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The Knowledge of Animals as Food Scale

Silke Feltz & Adam Feltz

University of Oklahoma

There have been extensive outreach programs to educate people about the realities of animal food production. However, there has been relatively little attention to measuring what people actually know about the production of animal food products and the conditions in which those animals exist. A reliable measure of knowledge of animal products is required to determine if making people more knowledgeable about the condition of animals reduces animal product consumption. In four studies, we developed an objective measure of knowledge of animal consumption — the Knowledge of Animals as Food Scale (KAFS). Study 1 (N = 265) used Item Response Theory to analyze 35 knowledge-based items. Based on Study 1, Study 2 (N = 243) tested the 11 best knowledge-based items and demonstrated that the scale had convergent, discriminant, and criterion validity. The KAFS successfully predicted fewer numbers of days per the average week one consumes meat. Study 3 (N = 289) refined the instrument to nine items and replicated the results of Study 2. Study 4 (N = 201) replicated the results and provided causal evidence that a very brief educational intervention can increase knowledge measured by the scale (d = .28). In Studies 2, 3, and 4, the KAFS was often a unique or best predictor of consumption of animal products compared to other values concerning animals. Having a valid, reliable measure of knowledge of animals used as food has important psychological and ethical implications including providing insight on whether education works and ways to help promote individual autonomy.

Keywords:

Correspondence concerning this article should be addressed to Adam Feltz, University of Oklahoma, Department of Psychology, 455 W. Lindsey St., Dale Hall, Tower Room 705, Norman, OK 73019. Email: afeltz@ou.edu

In 2015, People for the Ethical Treatment of Animals (PETA) spent more than $15 million on public outreach and education efforts (PETA, 2016). This is just one example of an organization spending large sums of money on education in part to help people become more knowledgeable about animal consumption. Was the money spent on effective educational programs? Without having a valid way to measure people's knowledge of animal products, it is difficult to know if any of these initiatives made people more knowledgeable. To date, knowledge about animals used in food production is largely unexplored (Faunalytics, 2016). Knowledge, along with values, is typically taken to be a key element in decision making (Baron, 2008). If one of the goals of psychologists and ethicists is to understand people and help them make decisions consistent with their values, then a comprehensive account of people's' food

choices that includes values and knowledge (and their interactions) is required. To help address the lack of evidence about what people know of animal food production, we present four studies that developed a new way to measure what people know about animals as food. We argue that having a reliable way to measure knowledge about animal products provides valuable avenues to help understand people's choices and to promote individual autonomy.

Decision Making, Knowledge, and Animal Consumption

Values and beliefs are core elements on standard models of decision making (Cokely, Garcia-Retamero, Ghazal, Allan, & Feltz, 2018; Simon, 1955, 1990). Values are things or states that a person finds desirable (Chang, 1997). Beliefs are representational mental states that depict how the world is thought to be. One key difference between values and beliefs is that values are typically neither true nor false but beliefs are. To illustrate, it is strange to say that it is false for one to value health. However, it is much more natural to say that a person can falsely believe that exercise does not contribute to health. More than that, to reliably realize one's values, one often needs true beliefs. If one has systematically false beliefs about health, then one would often decide to do things that do not contribute to health because of factually incorrect information. In this light, knowledge is standardly taken to involve true beliefs (Kornblith, 2002).

Decisions about animal consumption are not substantially different from other kinds of decisions people make. Beliefs and values play a role in whether one decides to consume animals. Most empirical studies about consuming animal products have focused on establishing correlations between animal consumption and values or value correlates (for a systematic review, see Ruby, 2012). For example, one prominent value-related factor that predicts consumption of animal products is whether eating animal products is considered *natural*, *normal*, *necessary*, and *nice* (4Ns) (Piazza et al., 2015). Those who score higher on the 4Ns consume more animal products than those who score lower on the 4Ns. A host of other values has been shown to be associated with increased animal consumption including being more religious (Ruby, Heine, Kamble, Cheng, & Wadder, 2013), having binding (i.e., politically conservative) moral foundations (Graham, Haidt, & Nosek, 2009; Hoffman, Stallings, Bessinger, & Brooks, 2013; Ruby et al., 2013), thinking that food has been produced ethically (Vanhonacker, van Loo, Gellynck, & Verbeke, 2013), having less compassionate attitudes toward animals (Herzog, 2007; Janssen, Busch, Roediger, & Hamm, 2016; Lund, McKeegan, Cribbin, & Sandoe, 2016), and being higher on speciesism (Piazza et al., 2015). Others have discovered that demographic variables like being male (Herzog, 2007), personality (Kessler et al., 2016), and conservative political orientation are related to increased consumption of animal products (Lusk & Norwood, 2016). Finally, some general emotional states like higher disgust and higher empathy are also related to decreased animal consumption (Rothgerber, 2014,

2015). So, it appears that values or value correlates are important predictors of animal consumption.

While there is gathering evidence about some values that predict eating animals, we know relatively little about what people *know* about animals used as food. Measuring what people know is important because not all people have the same beliefs when it comes to animals used as food. The diversity of beliefs is a vexing problem because people often think that facts support their own views about controversial topics. This tendency has come to be known as the *myside bias* (Stanovich, West, & Topiak, 2013). For example, Jon Baron (1995) has found that people tend to first think of arguments or reasons that support their own views about abortion. We see something similar in attitudes about animals used as food. For example, meat eaters tend to agree more than non-meat eaters that eating animals is natural for humans (Piazza et al., 2015). Hence, subjectively, people may think that their beliefs about animal consumption are supported by facts when they really are not — and overcoming that bias is a challenge for campaigns geared at education (Kuhn, 1991; Kuhn, Hemberger, & Khait, 2016).

Unlike values, there currently is no established instrument that measures objective knowledge about animal consumption. Consequently, we do not know if some people are making decisions about consuming animals that are based on factually inaccurate beliefs. For example, maybe people do not know about the suffering animals experience when used in food production and therefore find no issue with eating animal products even though they value eliminating unnecessary suffering (Terlouw et al, 2008). If those people were to come to understand that eating animals is inconsistent with one of their core values, they would stop consuming animals. Those who make decisions based on false beliefs are likely making a mistake because they are not making decisions or acting in accordance with their deeply held core values. Having a way to measure what people know about animal consumption would help to identify and possibly to correct a key factor in their decisions
(i.e., beliefs about animals used as food).

Some studies have measured people's subjective knowledge of animal consumption. For example, Faunalytics.org has used a subjective knowledge test (i.e., "How knowledgeable do you feel about issues that affect the welfare of animals in the following circumstances…") (Faunalytics, 2016). Less than half of the respondents thought they were very or somewhat knowledgeable. While subjective measures of knowledge are valuable and informative, the results can be systematically biased (e.g., people may overestimate their knowledge). There are also measures of what people know about nutrition and animal products (Hoffman et al., 2013; Ruby, 2012), but none of these instruments directly measure objective, factual information about animals used as food.

In four studies, we developed a psychometrically sound, objective knowledge measure — the Knowledge of Animals as Food Scale (KAFS). Study 1 was

designed to test an initial battery of knowledge of animals as food statements to determine the item-level properties using Item Response Theory (Baker, 2004). Studies 2 - 4 were designed to further refine the items and provide evidence that the new knowledge-based instrument uniquely predicted key outcomes (e.g., consumption of animal products) above and beyond already existing instruments. Study 4 was designed to demonstrate that performance on the knowledge scale can be improved by a short educational intervention whereas that same intervention does not change performance on instruments that measured values about animals as food.

Study 1

The main goal of Study 1 was to test the properties of 35 items measuring knowledge of animals used as food (items available upon request). The 35 items were submitted to analysis using Item Response Theory (IRT). IRT analyses measure latent traits. Latent traits are unobserved yet assumed to be causally responsible for a pattern of responses. In this case, the latent trait is knowledge of consuming animal products. Unlike classical test theory, IRT can provide item-level analyses (Baker, 2004). In particular, IRT methods can estimate the probability that people of different levels of knowledge will answer a question correctly. If one plots the probabilities of correct answers among people with different levels of knowledge, the resulting plot forms an S-curve (from low probability of correct answer for low-knowledge people to high probability for high-knowledge people). This S-curve is called the item characteristic curve. Difficulty and discrimination are two important properties of item characteristics curves. An item's characteristic curve can be located on a scale of how difficult the item is. Items that have better discrimination will have sharper up-slopes on the S-curve (i.e., the item does a better job discriminating among low and high ability at that ability location). Ideally for our purposes, the knowledge test should have items with strong discrimination and a variety of difficulties so that different ability levels can be estimated by the test. Study 1 was designed to identify those properties. The final set of items used in subsequent studies were initially conceptually developed in Study 1 but then retained based on empirical grounds.

Table 1. Demographics for Studies 1-4

		Study 1	Study 2	Study 3	Study 4
Age		*M* = 38, *SD* = 28.96	*M* = 38.34, *SD* = 12.88	*M* = 37.33, *SD* = 13.37	*M* = 19.87, *SD* = 1.62
Male		59%	59%	58%	72%
Religion					
	Catholic	15%	21%	22%	19%
	Protestant	35%	30%	32%	33%
	Mormon	1%	2%	1%	0%
	Muslim	3%	1%	0%	0%
	Jewish	2%	3%	1%	0%
	Atheist	13%	15%	16%	15%
	Agnostic	21%	18%	16%	21%
	Preferred not to indicate	10%	11%	12%	10%
Education					
	Grammar school	0%	0%	1%	0%
	High School	14%	9%	12%	18%
	Vocational	5%	5%	7%	0%
	Some College	27%	33%	34%	74%
	Bachelor's	46%	40%	34%	8%
	Master's	6%	7%	9%	0%
	PhD	2%	2%	2%	0%
	Professional	1%	4%	1%	0%
Ethnicity					
	Arab	0%	0%	0%	1%
	Asian/Pacific Islander	9%	7%	6%	4%
	Black	12%	8%	9%	3%
	Caucasian/White	69%	74%	77%	88%
	Hispanic	4%	5%	4%	1%
	Indigenous	1%	0%	0%	0%
	Latino	1%	1%	1%	1%
	Multiracial	3%	4%	1%	1%
	Would rather not say	0%	1%	2%	4%
Marital Status					
	Divorced	7%	7%	9%	0%
	Cohabitation	14%	14%	12%	2%
	Married	37%	42%	45%	0%
	Separated	1%	1%	1%	0%
	Single	39%	35%	32%	95%
	Widowed	1%	1%	1%	0%
	preferred not to respond	1%	1%	1%	3%
Income					
	<$10,000	8%	7%	8%	30%
	$10,000-19,999	11%	9%	10%	7%
	$20,000-29,999	17%	12%	12%	2%
	$30,000-39,999	12%	12%	13%	4%
	$40,000-49,999	10%	9%	11%	4%
	$50,000-74,999	23%	21%	23%	6%
	$60,000-99,999	12%	14%	12%	5%
	$100,000-150,000	6%	9%	7%	8%
	> $150,000	1%	3%	2%	3%
	Preferred not to respond	1%	3%	2%	34%
Living area					
	Urban	27%	29%	30%	15%
	Suburban	53%	53%	49%	37%
	Rural	19%	17%	20%	48%
	Preferred not to respond	1%	1%	1%	0%

Participants

Two hundred and sixty-five participants were recruited from Amazon's Mechanical Turk.[1] Twenty-nine participants were excluded for not completing the survey. Demographics for all four studies are reported in Table 1. All ethical standards were followed in conducting these studies and all studies received IRB approval (M1508, 949408-1).

Materials

Each item was rated by participants as being true or false. Items were created from scratch in consultation with two domain experts. The two domain experts helped create and provided feedback on the items. The main goal was to have a set of items that were likely to be representative of knowledge of animals used as food. The 35 items were given to participants in randomized order. After responding to the 35 knowledge-based items, basic demographic information was gathered.

Results

Difficulty and discrimination of items were estimated by using a two-parameter IRT model.[2] IRT analyses indicated that eleven items had desirable discrimination and difficulty (Appendix A). Nine of these 11 items were selected because they had very high discrimination (> 1.69). Two items were selected because they had moderate discrimination (> 0.6) but also were some among the most difficult items (difficulty > .21). As expected, some of the 35 items did not have desirable properties. Three items were discarded because they had negative discrimination (i.e., as one knows more, one is less likely to get the answer correct), 20 items were discarded because of low discrimination (< 1.3), and one item was discarded because of redundancy with another item that was retained (nearly identical discrimination and difficulty) (see Baker (2004) for rules of thumb regarding item-level analysis).

Study 2

Study 1 suggested that 11 of the knowledge items had desirable test properties. However, various elements of construct validity (e.g., criterion, convergent, discriminant validity) remained to be demonstrated (Messick, 1995). Study 2 was designed to help establish construct validity and replicate the IRT results of Study 1. To those ends, several animal value related instruments were used. It was hypothesized

[1] Studies suggest that for tasks involving responses to questionnaires, Amazon's Mechanical Turk is an acceptable and often better way of recruiting subjects when compared to traditional methods (e.g., Universities' subjects pools) (Gosling, Vazire, Srivastava, & John, 2004; Heen, J., & Miethe, 2014).

[2] A two-parameter model is different from a one-parameter model. One-parameter models only estimate item difficulty and assume that the discrimination for each item is the same. Three-parameter models include a pseudo-guessing parameter in addition to estimating difficulty and discrimination that helps to control for people getting items correct simply by guessing (Baker, 2004).

that the KAFS would be modestly correlated with these value instruments (i.e., convergent validity). It was hypothesized that the KAFS would also negatively predict the number of days animal products were consumed in an average week (i.e., criterion validity). Previous research has suggested that females and political liberals consume fewer animal products (Cordts, Nitzko, & Spiller, 2014; Hayley, Zinkiewicz, & Hardiman, 2015). Hence, we hypothesized that females and liberals would know more about animals used as food. Finally, personality traits were measured. Personality is conceptually and empirically distinct from many knowledge constructs, so a lack of correlation with personality traits should be expected if the KAFS measures objective knowledge and not general attitudes or traits. It was hypothesized that the KAFS would be unrelated to any of the Big Five Personality Traits (i.e., discriminant validity).

Participants

Two hundred and forty-three participants were recruited from Amazon's Mechanical Turk. Seven participants were excluded for not completing the entire survey.

Materials

Participants were given the following instruments in the same order. Each of the scales (except for the KAFS) have been shown to be correlated with meat consumption or related behaviors.

***KAFS*:** The 11 items identified from Study 1 were given to participants.

***Animal Attitude Scale (AAS*)** (Herzog, Betchart, & Pittman, 1991): The AAS is a 20-item measure of general attitudes toward animals (e.g., "It is morally wrong to hunt wild animals just for sport"). Responses are on a Likert scale (1 - 5, strongly agree to strongly disagree). The entire scale represents one factor, so the average score for the 20 items was calculated.

***Ethical Food Choices Motives Scale (EFC*)** (Lindeman & Vaananen, 2000; Vanhonacker et al., 2013): The EFC is a 5-item scale that measures how important it is that food has been produced in an ethically defensible way (e.g., "It is important that the food I eat on a typical day has been produced in a way that animals have not experienced pain"). Responses are on a 4-point Likert scale (not important to very important).

The 4Ns (Piazza et al., 2015): The 4Ns measure whether eating meat is *Normal* (e.g., "It is normal to eat meat"), *Nice* (e.g., "Meat is delicious"), *Necessary* (e.g., "Human beings need to eat meat"), and *Natural* (e.g., "It is only natural to eat meat"). Each of the subscales has four items with responses on a 7-point Likert Scale (1 – 7, completely disagree, neither agree nor disagree, completely agree). A total 4Ns score was used in analyses because previous research suggested that all subscales loaded on the same factor (Piazza et al., 2015).

Speciesism Scale (Piazza et al., 2015): The Speciesism Scale measures one's attitudes about preferring human interests to the interests of other species (e.g., "We should always elevate human interests over

the interests of animals"). The scale consists of five Likert scale items (1-7, strongly disagree to strongly agree).

The Meat Commitment Scale (MCS) (Piazza et al., 2015): The MCS measures how committed one is to eating meat (e.g., "I don't want to eat meals without meat."). The scale consists of seven items with responses on a 7-point Likert scale (1 – 7, strongly disagree to strongly agree).

Food Choices Measures: The main criterion variables were the number of days per the average week that participants consumed meat and animal products (0 - 7 days per the average week). Participants reported their consumption for each of the following: beef, pork, lamb, chicken, fish, and seafood. The animal products were eggs and dairy. We also included some non-animal products including bread, rice, vegetables, and fruit because researchers have done the same to show discriminant validity (e.g., higher scores on KAFS should be unrelated to choices of non-animal foods) (Piazza et al., 2015).

***Self-identification of eating habits*:** Participants identified themselves as Meat-eater, Vegetarian, or Vegan.

Comprehension Question: Because the survey was relatively long, we included a comprehension check to make sure the participants were paying attention. Participants were asked, "You have been answering questions about: Boats, cars, computers, presidents, food/animals, how much you like classical music." The same comprehension question was used in all subsequent studies. Nobody in any study was excluded for missing the comprehension question.

Ten Item Personality Inventory (TIPI) (Gosling, Rentfrow, & Swann, 2003): The TIPI is a brief measure of the Big Five Global Personality traits.

***Basic Demographic Information*:** Basic demographic information was gathered including political orientation (on a 7-point Likert scale, 1 = liberal, 7 = conservative) and sex (0 = female, 1 = male).

Results

The first step was a series of IRT analyses on the 11 items of the KAFS to assess test properties. A two-paramter model (*AIC* = 2271.27, *BIC* = 2348.11) was a better fit to the data than a one-parameter model (*AIC* = 2280.29, *BIC* = 2322.91), (*LRT* = 29.73, *p* = .001). However, there was a problem with the two-parameter model's fit to the data. Some items had chi-squared residuals 3.5 or higher. In particular, items 5 and 9 were consistently involved in residuals greater than 3.5. Items 5 and 9 also had roughly the same discrimination and difficulty, suggesting that these two items were not only responsible for a poor fit but also that they were redundant (see Table 2, all ICCs and IICs for all studies are in supplemental materials). The test information function is reported in Figure 1.

Second, analyses were conducted to determine convergent, discriminant, and criterion validity. Zero-order correlations among the different measures of attitudes

Table 2. Descriptive IRT Statistics for the KAFS in Studies 2 and 3

Item	% correct		Difficulty		Discrimination	
	Study 2	Study 3	Study 2	Study 3	Study 2	Study 3
Knowledge 1	76%	78%	-1	-1.26	1.82	1.5
Knowledge 2	87%	91%	-1.4	-1.4	2.62	5.49
Knowledge 3	89%	91%	-1.55	-1.46	2.25	3.6
Knowledge 4	84%	85%	-1.29	-1.73	2.26	1.28
Knowledge 5	86%		-2.54		0.8	
Knowledge 6	93%	88%	-2.53	-1.88	1.26	1.36
Knowledge 7	95%	95%	-3.72	-2.59	0.85	1.38
Knowledge 8	83%	88%	-1.66	-2.19	1.18	1.08
Knowledge 9	79%		-2.2		0.66	
Knowledge 10	54%	52%	-0.2	-0.24	0.85	0.37
Knowledge 11	44%	46%	0.51	0.89	0.46	0.19

towards animals are reported in Table 3. As predicted, the KAFS was related in the predicted direction to the AAS, EFC, 4Ns, Speciesism scale, and the MCS. The KAFS was unrelated to personality traits except for openness to experience. Since the relation with openness to experience was unexpected, it should be interpreted with caution (see Study 3). Finally, the KAFS was related to sex and political orientation in the predicted direction. Women and liberals were more likely to know more about animals used as food. As such, these data suggest that the KAFS has convergent and discriminant validity.

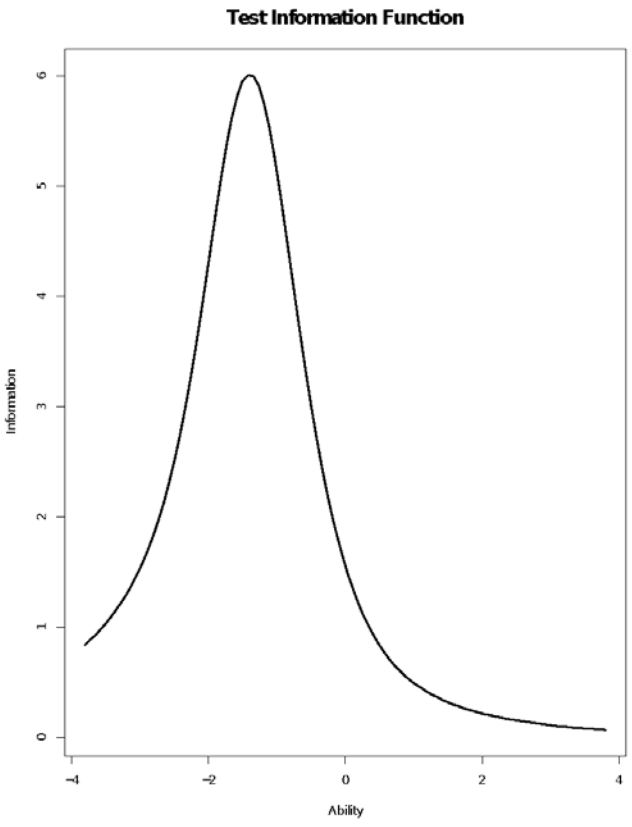

Figure 1. Test Information Function for Study 2

Increased knowledge of animal consumption as measured by the KAFS negatively predicted consumption of animal meat but not animal products (correlations, means, and standard deviations for criterion variables for Studies 2 - 4 are reported in Table 4). Those who self-identified as vegetarian (M = 9.6, SD = 1.85) or vegan (M = 10, SD = 1.58) knew more than those who self-reported as being meat-eaters (M = 8.5, SD = 1.87) (F [2, 236] = 6.02, p = .003, η_p^2 = .05). These results suggest that the KAFS has criterion validity.

While the correlations reported in Table 4 suggested that the KAFS had criterion validity, those correlations do not demonstrate whether the KAFS was a

Table 3. Correlations for Study 2.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. KAFS													
2. AAS	.45**												
3. EFC	.31**	.55**											
4. N4	-.44**	-.52**	-.27**										
5. Speciesism	-.28**	-.69**	-.48**	.45**									
6. MCS	-.37**	-.58**	-.32**	.85**	.53**								
7. Extraversion	-0.03	-0.06	0.03	-0.02	0.01	-0.01							
8. Agreeableness	0.12	.21**	.24**	-0.11	-.17*	-0.1	0.06						
9. Conscientiousness	0.11	0.06	0.03	0.03	-0.01	0.05	0.05	.33**					
10. Emotional Stability	0.02	-0.02	0.09	0.07	-0.01	0.03	0.13	.35**	.48**				
11. Openness to Experience	.24**	.29**	.26**	-.21**	-.23**	-.23**	0.12	.23**	.24**	.13*			
12. Sex	-.21**	-.34**	-0.07	.26**	.23**	.24**	-0.01	-0.11	-0.03	.14*	-.16*		
13.Politics	-.23**	-.31**	-.19**	.33**	.28**	.33**	0.04	0.08	0.08	0.11	-.30**	.13*	
14. Age	.13*	.17*	.18**	-0.08	-0.03	-0.05	-0.11	.36**	.25**	.23**	0.13	-.15*	0.09

** p < .01, * p < .01.

Table 4. Correlations for Food Items in Studies 2-4.

	Study #	KAFS	AAS	EFC	4N	SPECIES	MCS	*Mean*	*SD*
Beef	2	-.38**	-.36**	-.16*	.52**	.24**	.5**	2	1.66
	3	-.28**			.35**	.17**	.45**	1.89	1.42
	4	.24**			.34**	.22**	.47**	3.59	1.25
Pork	2	-.36**	-.31**	-.07	.34**	.14*	.29**	1.2	1.38
	3	-.35**			.3**	.2**	.28**	1.21	1.25
	4	-.2**			.36**	.23**	.36**	2.39	1.3
Lamb	2	-.36**	-.25**	-.08	.15*	.09	.12	0.45	1.22
	3	-.34**			.13*	.04	.04	0.32	1.06
	4	-.18*			.19**	.17*	.15*	1.22	0.88
Chicken	2	-.18**	-.31**	-.13*	.49**	.27**	.55**	2.86	1.89
	3	-.17*			.25**	.16*	.31**	2.78	1.75
	4	-.06			.24**	.14*	.32**	4.2	1.84
Fish	2	-.26**	-.25**	-.06	.18**	.13*	.14*	1.35	1.52
	3	-.08			.07	-.05	.01	1.29	1.39
	4	-.1			.19*	.24**	.17*	2.11	1.23
Seafood	2	-.27**	-.22**	0.06	.15*	.09	.08	1.04	1.38
	3	-.13*			.07	-.08	.03	0.9	1.29
	4	-.14*			.13	.2**	.28**	1.76	1.11
Eggs	2	-.05	-.12	0.03	.25**	.05	.23**	2.71	2.13
	3	-.06			.13*	.09	.16*	2.92	1.29
	4	-.02			.14*	.1	.14*	4.19	2.09
Dairy	2	0	-.2**	-.08	.23**	.13*	.22**	4.35	2.33
	3	-.06			.05	.11	.19**	4.22	2.24
	4	-.02			.23**	.15*	.23**	5.98	2.17
Gestation	3	.23**			-.21*	-.28**	-.3**	63%	
	4	.22**			-.28**	-.35**	-.25**	59%	
Veal	3	.2**			-.38**	-.33*	-.49**	46%	
	4	.2**			-.28**	-.35**	-.25**	32%	
Protection	3	.14*			-.24**	-.16*	-.24**	77%	
	4	.2**			-.1	-.33**	-.2**	80%	
Mean	2	8.7	3.48	3.02	3.97	3.65	3.94		
	3	7.11			4.18	4	4.13		
	4	7.24			4.25	4.35	4.56		
SD	2	1.9	0.72	0.78	1.34	1.35	1.91		
	3	1.54			1.21	1.01	1.82		
	4	1.2			1.08	1.4	1.4		

** p < .01, * p < .05. Correlations for Study 4 are taken from the pre-test scores.

Table 5. Final model for the stepwise regression analyses for Study 2.

Food	Predictor	β	Adjusted R^2	F	P	R^2_{Change}	F_{change}	P F_{change}
Beef	4N	.22	.26	84.67	< .001	.27	84.67	< .001
	KAFS	-.17	.29	47.74	< .001	.03	8.18	.005
	Sex	.14	.3	34.74	< .001	.02	6.32	.01
	MCS	.22	.31	27.64	< .001	.01	4.84	.03
Pork	KAFS	-.24	.12	32.63	< .001	.12	32.63	< .001
	4N	.23	.16	22.44	< .001	.04	10.86	.001
Lamb	KAFS	-.31	.11	29.65	< .001	.11	29.65	< .001
	Sex	.13	.12	17.36	< .001	.02	4.61	.03
Chicken	MCS	.56	.31	104.16	< .001	.31	104.61	< .001
Fish	KAFS	-.18	.06	15.84	< .001	.06	15.84	< .001
	AAS	-.16	.08	10.64	< .001	.02	5.15	.02
Seafood	KAFS	-.26	.06	16.92	< .001	.07	16.92	< .001
Eggs	4N	.25	.06	15.55	< .001	.06	15.55	< .001
Dairy	4N	.31	.05	14.1	< .001	.06	14.09	< .001
	KAFS	.14	.06	8.98	< .001	.02	3.71	.05

unique predictor of consumption of animal products. To address this issue, a series of stepwise regressions was conducted using each of the food choices as outcome variables and all animal attitudes measures, the KAFS, sex, and politics as predictor variables. The final model for each stepwise regression analysis is reported in Table 5. For five of the seven criterion variables, knowledge was a unique predictor of animal consumption.[3] The KAFS was not a unique predictor of egg or chicken consumption and was a positive predictor of dairy consumption after controlling for the 4Ns.

Study 3

Study 2 provided evidence that the KAFS had construct validity and was a unique and often best predictor of consuming animal products. However, the 11-item instrument could be improved. Analyses from Study 2 suggested that two of the 11 items could be eliminated without loss of information while also improving model fit. Study 3 was designed to improve the instrument, replicate the findings of Study 2, and provide additional criterion items that the KAFS should predict.

Participants

Two hundred and eighty-nine participants were recruited from Amazon's Mechanical Turk. Thirty-four participants were excluded for not completing the survey. An additional 17 participants were excluded from criterion analyses because they did not complete those portions of the survey (e.g., did not respond to questions about the number of days per the average week they ate beef).

Materials

[3] Multicollinearity did not appear to be problematic in the regression analysis. Multicollinearity tolerances for all analysis in all studies were greater than .44 (*VIF* < 2.5).

Study 2 suggested that the KAFS could be modified to be shorter and a more effective predictor of relevant criteria. Items 5 and 9 were removed from the instrument in Study 3 mainly for three reasons. First, those two items were relatively easy and did not provide much unique information about knowledge relative to other items (i.e., the information they provided were also provided by other items). Second, item level correlations were conducted with the criteria, and those two items had no significant correlation with the criteria (and likely detracting from the scale's predictive power) (Item 5 *rs* -.11 - .13; Item 9 *rs* -.11 - -.03, *ps* > .05). Finally, item 9 was worded poorly and was likely to be confusing or vague to participants, possibly contributing to model misfit. After eliminating those two items, nine items remained in the KAFS.

The major animal-related instruments used in Study 2 were used in Study 3 except for the AAS and EFC. The main reason we did not use the AAS or the EFC was that the regression analyses in Study 2 suggested that the AAS and EFC were not unique, consistent predictors of animal product consumption.

Participants indicated how many days per the average week they ate animal products. Three additional behavioral intention criteria items were included that went beyond actual animal consumption. These additional items (No = 0, Yes = 1) were:

1. Would you be willing to sign a petition to ban gestation crates for pigs?
2. Would you be willing to sign a letter to your senator to ban veal?
3. Would you vote for a senator who wants to increase protections for farm animals?

Finally, participants received the TIPI and basic demographics information was gathered.

Results and Discussion

One assumption of the IRT model is unidimensionality. There are several methods to establish unidimensionality. We used a confirmatory factor analysis (CFA) in a structural equation model with weighted least squares. This is a tested practice for binary indicator variables such as those in the KAFS (McCallum, Zhang, Preacher, & Rucker, 2002). The CFA model specified each of the 9 KAFS items as indicator variables for a single knowledge of animals as food factor. One of the dominant fit indices for a CFA is the chi-squared goodness of fit index. A non-significant chi-squared value is indicative of acceptable model fit, which was found (χ^2 (36) = 42.98, p = 0.2). Other fit indices were evaluated. The *RMSEA* = 0.03, 90% confidence interval 0-.06 was acceptable (*RMSEA* ≤ .05, 90% *CI* 0 - .1 including 0) along with a non-significant *p-close test* = 0.9 (Kline, 2005). Hence, we can conclude for theoretical and empirical reasons that the KAFS is unidimensional.

Table 6. Correlations in Study 3

	1	2	3	4	5	6	7	8	9	10	11
1. KAFS											
2. 4Ns	-.38**										
3. Speciesism	-.21**	.42**									
4. MCS	-.34**	.74**	.49**								
5. Extraversion	-.12	.05	.08	.07							
6. Agreeableness	-.06	-.05	.02	-.01	.05						
7. Conscientiousness	-.15*	-.1	.01	-.01	.18**	.35**					
8. Emotional Stability	-.01	.03	.14*	0	.23**	.37**	.45**				
9. Openness to Experience	.17**	-.07	-.05	-.15*	0	.19**	.26**	.18**			
10. Sex	-.22**	.23**	.18**	.18**	.01	-.08	-.08	.17**	-.12*		
11. Politics	-.15*	.25**	.24**	.31**	.05	.05	.12*	.14*	-.21**	0	
12. Age	.05	-.02	.06	.02	.09	.11	.22**	.24**	.12*	-.14*	.09

** p < .01, * p < .05

Descriptive statistics for the 9-item KAFS are reported in Table 2. A two-parameter IRT model (*AIC* 1881.5, *BIC* 1945.25) demonstrated better fit to the data than a one-parameter model (*AIC* 1923.12, *BIC* 1959.53), (*LRT* = 58.61, *p* < .001). The two-parameter model also had acceptable fit to the data (all chi-squared values of the margins were < 3.5). The test information function is in Figure 2.

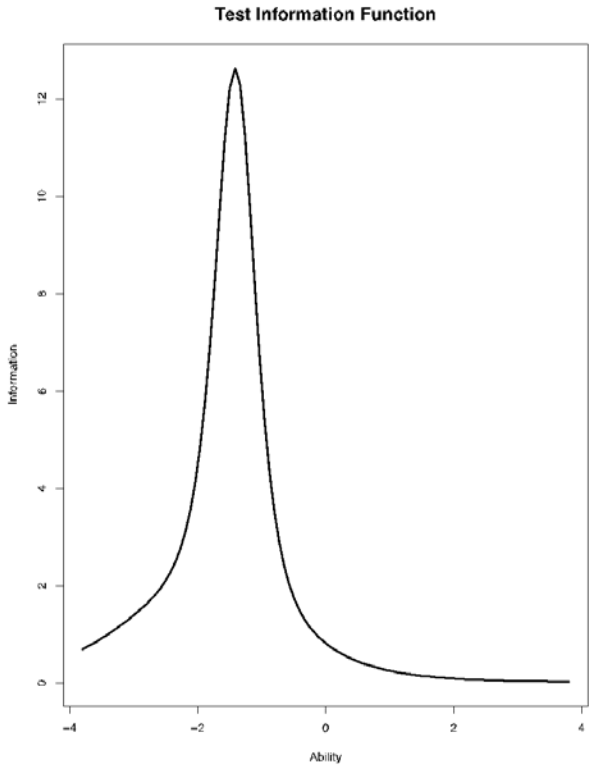

Figure 2. Test Information Function for Study 3

Next, a series of zero-order correlations were conducted (see Table 6). The KAFS was related to the 4Ns, Speciesism, and MCS scales in the predicted directions. The KAFS was related to both sex and political orientation in the predicted directions. The KAFS was also unrelated to personality except for conscientiousness. The relation with openness to experience was not replicated in Study 3, and the relation with conscientiousness was small and unexpected. So, the lack of relation with personality traits suggests discriminant validity.

The KAFS was negatively correlated with almost all items measuring how many days per the average week people consume meat and animal products, predicting consumption of beef, pork, lamb, chicken and seafood (but failing to predict eggs and dairy). Additionally, the KAFS was positively related to attitudes about banning

gestation crates, banning veal, and increasing protections for farmed animals.

As in Study 2, a series of stepwise regressions was conducted to determine if the KAFS was a unique predictor of animal consumption. The three animal attitudes scales, sex, politics, and KAFS were all entered as predictor variables and animal product consumption was entered as outcome variables. Again, the KAFS was often a unique or best predictor of animal consumption (see Table 7).

Study 4

Studies 1 - 3 suggested that the KAFS is a reliable and valid measure of knowledge of animals as food. Study 4 was designed to determine if one's knowledge of animals used as food as measured by the KAFS can change through education. If the KAFS measures knowledge, then performance on the scale should be relatively easy to change with educational interventions. To this end, Study 4 adopted a randomized, controlled, pre-test post-test experimental design to test the effectiveness of an educational infographic used by PETA. A secondary goal was to replicate the unique predictive ability of the KAFS on a sample drawn from undergraduates at a midwestern university. Given the design of the study, we did not attempt to measure changes in animal consumption as a function of change in knowledge since the pre- and post-test occurred in the same testing session (total session M = 17.66 minutes).

Participants

Two hundred and one participants were recruited from a midwestern university and received partial course credit. Three participants did not complete one part of the pre-/post-test and were excluded from the pre-/post-test analyses.

Materials

Table 7. Final model for the stepwise regression analyses for Study 3

Food	Predictor	β	Adjusted R^2	F	P	R^2_{Change}	F_{change}	P F_{change}
Beef	MCS	.4	.19	56.08	< .001	.19	56.08	< .001
	KAFS	-.13	.2	30.56	< .001	.02	4.26	.04
Pork	KAFS	-.25	.11	30.66	< .001	.12	30.66	< .001
	4n	.16	.14	19.68	< .001	.03	7.81	.006
	Sex	.15	.15	15.24	< .001	.02	5.6	.02
Lamb	KAFS	-.26	.08	21.73	< .001	.09	21.73	< .001
	Sex	-.13	.09	13.01	< .001	.02	4.02	.05
Chicken	MCS	.3	.08	22.55	< .001	.08	22.55	< .001
Fish	KAFS	-.11	.01	2.93	.09	.01	2.93	.09
Seafood	KAFS	-.21	.03	8.27	.004	.03	8.27	.004
	Species	-.14	.04	6.41	.002	.02	4.44	.04
Eggs	MCS	.15	.02	5.51	.02	.02	5.51	.02
Dairy	MCS	.33	.03	7.92	.005	.03	7.92	.005
	4N	-.2	.04	6.42	.002	.02	4.79	.03

Participants received the KAFS, the 4Ns, the MCS, and the Speciesism scale. Participants then responded to the same animal consumption items used in the previous experiments. Participants were asked the same behavioral intention questions that were used in Study 3. We also included the Berlin Numeracy Test (BNT). The BNT is a measure of numeracy, or one's ability to understand and apply statistical information. Numeracy as measured by the BNT has been shown to be one of the best domain-general predictors of good decision making (Cokely, Galesic, Schulz, Ghazal, & Garcia-Retamero, 2012; Cokely et al., 2018). Previous research has shown that educational interventions often help those who are the most numerate, so including the BNT allowed for estimating how superior decision making interacts with education with respect to the KAFS (Garcia-Retamero, Petrova, Feltz, & Cokely, 2018).

The major intervention was an infographic provided by People of the Ethical Treatment of Animals (infographic URL: http://www.petakids.com/wp-content/uploads/2014/07/truth-about-eating-animals-pkids.gif, Flesch-Kincaid 6th grade reading level). This infographic was selected because it was short, informative, and was an infographic that an organization has used to educate the public. It provided graphical information about some of the facts of animal production (e.g., tens of billions of animals are slaughtered in the U.S. every year). The infographic also included some non-factual, evaluative information (e.g., eating meat is murder). While the evaluative information was not a desired feature of the infographic, the trade-off between the evaluative information and using a "real" intervention was deemed to be positive. This infographic was matched with a roughly equivalent, neutral infographic about coffee beans (http://visual.ly/coffee-facts). Participants were randomly assigned to either the experimental (educational intervention, N = 98)) or the control (coffee bean, N = 99) conditions. Participants responded to all materials listed above before and after the intervention except for the food consumption items.

Results and Discussion

Planned analyses proceeded in several steps. First, we examined the relations among the KAFS, values instruments, food consumption, and behavioral intentions. As expected, the KAFS was related to the 4Ns (r (195) = .28, p < .001), Speciesism (r (195) = .13, p = .06), and the MCS (r (195) = -.2, p = .004) as well as most of the criterion variables (see Table 4).

As in the previous two studies, planned analyses attempted to replicate the unique predictive ability of the KAFS. A series of stepwise regressions was conducted that used each of the animal food consumption measures as dependent variables and the KAFS, sex, politics, and the three animal attitudes scales as predictor variables (see Table 8). The KAFS was often a unique predictor of lower animal consumption.

Table 8. Final model for the stepwise regression analyses for Study 4

Food	Predictor	β	Adjusted R^2	F	P	R^2_{Change}	F_{change}	P F_{change}
Beef	MCS	.44	.21	55.06	< .001	.22	55.06	< .001
	KAFS	-.15	.23	20.94	< .001	.02	5.55	.02
Pork	MCS	.34	.13	30.4	< .001	.14	20.4	< .001
	KAFS	-.14	.14	17.52	< .001	.02	4.16	.04
Lamb	N4	.19	.03	7.21	.008	.04	7.21	.008
	KAFS	-.14	.04	5.4	.005	.02	3.5	.06
Chicken	MCS	.35	.1	22.4	< .001	.1	22.4	< .001
	KAFS	-.13	.11	13.28	< .001	.02	3.84	.05
Fish	Species	.24	.05	11.94	.001	.06	11.94	.001
Seafood	Species	.2	.04	8.29	.004	.04	8.29	.001
Eggs	N4	.14	.02	4.1	.04	.02	4.1	.02
Dairy	N4	.23	.05	11.36	.001	.05	11.36	.001

Finally, we tested whether the educational infographic changed performance on the KAFS and values scales. We used a mixed-model analysis with the KAFS as the repeated measure and the infographic and BNT as between subject factors. BNT was included in the model because in other research, those who were more numerate were more likely to extract more numerically accurate information from simple, direct visual aids (Garcia-Retamero, Petrova, Feltz, & Cokely, 2018). Overall, performance increased from the pre-test (*M* = 7.25, *SD* = 1.18) versus post-test (*M* = 7.58, *SD* = 1.25) (*F*[1, 193] = 14.96, *p* < .001, η_p^2 = .07, pre-/post-test correlation = .6). As predicted, this change was the result of an interaction with the educational intervention. The performance on the KAFS of those in the control condition did not increase (*M* = 7.2, *SD* = 1.18 v. *M* = 7.36, *SD* = 1.34, pre-/post-test correlation = .69) as much as those who received the educational intervention (*M* = 7.3, *SD* = 1.19 v. *M* = 7.8, *SD* = 1.11, pre-/post-test correlation = .5) (*F* [1, 193] = 5.06, *p* = .03, η_p^2 = .03). An interaction was also found with BNT. Those low in BNT (*M* = 7.48 *SD* = 1.18 v. *M* = 7.61, *SD* = 1.25, pre-/post-test correlation = .6) performed worse than those who scored high on BNT (*M* = 7.05 *SD* = 1.13 v. *M* = 7.56, *SD* = 1.25, pre-/post-test correlation = .58) (*F*[1, 193] = 5.12, *p* = .03, η_p^2 = .03).

The three-way interaction of BNT and educational intervention was not significant (*F* < 1). But still, looking at the descriptive statistics is informative of the overall pattern of results. For ease of presentation, a difference score for pre-test and post-test knowledge scores was calculated. Those who were high in BNT and received the intervention had the largest increase on the KAFS (*M* = .63, *SD* = 1.25), whereas those low in BNT and did not receive the intervention increased the least (*M* = -.07, *SD* = 1.03). Those who were either high in BNT and did not receive the intervention (*M* = .33, *SD* = 0.94) or received the intervention but were low on the BNT (*M* = .33, *SD* = 1.11) performed roughly the same on the KAFS.

A final series of analyses were conducted to see if value-related judgments changed as a function of being provided with the educational intervention. These analyses were done on each of the value related items (4Ns, speciesism, meat commitment, and behavioral intentions). There were no reliable interactions with the educational intervention: 4N (F [1, 193] = 21. 95, p = .09, η_p^2 = .02); MCS (F < 1); Speciesism (F < 1); banning Veal (F < 1); banning gestation crates (F [1, 193] = 2.45, p = .12, η_p^2 = .01); increasing protections for farmed animals (F [1, 193] = 2.47, p = .12, η_p^2 = .01).

Finally, a set of analyses was conducted to determine if increased knowledge was related to changes in value related items. A series of difference scores for the pre-/post-test values measures were calculated. Then, a series of zero-order correlations was conducted to test for associations. The only reliable association was between the KAFS and the 4Ns (r (195) = -19, p = .007). This suggests that as one becomes more knowledgeable, attitudes consistent with the acceptability of eating animals decreases. All other associations were small and non-significant (-.04 - .03, ps > .41).

One might worry that demand effects are responsible for the increase in knowledge measured by the KAFS. That is, those who saw the infographic may have been alerted to the purpose of the study and that is responsible for the differences between the experimental and control conditions. Our data and experimental designs cannot rule out this possibility, but we think there are at least two reasons that speak against demand effects being worrisome in this case. First, even if there are demand effects, people know more in the post-test condition. It is hard to insincerely report knowledge (i.e., *true* belief). Second, we do not see values reliably change as a function of the educational intervention as one would expect if demand characteristics were present. Still, future research should explore the extent to which demand features are involved.

Implications of Knowledge About Animals as Food

In four studies, we developed the KAFS — an objective knowledge test of animals used as food. The scale demonstrated criterion validity by predicting animal consumption, convergent validity by being related to similar attitudes about animals, and discriminant validity by being unrelated to irrelevant personality traits. The KAFS was often a unique or best predictor of consumption of animal products compared to related attitudes about animal consumption (Studies 1 - 3). Study 4 showed that performance on the KAFS could be improved with a simple infographic whereas other, more value-laden attitudes did not significantly change as a function of the infographic. These results suggest that knowledge of animal consumption as measured by the KAFS is non-redundant, important predictor of animal product consumption.

Demonstrating that knowledge of animal used as food uniquely matters and having an adequate way to measure that knowledge has several important

psychological and ethical implications. It is commonly accepted that the right choice for people is one that fits with their own strongest values (Benn, 1976; Buchanan & Brock, 1989; Dworkin, 1981, 1988; Felsen, Castelo, & Reiner, 2013; Haworth, 1986; Mele, 1995). As our data indicate, meat-eaters do not know as much as vegans or vegetarians about animals used for food. That raises the possibility that meat-eaters are simply making a mistake about their food choices — mistake in the sense that they are engaging in behaviors that violate *their own* values (whatever they are). This means that providing information to people in a format that they can understand (e.g., simple infographics) could potentially lead to decisions that are more consistent with meat-eaters' values — values that could entail that they reduce or eliminate the consumption of meat and animal products.

If knowledge plays an important role in people's decisions to consume animals and if education can give people relevant knowledge, then there are at least two desirable upshots of an educational approach. First, we can simply avoid contentious ethical issues surrounding why people should value animals, what the best ethical arguments to prevent cruelty are, animal rights, etc. We need not prescribe the values that people ought to have. After all, at least from a psychological point of view (and probably an ethical point of view), there are a number of defensible and normal values that one can have. For example, one may simply value the taste of meat whereas others do not value the taste of meat. These values are equally permissible to have. There are also likely a number of different beliefs that one could have that are defensible and adaptive. One could believe that animals cannot feel pain, or one could believe that most food animals are raised in pastures. However, since knowledge involves true beliefs, there is not an equally permissible set of beliefs that one could have. It simply is false that animals cannot feel pain or that most food animals are raised in pastures.

Second, by providing information to people, there is the potential to promote ethically desirable outcomes like increasing people's autonomy. Autonomy is often taken to be a fundamental human value (Bentham, Burns, & Hart, 1996; Dworkin, 1988; Mill & Williams, 1993). While any well-specified definition of autonomy is contentious, all accounts in some way capture the central notion that autonomy involves people being self-determined and making informed decisions in accordance with their values (Dworkin, 1988; Mele, 1995). Improving knowledge helps promote autonomy and has been successfully implemented in other domains such as medicine and finance (Cokely & Feltz, 2014; Cokely et al., 2018; Feltz, 2015, 2016; Garcia-Retamero & Cokely, 2013, 2015a, 2015b). Hence, regardless of any changes in behavior, people would make more informed choices. That result is ethically desirable.

Limitations

It is still an open question if knowledge of animals used as food changes behaviors or if education can impart the relevant knowledge to play a role in decisions

about animal consumption. As we have noted, there is considerable evidence that people are often motivated to believe things that are consistent with their pre-existing views (Stanovich et al., 2013). Existing literature and some of the results from the current studies might bolster one's skepticism of the power of education. For example, research suggests that some people change their beliefs that animals do not have minds if they have a strong preference for eating animals (Bastian, Loughnan, Haslam, & Radke, 2012). Other evidence suggests that those who really think that eating meat is normal and desirable willfully ignore evidence suggesting that animal products are morally problematic (Piazza & Loughnan, 2016). Even the current studies suggested that educational interventions do not interact with behavioral intentions relevant to the treatment of animals. In this light, one may be skeptical of the power of informing individuals about the condition of animals. More work needs to be done to explore these issues.

Apart from the worry about the ability of knowledge to change behavior, there are several other limitations with the currents series of studies. First, the samples used may limit generalizability. Online and college undergraduate samples are somewhat different from the general population, and the samples we drew from are generally slightly more educated and computer literate than the average American. However, the online samples were roughly similar to the general American population (Gosling et al., 2004; Heen et al., 2014). Further, since we drew only from IP addresses in America, generalizing beyond Americans may be limited. Relatedly, the truth of some of the items may be geographically localized. For example, the correct answer to Item 10 of the KAFS could be different in different parts of the world.

Second, we used only one main set of items for criterion validity (i.e., number of days animal products are consumed per the average week). While this may limit the generalizability of the predictive ability of the KAFS, those are major behavioral outcomes concerning animal-related behaviors and follow recommendations for measuring animal consumption behaviors (Animal Charity Evaluators, 2016).

A third limitation is that the KAFS provides the most information for people with below average knowledge. This suggests that for those who know a lot about consuming meat and animal products, the KAFS will have relatively lower predictive ability. Future modifications of the KAFS may be required to have fidelity among high knowledge individuals.

A fourth limitation of our data is that they are mainly correlational. These correlational data are consistent with either knowledge causing people to eat fewer animals, eating fewer animals causing more knowledge, or some third factor causing both knowledge and reduction of consuming animal products (Study 4 was not designed to test causal relations for eating animals). We currently do not have the kinds of data to help tease out which causal model is correct, but we speculate that knowing more results in eating fewer animals since knowledge, or expertise, has been linked to superior,

different decisions across a host of domains (Cokely et al., 2018).[4]

Finally, one may worry that the way we have characterized knowledge of animals as food is too thin. For example, the KAFS has four items that mainly deal with the ways animals are treated (items 4, 6, 10, and 11) where the remaining items are about nutrition. One might worry that this way of operationalizing knowledge of animals used as food is too narrow — focusing largely on nutrition. Rather, the instrument should capture a wider range of beliefs about how animals are treated. We are very open to the possibility that more comprehensive instruments and more fine-grained instruments could be created. With this having been said, we think that the KAFS represents a significant step forward in measuring knowledge specific to animals used as food. Moreover, the IRT analysis and CFA from Study 3 suggested that these beliefs are unidimensional. Plus, the IRT methods afforded a very efficient instrument (a total of nine items that took on average one minute to complete). Given the unidimensionality of the construct, fewer, well-chosen items are likely to provide the same predictive power as larger, more complex instruments. So, while instruments that are more comprehensive in nature are possible, researchers will have to estimate benefits versus costs of developing larger, more fine-grained instruments to measure beliefs about animals as used as food.

Even given these limitations, we have provided an important step forward in understanding why people consume animal products. Knowledge, in addition to values and attitudes, is an important predictor of animal consumption. Knowledge is relatively easy to change. Educating people about animals used as food is a viable option for changing behavior or bringing behavior in line with deeply held values. In this way, the hope is that we can fully respect people as autonomous decision makers who can make fully informed, ethical decisions for themselves.

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[4] Work in our lab is currently actively exploring an experimental manipulation of knowledge with respect to consuming animal products.

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Appendix A

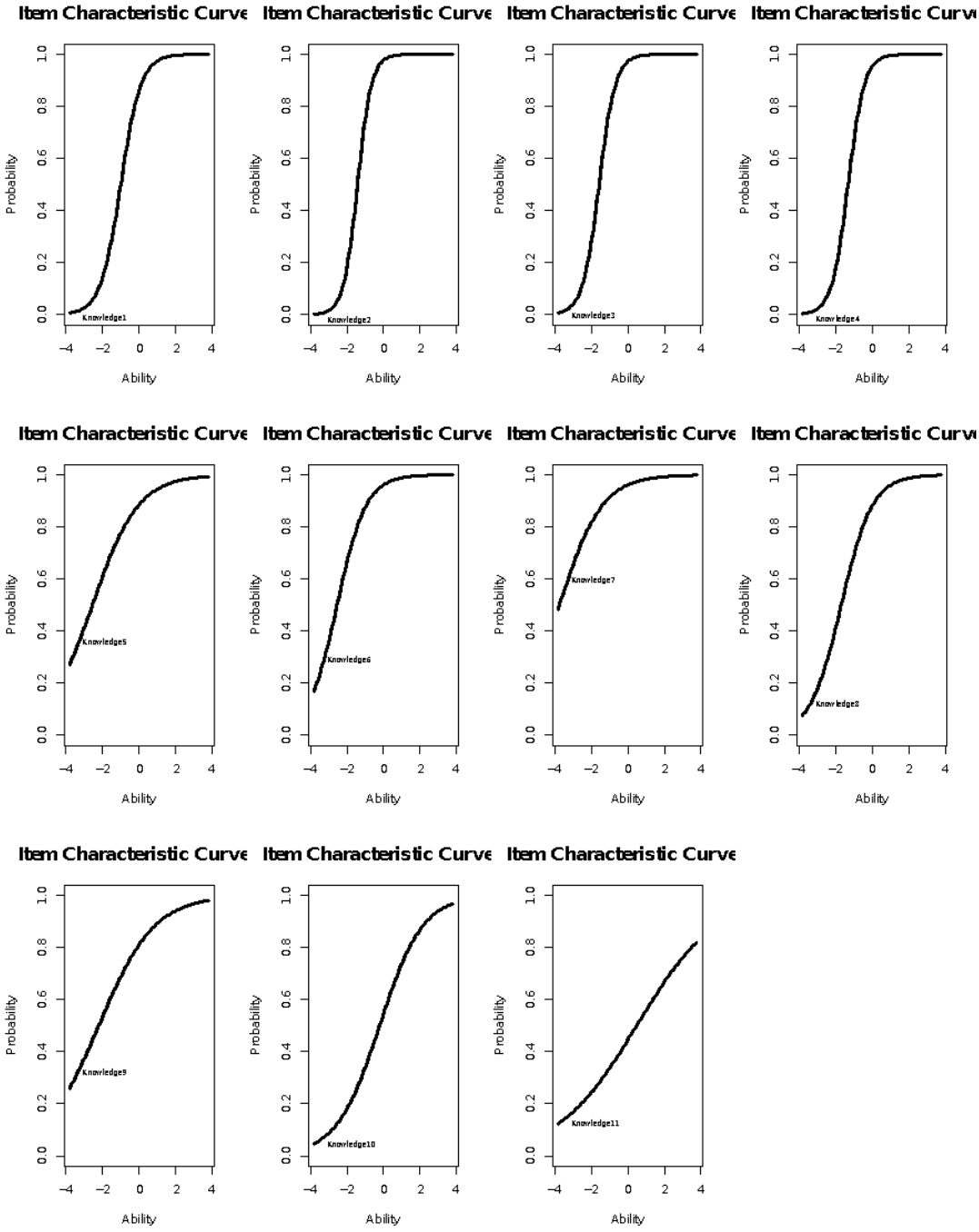
Knowledge of Animals as Food Scale in Study 2, 3 and 4

1. You must eat animals to have a healthy diet. (F)
2. The only way to have protein in your diet is to eat animals. (F)
3. Animal products are the only source of calcium. (F)
4. Most chickens used for food and eggs live in open spaces. (F)
5. *[*]From 2010 to 2015, over 9 billion animals per year were slaughtered for food in the U.S.*. (T)
6. In 2015, more than 25 million cows were slaughtered for food. (T)
7. Americans are in the top 5 in the world of meat consumption per person. (T)
8. Eating too much meat increases your risk of heart disease. (T)
9. *[*]Factory farming animals often leads to deformities in farmed animals. (T)*
10. Federal laws protect how poultry are slaughtered. (F)
11. More than 50% of pigs have pneumonia when they are slaughtered. (T)

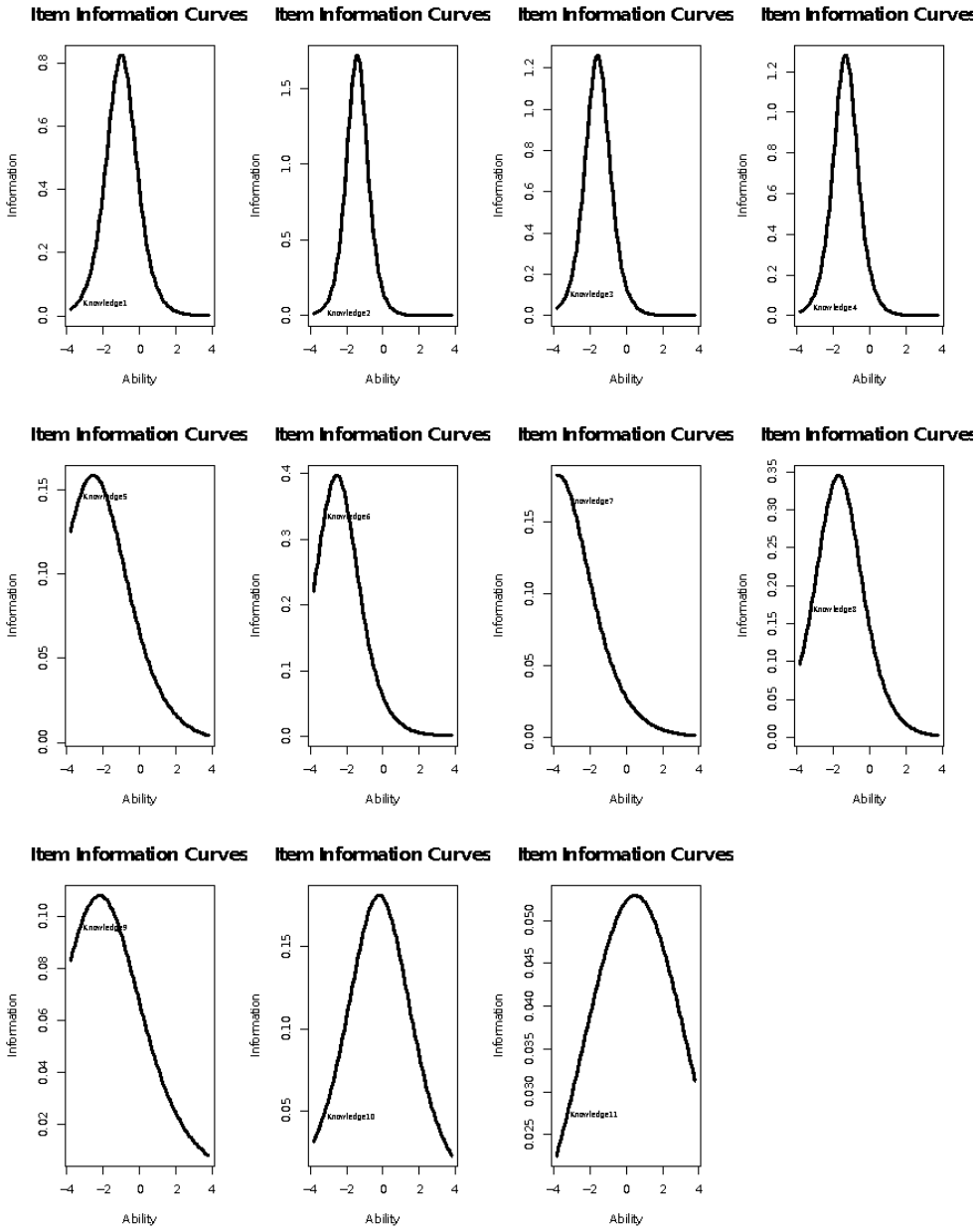
[*] Italicized items removed in Studies 3 and 4

Supplemental Materials

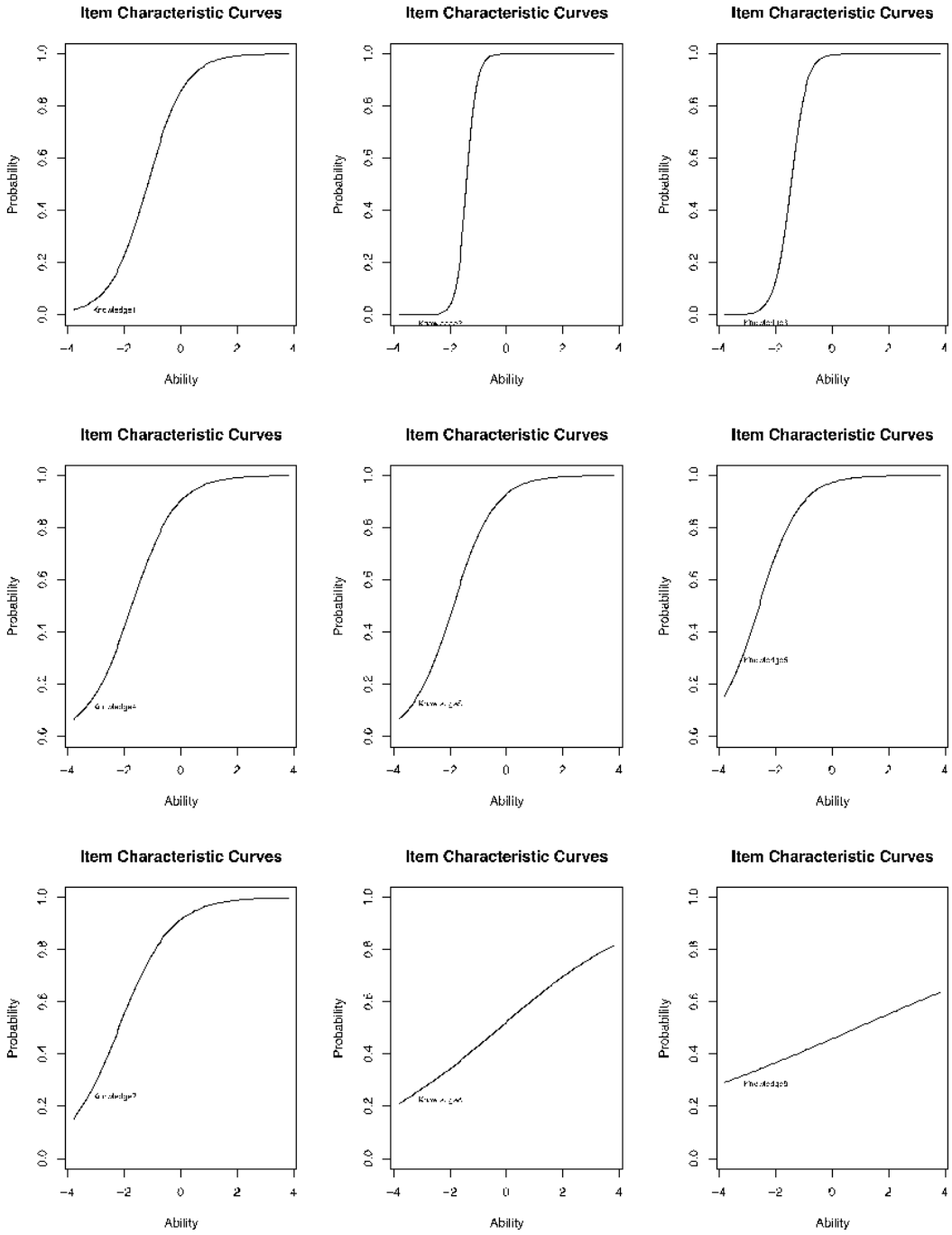
The following figures provide S-curve data for each of the four studies conducted.



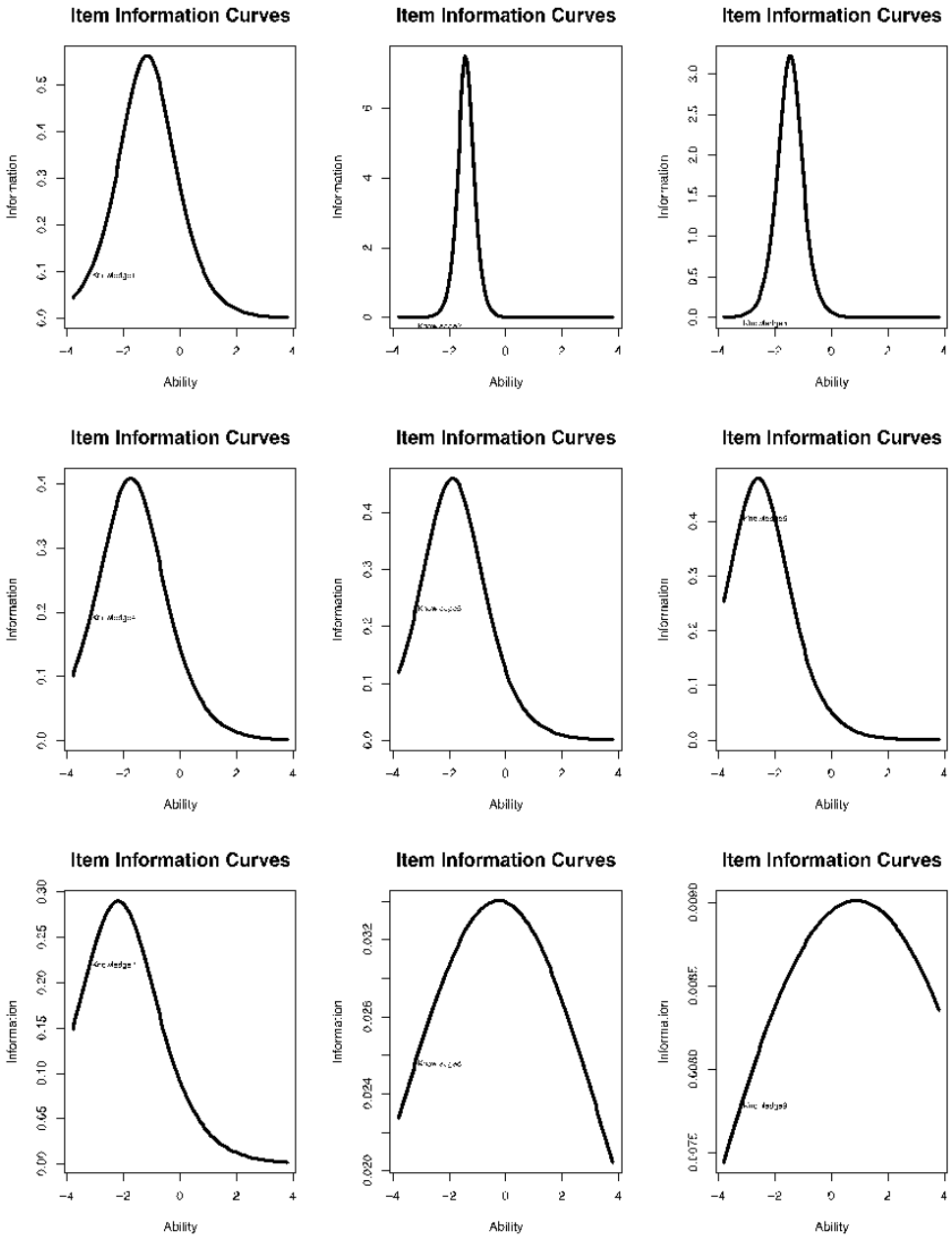
SI Figure 1. Item Characteristic Curves for Study 1.



SI Figure 2. Item information Curves for Study 2.



SI Figure 3. Item Characteristic Curves for Study 3.



SI Figure 4. Item information Curves for Study 4.