmans, Victoir, Notelaers, Vansant, & Van den Bergh, 2006), who conjectured different connotative meanings in different countries. Furthermore, the FCQ only provides a rough estimation of how people perceive food because it was constructed as a broad measure that applies to a wide range of different foods and situations. Furthermore, there are many other sensory and non-sensory factors that influence food choices that are not captured by the FCQ (Eertmans, Baeyens, & Van den Bergh, 2001; North, Shilcock, & Hargreaves, 2003; Rozin & Millman, 1987). Yet despite these limitations, nevertheless a good proportion of the decisions in our experiment could be explained, suggesting that the FCQ indeed taps into aspects that matter for people's food choices.

Single choices vs. aggregated consumption over time

Although we found that fast and frugal heuristics are almost as good in predicting single choices as a weighted additive model it does not follow that the choice of a given person can always be predicted on the *same* attribute. We would instead expect that the importance of the factors is highly context dependent. For instance, a person who is extremely hungry might perceive nutritional content as the most important factor and choose the dish that has the highest value on that factor, whereas a person who is not hungry might value price more. Also, it is possible that once in a while, even a usually unimportant factor will temporarily govern a choice. The idea of shifting attribute importance is also in line with Connors et al. (2001), who found that allowing a single attribute to dominate choice in one situation influences which attribute will dominate in the next situation. The LEX choice heuristic that we propose is a model for how an individual chooses food at a particular moment. As such, the model does not refute the well-established finding that a weighted additive model (e.g., in the form of a multiple regression) provides a superior fit to a person's consumption within a given period of time. However, the analysis of data aggregated across many single decisions usually does not allow inferences about the actual decision process that generated the data, our interest here.

Applications and implications

Our results suggest that trade-offs between attributes may well be avoided when choosing food. If so, then a number of reasonable values on unimportant features would seldom outweigh a weakness on an important attribute. Knowing this, marketers in the field are well

advised to focus their communication on just a few strengths of a product with respect to specific target groups. For example, people who are deeply concerned about a product's ethics will likely be unconvinced by its improved taste, colour, texture, and convenience. Likewise, if price is a major concern an increase in healthiness will probably prove inconsequential.

For policy makers concerned with educating consumers about healthy food choices, our results may help explain why many people do not obtain or adequately comprehend nutrition information: if health-related issues are valued less than other aspects of a food, consumers using a LEX heuristic may simply never consider health-related cues before making their choices.

Paying more attention to decision processes also allows us to better interpret the results of the FCQ and questionnaires like it: food aspects that are *relatively* unimportant compared to other aspects might not enter into food choices at all even though their *absolute* importance rating might be high.

Conclusion

We have focused here on two prominent models of individual decision making: a compensatory weighted additive model and a non-compensatory lexicographic strategy. We found that there is no reason to favour weighted additive models over a fast and frugal heuristic such as LEX as an account of how people make food choices. Human decision making is certainly multifaceted and adaptive, and there is good evidence that people access a wide repertoire of different decision strategies depending on their goals and the situation they face (Gigerenzer & Selten, 2001). Consequently, we should not limit our theories about food choices to a single model.

Appendix A. The 20 lunch dishes used in the experiment

Dish	Price	Name of restaurant	Cuisine
Bacon and cheese croissant	€ 1.10	Ditsch	German
Bagel with lox	€ 4.50	Salomon Bagels	Jewish
Baked potato with cottage cheese	€ 4.50	Pomme de Terre	Various
Big Mac Maxi Menu (Big Mac, garden salad, French fries)	€ 5.79	McDonald's	US fast food

Bockwurst (German sausage) with potato salad	€ 3.25	Bendig Imbiss (snack bar)	German
Caesar salad with grilled chicken	€ 4.99	McDonald's	US fast food
Cheeseburger	€ 1.00	McDonald's	US fast food
Chocolate muffin	€ 1.80	Salomon Bagels	US
Currywurst (sausage in curry sauce) with French fries	€ 3.80	Bendig Imbiss (snack bar)	German
Lasagna	€ 2.50	Pizza Pasta Salumeria	Italian
Maki sushi set	€ 3.45	Sushi Circle	Japanese
Mini pizza	€ 1.50	Pizza Pasta Salumeria	Italian
Miso soup	€ 2.10	Sushi Circle	Japanese
Pasta with vegetables	€ 2.50	Pizza Pasta Salumeria	Italian
Pretzel (large, soft)	€ 0.60	Ditsch	German
Rissole with roll	€ 2.90	Bendig Imbiss (snack bar)	German
Tom Kha Gai (chicken soup)	€ 2.00	Asia Pavilion	Thai
Tomato soup with bagel	€ 4.00	Salomon Bagels	Jewish
Vegetarian sushi set	€ 5.75	Sushi Circle	Japanese
1/2 grilled chicken	€ 2.30	Saray Grill	Turkish

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