THREE ESSAYS EXAMINING THE EFFECTS OF INFORMATION ON CONSUMER RESPONSE TO CONTEMPORARY AGRICULTURAL PRODUCTION

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THREE ESSAYS EXAMINGING THE EFFECTS OF INFORMATION ON CONSUMER RESPONSE TO CONTEMPORARY AGRICULTURAL PRODUCITON

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Abstract: Future agricultural innovation and increases in the food supply may be limited by consumer aversion to food technology and factors associated with the concentration of production. The ability of agricultural innovators and producers to contribute to these pressing issues depends on how the public assimilates various information. The objective of this dissertation was to contribute to the understanding of consumer concerns about crop biotechnology and hen welfare in egg production and to examine the effect of information on those concerns. The results from this dissertation provide insight into beliefs and preferences for crop biotechnology and agricultural production methods and the effectiveness of advocacy and scientific information.

The first essay examined the results of a survey designed to determine voting intentions prior to the vote of Proposition 37 in 2012, a ballot initiative voted that would have required mandatory labeling of genetically modified foods. Overall, people had inaccurate knowledge about the prevalence of genetically engineered foods and findings suggested that the effectiveness of opposition advertising was likely a formative factor in the defeat of Proposition 37.

The second essay determined beliefs about crop biotechnology compared to a contemporaneous nonagricultural issue. The purpose was to determine the effects of prior beliefs on assimilation of scientific information and test several hypotheses about the manner in which people process scientific information about genetically modified food and global warming. Results indicated that assimilation of information is dependent on prior beliefs and that the failure to converge beliefs to information is a result of several factors.

The third essay amalgamated economics and neuroscience to examine choice and brain activity associated with the tradeoff between farm animal welfare and price. Commercials from advocacy groups surrounding the 2008 campaign of Proposition 2, a ballot initiative to increase the confinement space for some farm animals, were displayed to a number of subjects to determine if brain activation signals how information will be assimilated. Results suggested that the right dorsolateral prefrontal cortex had a larger role in the decision-making and was a better predictor of responsiveness to information than the right dorsolateral prefrontal cortex.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

Over the next forty years, population and per capita income are expected to increase 2.25 billion and 1.8-fold, respectively (Alexandratos and Bruinsma, 2012). Consumption in developing countries (e.g., India) will likely transition to meat-based diets due to increases in income over this period, and increases in meat demand will also increase the demand for feedstuffs. Fortunately, the increase in population over the next forty years is less than the population growth over the previous forty years, thus the growth rate of agricultural production does not necessarily need to increase. Nonetheless, available land and water resources are ever more constrained and this constraint beckons for increases in food technology and concentration of production.

The agricultural community has responded to increased pressure on the food supply by improving plant breed practices, including the creation of Genetically Modified Organisms (GMOs), and modernizing farm animal facilities, including cage systems for egg production. However, future agricultural innovation and increases in the food supply may be limited by consumer aversion to food technology and factors associated with the concentration of production. These aversions are evident by increases in options provided by the market (e.g., non-GMO verified products and products differentiated by

production systems providing more space for farm animals) and relatively recent legislation, successfully passed or not.

The objective of this dissertation was to contribute to the understanding of consumer concerns about crop biotechnology and hen welfare in egg production and to examine the effect of information on those concerns. The first essay, found in Chapter 2, examined the results of a survey designed to determine Californians' voting intentions prior to the vote of Proposition 37 in 2012, a ballot initiative in California that would have required mandatory labeling of GMO crops and animals. It was the first major public vote to transition from voluntary to mandatory labeling of GMO foods in the United States. Opposing advocacy groups provided information to citizens in an attempt to influence the vote outcome. Subjects of the survey were exposed to a commercial by one advocacy group and the effectiveness of information on voting intention was observed.

The second essay, found in Chapter 3, determined beliefs about crop biotechnology compared to a contemporaneous nonagricultural issue (i.e., global warming). Subjects of this survey were provided scientific information about both crop biotechnology and global warming. Change in perception was measured to examine the effectiveness of scientific information and to determine if information assimilation was a function of beliefs prior to receiving the information.

The third essay, found in Chapter 4, amalgamated economics and neuroscience to examine choice and brain activity associated with the tradeoff between farm animal welfare and price. Subjects made decisions between two egg products that varied by production method and price while in a functional magnetic resonance imaging machine

(fMRI). Commercials from advocacy groups surrounding the 2008 campaign of Proposition 2, a ballot initiative in California to increase the confinement space for some farm animals, were displayed to a number of subjects to determine if brain activation signals how information will be assimilated.

The ability of information, either from advocacy groups or scientists, to contribute to these pressing issues faced by agricultural innovators and producers depends on how the public assimilates various information. The results from this dissertation provide insight into beliefs and preferences for crop biotechnology and agricultural production methods and the effectiveness of advocacy and scientific information.

CHAPTER II

EFFECTS OF COST AND CAMPAIGN ADVERTISING ON SUPPORT FOR CALIFORNIA'S PROPOSITION 37

On November 6, 2012, Californians voted on Proposition 37 (hereafter Prop 37), a ballot initiative that would have required mandatory labeling of raw or processed food made from genetically engineered (GE) plants or animals. California is one of the largest states in terms of both agricultural imports and exports; Prop 37 was therefore thought to be the first major policy attempt to transition from voluntary to mandatory labeling of GE foods in the United States. Some economists warned that the proposition could result in restricted choice and serve as a regressive food tax on the poor and elderly (Alston and Sumner, 2012; Carter et al., 2012; Kalaitzandonakes and Lusk, 2012), while advocates claimed the proposition would give the consumers "the right to know" at a minimal cost (Pino, 2012; Boxer, 2012).

Many experiments have shown that consumers are willing to pay to avoid GE foods (e.g., Lusk et al., 2001; Noussair et al., 2002; Huffman et al., 2003; Tonsor and Schroeder, 2003; Van Wechel et al., 2003; Lusk et al., 2004; Noussair et al., 2004), and other analyses have used consumer preferences to infer implications for GE food-labeling policies (e.g., Teisl, Bockstael, and Levy, 2001; Dhar and Foltz, 2005; Hu, Veeman, and

and Adamowicz, 2005; Lusk et al., 2005; Rousu et al., 2007). An implicit assumption when using experimental data to infer preferences for policies is that the same underlying preferences drive both decisions.

However, it has been argued that the factors motivating voting and purchasing decisions often differ. As Brooks and Lusk (2012) or Hamilton, Sunding, and Zilberman (2003) demonstrate, purchasing behavior may not reflect voting behavior. This behavioral dissonance is often referred to as the "citizen versus consumer" conflict, although Brooks and Lusk (2012) point out that it is not always the case that consumers demand more regulation than their shopping behavior would suggest.

Prop 37 failed to pass, with 51.4% (6,442,370) of Californian voters opposing the ballot measure. The result astounded many observers, as virtually every poll leading up to the election indicated the proposition would pass. Support for Prop 37 repeatedly polled around 70% until less than a month before the election. The reasons for the sudden decline in voter intentions are unknown, but information from advocacy groups likely had some effect.

In the weeks just prior to the election, both opponents and supporters of Prop 37 communicated information about the possible outcomes of the proposition through media campaigns. Some supporters of Prop 37 blame the change in voter intentions on the deep pockets of biotechnology corporations that produce GE seed and food companies that use GE ingredients. This belief is not completely unfounded, as opponents of Prop 37 raised almost $45 million compared to the almost $11 million raised by supporters (California Secretary of State, 2013).

It is likely that consumers used advocacy information about Prop 37 to update prior knowledge about GE foods. Previous experiments have examined how consumers' willingness-to-pay (WTP) is influenced by benefit/risk information about food technologies (Fox, Hayes, and Shogren 2002; Lusk et al., 2004; Rousu and Shogren, 2006; Marette et al., 2008; Rousu and Lusk, 2009); however, many of these studies did not incorporate the types of advocacy information actually used by activist organizations in the "real world." Many (if not most) of the campaign information disseminated about Prop 37 had little to do with the benefits and risks of GE foods *per se*. Rather, opponents' ads focused on the labeling contradictions of the proposition and the likely costs, while supporters' ads focused on the deception of large corporations and consumers' "right to know." Notable exceptions are studies by Marks et al. (2003) and Kalaitzandonakes, Marks, and Vickner (2004), which examined media coverage of GE foods and its influence on consumer choice. However, these analyses were not related to a specific policy. Due to the "consumer vs. citizen" issue, it is not clear that WTP studies will reveal how consumers will vote on an issue or how sensitive votes are to information.

This study examines the intended voting behavior of Californians and determining: 1) how consumers intended to vote on Prop 37 before the actual vote; 2) the sensitivity of voting intentions to potential increases in food costs; 3) the effects of opponent and supporter advertisements on voting intentions; and 4) how prior perceptions of GE foods and socioeconomic characteristics affect voting behavior and response to information. Overall, this study reveals insights that help explain how prior perceptions and advocacy advertising affected voting intentions and ultimately ended in the failure of Prop 37.

Survey Questions, Methods, and Summary Statistics

Five weeks before the election, September 20--27, 2012, we administered a survey to a random sample of Californians chosen from an online panel maintained by Qualtrics© and their associated partners. The completed sample included 1,003 Californians. Although online surveys have disadvantages related to potential weaknesses in representativeness, the online platform allowed us to show actual television advertisements from opponents and supporters of Prop 37 and measure their effectiveness.

Survey questions, described in more detail in subsequent sections, were asked in the following order: 1) voting intention on Prop 37 (*Initial Vote*); 2) respondents in support of Prop 37 and a mandatory label were then asked a contingent valuation (CV) question to determine WTP for a mandatory label (*WTP Vote*); 3) a series of questions to determine perceptions about the proliferation of GE crops and ingredients in the U.S. food supply (*Perceptions about the Proliferation of GE Crops and Ingredients*); 4) voting intention on Prop 37 after viewing either an anti-Prop37 advertisement or a pro-Prop 37 advertisement (*Advertisement Vote*); and 5) a series of demographic questions.[1] A complete list, description, and means of all dependent and independent variables used in model estimation can be found in Table 2.1. It should be noted that the sample is slightly younger and more educated than the average U.S. citizen.

[1] The analysis was conducted both by focusing only on those people who intended to vote in the November election and using weights for county size. The findings were virtually identical to the full sample results; as such, we report the results for the full sample.

Perceptions about the Proliferation of GE Crops and Ingredients

Respondents were asked two series of questions to determine their perceptions about the proliferation of GE crops and ingredients in the U.S. food supply. The first questions asked, "In the United States, what percent of CORN acres are planted with genetically engineered seed?" Participants responded by choosing a number that ranged from 0% to 100% in intervals of 5%. Respondents answered similar questions for soybeans and wheat. The second series of questions asked, "Do any Coca-Cola and/or Pepsi products contain genetically engineered ingredients?" Response categories were "Yes," "No," and "I don't know." Respondents answered similar questions for Frito-Lay, Kashi, and Kellogg.

Across respondents, the average percentage of corn, soybean, and wheat acres believed to be planted with GE seed was 48%, 47%, and 45%, respectively. In 2012, 88% and 93% of all corn and soybean acres planted were GE according to the USDA; however, there is no commercial production of GE wheat in the United States at present (USDA, 2012). Only 11.2% and 12.2% of respondents said they thought more than 85% of corn and soybean acres were GE, and only 4.9% of respondents correctly stated that 0% of wheat acres were GE. We found that 31%, 45%, 21%, and 41% of respondents said "Yes" that Coca-Cola/Pepsi, Frito Lay, Kashi, and Kellogg sell at least one product that contains GE ingredients. However, all these brands sell products that contain or have contained GE ingredients.

The models included two explanatory variables designed to measure perceptions about the extent of GE use in the food-supply chain. Answers to questions about the percentage of corn, soybean, and wheat acres believed to be planted with GE seed were

summed for each respondent to create a variable (*GE Crops*). *GE Crops* ranges from 0 to 3 in intervals of 0.05 and provides an index related to perceptions about prevalence of GE seed in U.S. crop production. A higher number indicates a belief that GE is more widely adopted. In terms of perceptions about the GE content of retail food products, indicator variables equal to 1 were created for each major food brand (Coke/Pepsi, Frito-Lay, Kashi, or Kellogg's) if a respondent believed the brand sold a product that contained GE ingredients and 0 for each brand not believed not to have a product containing GE ingredients. The indicator variables were summed for each respondent to create a measure of prior belief about the use of GE ingredients in food products (*GE Products*). *GE Products* ranges from 0 to 4. *A priori*, the effect of perceptions about prevalence of GE crops or food on voting behavior is unknown; it is plausible that a belief in high prevalence may increase or decrease demand for a mandatory label. In addition to the belief measures, the regressions include age, education, gender, income, and political ideology as independent variables.

Initial Vote

Respondents were asked about their Prop 37 voting intentions using text provided in the California Voter Information Guide. A "YES" vote mandates a label and a "NO" vote maintains the status quo of voluntary labeling. Of the sampled California respondents, 75.4% intended to vote "YES" on Prop 37. This result does not mirror the actual outcome, as Prop 37 ultimately failed to pass; however, as shown in figure 1, most major polls (including this one) leading up to the election indicated that Prop 37 would pass. The California Business Roundtable was the only poll that indicated Prop 37 would fail,

and that particular poll occurred just six days prior to the election and conflicted with the results of the previous seven polls conducted.

WTP Vote

Although the precise change in food costs caused by Prop 37 was unknown, opponents and supporters agreed that food costs would increase by *some* amount. Following the one-and-a-half bound CV format discussed in Cooper, Hanemann, and Signorello (2002), we sought to determine WTP for a mandatory label by asking the follow-up question: "Would you still vote "YES" on Proposition 37 if you knew it would increase food costs by <<*Cost*>>%?" to respondents who initially said they intended to vote "YES" on Prop 37. *Cost* randomly varied from 5 to 25 across respondents and had a mean of 15.08.

The number of respondents intending to vote "YES" on Prop 37 after being asked the CV question was nearly halved, decreasing from 756 to 388. Figure 2 displays the percentage of respondents for each *Cost* that intended to vote "NO" after the CV question. More than 30% of respondents intended to vote "NO" at lower *Cost* values, and, as expected, the percentage of respondents intending to vote "NO" increased at higher *Cost* values. This result indicates that demand for a mandatory labeling policy is price sensitive.

Advertisement Vote

At the time the survey was developed, there were only two television advertisements that had been made public (No on Prop 37, 2012; Yes on Prop37, 2012). We randomly assigned half of the subjects to each of the two advertisement treatments. After viewing

one of the two advertisements, respondents were asked to vote on Prop 37 again. The anti-Prop 37 advertisement (No on Prop 37, 2012) focused on the exemptions or "loopholes" provided by Prop 37, including the exemption of prepared food, while the pro-Prop 37 advertisement (Yes on Prop37, 2012) focused on the deceptions of large industries like Big Tobacco and then referenced Monsanto to suggest that consumers should mistrust GE technology.

Figure 3 shows the effects of the advertisement treatments. Of 503 respondents assigned to the anti-Prop 37 advertisement treatment, 375 (74.5%) initially intended to vote "YES." After viewing the No on Prop 37 advertisement, 95 respondents changed their vote from "YES" to "NO" and 16 respondents changed their vote from "NO" to "YES," decreasing the intended "YES" vote by 15.7%. Of 500 respondents assigned to the pro-Prop 37 advertisement treatment, 381 (76.2%) initially intended to vote "YES." After viewing the pro-Prop 37 advertisement, 36 respondents changed their vote from "NO" to "YES" and 38 respondents changed their vote from "YES" to "NO," *decreasing* the intended "YES" vote by 0.4%.

Econometric Modeling and Results

Vote Models

A binary probit model was estimated using the data from the initial vote (before cost or advertising information was introduced) as a dependent variable (*Initial Vote*). The assumption that the parameter estimates for both treatments were equal was a valid concern when combining data from two treatments (i.e., the two campaign advertisement treatments) to estimate models. Therefore, log-likelihood ratio tests estimated to test

whether combining the data was appropriate were conducted for all models. As expected (due to random assignment to treatment), there were no significant differences in estimates prior to the videos. We therefore do not report separate estimates related to the *Initial Vote* model.[2]

Only respondents who voted "YES" on the initial vote question were presented with a follow-up cost question. As a result, there are three possible voting outcomes ("NO"; "YES, NO"; and "YES, YES"). We estimated an econometric model based on the probability of falling into each of these three categories as a function of cost, demographic characteristics, and perceptions. Following the approach of Cooper, Hanemann, and Signorello (2002), the probabilities for "NO" (π_i^{NO}); "YES, NO" ($\pi_i^{\text{YES},NO}$); and "YES, YES" ($\pi_i^{\text{YES},YES}$) responses for the i^{th} respondent are given by

(1) $$\pi_i^{NO} = \text{Prob}\{WTP_i \leq 0\%\} = 1 - \Phi(0\%; \boldsymbol{\beta}_{V2}, \gamma),$$

(2) $$\pi_i^{\text{YES},NO} = \text{Prob}\{0\% \leq WTP_i \leq Cost_i\%\} =$$

$$\Phi(0\%; \boldsymbol{\beta}_{V2}, \boldsymbol{\gamma}) - \Phi(Cost_i\%; \boldsymbol{\beta}_{V2}, \gamma),$$

(3) $$\pi_i^{\text{YES},YES} = \text{Prob}\{WTP_i \geq Cost_i\%\} = \Phi(Cost\%; \boldsymbol{\beta}_{V2}, \gamma),$$

[2] The null hypothesis that the parameter estimates for the two treatments are equal was not rejected at a 0.05 significance level by a Chi-square test. The combined model had a log-likelihood function value of -543.18, whereas the separate models had values of -275.91 and -265.26. The test statistic is 2*(543.18-541.17)=4.02, which is a distributed chi-square with eight degrees of freedom; the 0.05 critical chi-square value with eight degrees of freedom is 15.51.

where WTP_i is the true unobserved WTP for respondent *i*, $Cost_i$ is the increase in food cost random assigned to respondent *i*, $\boldsymbol{\beta}_{V2}$ is a vector of coefficients to be estimated for explanatory variables in vector $\boldsymbol{X}$, and γ is an additional coefficient to be estimated for *Cost*. The coefficients are estimated using maximum likelihood. The log-likelihood function is

$$(4) \quad \ln L(\boldsymbol{\beta}_{V2}, \gamma) = \sum_{i=1}^{1,003}\{I_i^{NO}[1 - \Phi(0\%; \boldsymbol{\beta}_{V2}, \gamma)] + I_i^{\text{YES,}NO}[\Phi(0\%; \boldsymbol{\beta}_{V2}, \gamma) - \Phi(Cost_i\%; \boldsymbol{\beta}_{V2}, \gamma)] + I_i^{\text{YES,}YES}[\Phi(Cost\%; \boldsymbol{\beta}_{V2}, \gamma)]\},$$

where $I_i^{NO} = 1$; $I_i^{\text{YES,}NO} = 1$; or $I_i^{\text{YES,}YES} = 1$ if respondent *i* responded "NO"; "YES, NO"; or "YES, YES" to the two voting questions.

Mean WTP for a mandatory label was calculated using the variable means in vector $\boldsymbol{X}$ and the coefficients from the estimated model. Specifically, mean WTP was calculated by

$$(5) \quad WTP^{mean} = -\frac{\bar{\boldsymbol{X}}'\boldsymbol{\beta}_{V2}}{\gamma}.$$

As before, we tested whether it was appropriate to pool the data across the two campaign advertisements and failed to reject the null hypothesis that the parameter estimates were equal at a 0.05 significance level.[3] These results reconfirm that assignment of participants to the two advertising treatments was indeed random.

[3] The combined model had a log-likelihood function value of -1108.40, whereas the separate models had values of -574.67 and -533.73. The test statistic is 2*(1108.40-1108.40)=0, which is a distributed chi-square with eight degrees of freedom; the 0.05 critical chi-square value with eight degrees of freedom is 15.51.

A binary probit model was estimated using the data from the vote after advertising information was introduced as a dependent variable (*Advertisement Vote*). Unlike the two previous models, combining the data for the two campaign advertisement treatments was not appropriate, because the null hypothesis that the parameter estimates for the two treatments were equal was rejected at a 0.05 significance level.[4] This result implies that the different television ads had significantly different effects on voting outcomes.

Vote Models Results

Table 2.2 shows the results for the five models estimated to determine the effects of GE prevalence perceptions and demographics on intended vote for Prop 37. The *Political Ideology* coefficients were negative across all models, indicating that self-identified conservatives were significantly less likely to vote "YES" on Prop 37 (and by implication, liberals were more likely to vote "YES"). This result is consistent with the theory that, in general, conservatives vote against policies that reflect a "nanny" state. The *GE Products* coefficients were positive across all models, indicating that respondents who believe popular brands include GE ingredients in food products were more likely to vote "YES" on Prop 37. The *Gender* coefficients were positive and significant in all models except the anti-Prop 37 *Advertisement Vote* model, indicating that females were more likely to vote "YES" on Prop 37.

[4] The combined model had a log-likelihood function value of -616.16, whereas the separate models had values of -326.10 and -267.48. The test statistic is 2*(616.16-593.58)=45.16, which is a distributed chi-square with eight degrees of freedom; the 0.01 critical chi-square value with eight degrees of freedom is 20.09.

The *Cost* coefficient and was negative and significant, indicating that possible increases in the price of food caused by Prop 37 decreased the likelihood that a respondent would vote in favor of the mandatory labeling policy. The mean WTP for a mandatory label was 13.8%.[5] Thus, if food costs were projected to increase less (more) than 13.8% as a result of the policy, Prop 37 would pass (fail). It should be noted that this estimated mean WTP for a mandatory label is likely inflated, for at least two reasons. First, the CV question was hypothetical, and there is abundant evidence that individuals tend to inflate their WTP in hypothetical surveys compared to real-money experiments (Loomis, 2011). A common practice in the CV literature is to apply a calibration factor to estimated WTP values, with a value of two being suggested by the NOAA panel (Arrow et al., 2003). Applying this factor to our estimate would imply a mean WTP of 13.8/2 = 6.9%. Secondly, in the present study, more respondents indented to vote "YES" than were observed in the actual vote. This would also exaggerate mean WTP.

The decrease in support of Prop 37 leading up to the election may be due to fears of possible increases in food costs or an indication of the effectiveness of the media campaign by opponents of Prop 37. After viewing the anti-Prop 37 advertisement, 79 respondents changed their vote to "NO." This is a large change in intended voting considering the sample size assigned to this video was 503; equaling a change in intended voting behavior of approximately 16%. Thus, it is no surprise that the Pearson's Chi-squared test statistic is significant at a level of less than 0.001. We conclude that the No

[5] Mean WTP was calculated at variable means and is normally distributed; therefore, mean WTP and median WTP are equivalent. When using predicted respondent WTP, mean WTP was 13.3% and median WTP was 12.4%.

on Prop 37 advertisement significantly affected the frequency distribution of intended votes.

Voting intentions changed little after respondents viewed the pro-Prop 37 advertisement. Counter to intuition, more respondents actually intended to vote "NO" after viewing the pro-Prop 37 advertisement. Although the pro-Prop 37 advertisement had a negative effect, it was extremely small, with only 0.4% switching from "YES" to "NO," and the null hypothesis of independence could not be rejected. Consequently, these findings indicate that one advertisement (anti-Prop 37) was extremely effective in changing the voting intentions of respondents while the other (pro-Prop 37) was ineffective, if not counter-productive to the advertiser's aim. Taken together, these findings are perplexing, but the outcome of the actual election did coincide with and possibly confirm the findings.

Change in Vote Models

Only respondents who initially intended to vote "YES" on Prop 37 were asked the CV question; thus the only possible change in voting intention was from "YES" to "NO." An indicator variable equal to 1 was created for respondents who changed their vote after the CV question, 0 if there was no change in vote. The indicator variable was used as a dependent variable (*WTP Vote Change*) to estimate a binary probit model.

Reporting separate *WTP Vote Change* models for the two campaign advertisement treatments was not necessary, because the null hypothesis that the difference in parameter

estimates for the two treatments is equal to zero was not rejected at a 0.05 significance level.[6]

Each respondent voted on Prop 37 before and after viewing a campaign advertisement. Therefore, a respondent's intended vote could change from "YES" to "NO" or from "NO" to "YES." If a respondent's intended vote changed in a way that corresponded with the advertisement treatment (e.g., a respondent that viewed the No on Prop 37 video changed his or her intended vote from "YES" to "NO"), an indicator variable was coded as a 1; if a respondent had a change in intended vote that contradicted with the advertisement treatment (e.g., a respondent that viewed the No on Prop 37 video changed intended vote from "NO" to "YES"), an indicator variable was coded as a -1; the indicator variable was coded as a 0 for no change in intended vote. The indicator variable for change in intended vote after campaign advertisement was used to estimate an ordered probit model.

Separate ordered probit models were estimated for each campaign advertisement treatment, as the null hypothesis that the difference in parameter estimates for the two treatments is equal to 0 was rejected at a 0.05 significance level.[7] Additionally, an

[6] The combined model had a log-likelihood function value of -474.77, whereas the separate models had values of -228.97 and -241.10. The test statistic is 2*(474.77-470.07)=9.4, which is a distributed chi-square with eight degrees of freedom; the 0.05 critical chi-square value with eight degrees of freedom is 15.51.

[7] The combined model had a log-likelihood function value of -588.01, whereas the separate models had values of -306.72 and -259.90. The test statistic is 2*(588.01-

Advertisement Vote Change model was estimated using an indicator variable for advertisement treatment to examine whether change in vote was effected by a particular advertisement. The variable *Video* is equal to 1 if a respondent was randomly assigned to the Yes on Prop 37 advertisement treatment and 0 if a respondent was randomly assigned to the No on Prop 37 advertisement treatment.[8]

Change in Vote Models Results

Table 2.3 shows results for the four models estimated to determine the effects of prior perceptions and demographics on change in intended vote. *Gender*, *Income*, and *GE Products* were all significant and negative in the *WTP Vote Change* model. Therefore, respondents who are males, have a lower income, and believe major food brands do not use GE ingredients were more likely to change voting intention from "YES" to "NO" after being presented with the possibility that Prop 37 would result in an increase in food costs. This indicates that respondents with these characteristics have a lower WTP for a mandatory labeling policy. The *Cost* coefficient was positive and significant, indicating that respondents were more likely to change their voting intentions as food costs

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566.62)=42.78, which is a distributed chi-square with eight degrees of freedom; the 0.01 critical chi-square value with eight degrees of freedom is 20.09.

[8] Including *Video* into the *Advertisement Vote Change* model did provide a better fit at the 0.01 significance level. The test statistic is 2*(588.01-568.99)=38.04, which is a distributed chi-square with one degree of freedom; the 0.01 critical chi-square value with one degree of freedom is 6.63.

increased. This confirmed the previous finding that demand for a mandatory food-labeling policy is price sensitive.

Video and *GE Products* were the only variables significant in any of the advertisement vote-change models. The *Video* coefficient was negative and indicates that respondents who viewed the anti-Prop 37 advertisement were more likely to change their voting intentions in a way that corresponded with the treatment. This result jointly signals the effectiveness of the anti-Prop 37 advertisement and the ineffectiveness of the Yes on Prop 37 advertisement.

The *GE Products* coefficient was negative and significant for the No on Prop 37 *Advertisement Vote Change* model; this was the only variable significant in both the change in vote after the CV question and after an advertisement. Therefore, respondents who believed that major food brands use GE ingredients were less willing to change their voting intention to "NO."

Conclusions

On November 6, 2012, Prop 37 failed to pass by margin of 2.9%. If Prop 37 had passed, raw or processed food made from GE plants or animals would have required a label. Using data from surveys of 1,003 Californians, this study identified intended voting behavior of Californians on Prop 37 before the election. Results indicated that 75.4% of respondents intended to vote "YES" on Prop 37. Obviously, this result is 28.3% higher than what was actually observed in the election. However, at the time of the survey, other polls also showed the "YES" vote to be over 65%.

This study examined the statistical relationship between prior perceptions about GE crops/foods and intended voting behavior. Results imply a dearth of knowledge on the part of Californian respondents about the proliferation of GE crops sown for production and the inclusion of GE ingredients in major brand name foods; however, respondents who believed that major food brands use GE ingredients were more likely to desire a mandatory labeling policy. This finding was consistent with the rhetoric that proponents of Prop 37 are intrinsically more likely to believe there is a "right" to know relative to others. Women and respondents who self-identified as liberal were also more likely to vote "YES" on Prop 37.

If a mandatory food-labeling policy were to pass, food costs would likely increase by some amount. Possible increases in food costs provided strong motivation for a respondent to change voting intention from "YES" to "NO," as nearly half of the respondents who were formerly in favor changed voting intention after being asked a CV question eliciting WTP for the mandatory labeling policy. Respondents who are low-income, male, and did not believe that major food brands use GE ingredients were especially sensitive to food price increases

Campaign advertising may have played a large role in the failure of Prop 37. Results indicate that a campaign advertisement by opponents of Prop 37 was effective in changing voting intention, while a campaign advertisement by supporters of Prop 37 had a slightly perverse effect. Moreover, other than believing that major food brands used GE ingredients, viewing the anti-Prop 37 advertisement was the only factor that significantly contributed to a respondent changing his or her voting intention after receiving information via a campaign advertisement. Not only did opponents of Prop 37 outraise

supporters more than two to one ($44.4 million versus $10.6 million), the results presented here suggest that their ad was also much more effective.

Table 2.1 Description of Variables Used in Data Analysis

Dependent Variables	Description	Mean
Initial Vote	1 if vote of "YES" on Prop 37 before WTP question and campaign advertisement, 0 if "NO."	0.754
WTP Vote	1 if vote of "YES" on Prop 37 after WTP question and before campaign advertisement, 0 if "NO."	0.513
Advertisement Vote	1 if vote of "YES" on Prop 37 after campaign advertisement, 0 if "NO."	0.673
WTP Vote Change	1 if vote changed from "YES" to "NO" after WTP question, 0 if no change.	0.487
Advertisement Vote Change	1 for a change in vote that corresponds with commercial viewed, -1 for a change in vote that contradicts commercial viewed, 0 if no change.	0.077
Independent Variables		
Age	Age in years.	26.10
Education	1 if Bachelor's degree or higher, 0 otherwise.	0.493
Gender	1 if female, 0 if male.	0.507
Income	An integer variable ranging from 1 to 8, used to represent income categories (1=$0-19,999, 2=$20,000-$39,999…8=$140,000 or more).	3.776
Political Ideology	-2 if extremely liberal, -1 if liberal, 0 if independent or I don't know, 1 if conservative, and 2 if extremely conservative.	-0.109
GE Crops	Ranges from 0 to 3 in intervals of 0.05, determined by the sum of percent of acres believed to be planted to GE corn/soybeans/wheat in the United States.	1.360
GE Products	An integer variable ranging from 0 to 4, determined by the sum of indicator variables equal to one if a respondent believed that Coke or Pepsi/Frito-Lay/Kashi/Kellogg's products contain GE ingredients, 0 otherwise.	1.312
Cost	An integer variable ranging from 2 to 25, equal to the randomly assigned Cost value in the WTP question.	15.08
Video	1 if in "YES" advertisement treatment, 0 if in "NO."	0.499

Table 2.2 Probit Model Coefficient Estimates for *Vote* Variables

	Dependent Variables				
Independent Variables	*Initial Vote*	*WTP Vote*	*Advertisement Vote*	No on Prop 37 *Advertisement Vote*	Yes on Prop 37 *Advertisement Vote*
Constant	0.430*	-0.122	0.166	-0.249	0.454
	(0.147)	(0.143)	(0.141)	(0.210)	(0.206)
Age	0.000	0.001	0.000	0.001	0.002
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
Education	0.052	0.051	0.000	0.196	-0.216
	(0.099)	(0.094)	(0.094)	(0.129)	(0.141)
Gender	0.267***	0.315***	0.173**	0.154	0.249**
	(0.089)	(0.085)	(0.084)	(0.116)	(0.126)
Income	0.003	0.049	0.001	0.016	0.024
	(0.022)	(0.021)	(0.021)	(0.028)	(0.033)
Political Ideology	-0.159***	-0.134***	-0.132***	-0.124**	-0.175***
	(0.042)	(0.039)	(0.040)	(0.054)	(0.061)
GE Crops	-0.008	-0.015	0.004	0.010	-0.015
	(0.063)	(0.059)	(0.060)	(0.081)	(0.092)
GE Products	0.076**	0.171*	0.120***	0.143***	0.093*
	(0.034)	(0.032)	(0.032)	(0.044)	(0.050)
Cost		-0.037***			
		(0.003)			
Log Likelihood	-543.18	-1108.40	-616.16	-326.10	-267.48

Note: Estimates are from a binary probit modeled for the probability of a "YES" vote on Prop 37. Number of observations equals 1,003 for *Initial Vote*, *WTP Vote*, and *Advertisement Vote*, 503 for No on Prop 37 *Advertisement Vote*, and 500 for Yes on Prop 37 *Advertisement Vote*. Standard errors are reported in parenthesis. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level.

Table 2.3 Probit Model Coefficient Estimates for *Vote Change* Variables

	Dependent Variables				
Independent Variables	*WTP Vote Change*	*Advertisement Vote Change*	*Advertisement Vote Change*	No on Prop 37 *Advertisement Vote Change*	Yes on Prop 37 *Advertisement Vote Change*
Constant 1	-0.407**	-1.160***	-0.885***	-0.773***	-1.558***
	(0.207)	(0.146)	(0.154)	(0.205)	(0.217)
Constant 2		2.747***	2.839***	2.771***	2.904***
		(0.079)	(0.084)	(0.124)	(0.114)
Age	-0.002	0.001	0.000	-0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
Education	-0.036	-0.089	-0.110	-0.062	-0.151
	(0.107)	(0.094)	(0.095)	(0.130)	(0.141)
Gender	-0.214**	0.114	0.103	0.148	0.064
	(0.097)	(0.084)	(0.085)	(0.117)	(0.125)
Income	-0.087***	0.009	0.001	-0.011	0.017
	(0.025)	(0.021)	(0.021)	(0.029)	(0.033)
Political Ideology	0.036	0.019	0.028	0.025	0.032
	(0.045)	(0.039)	(0.040)	(0.054)	(0.060)
GE Crops	-0.008	0.010	0.025	0.012	0.027
	(0.060)	(0.060)	(0.061)	(0.083)	(0.092)
GE Products	-0.235***	-0.043	-0.045	-0.092**	0.011
	(0.036)	(0.032)	(0.032)	(0.044)	(0.048)
Cost	0.026***				
	(0.008)				
Video			-0.533***		
			(0.088)		
Log Likelihood	-474.77	-588.01	-568.99	-306.72	-259.90

Note: Estimates for *WTP Vote Change* are from a binary probit and estimates for *Advertisement Vote Change* are from an ordered probit using 756 and 1,003 observations, respectively. Estimates for No on Prop 37 *Advertisement Vote Change* and Yes on Prop 37 *Advertisement Vote Change* are from an ordered probit using 503 and 500 observations, respectively. Standard errors are reported in parenthesis. Standard errors are reported in parenthesis. Double and triple asterisks (**, ***) indicate statistical significance at the 5% and 1% level.

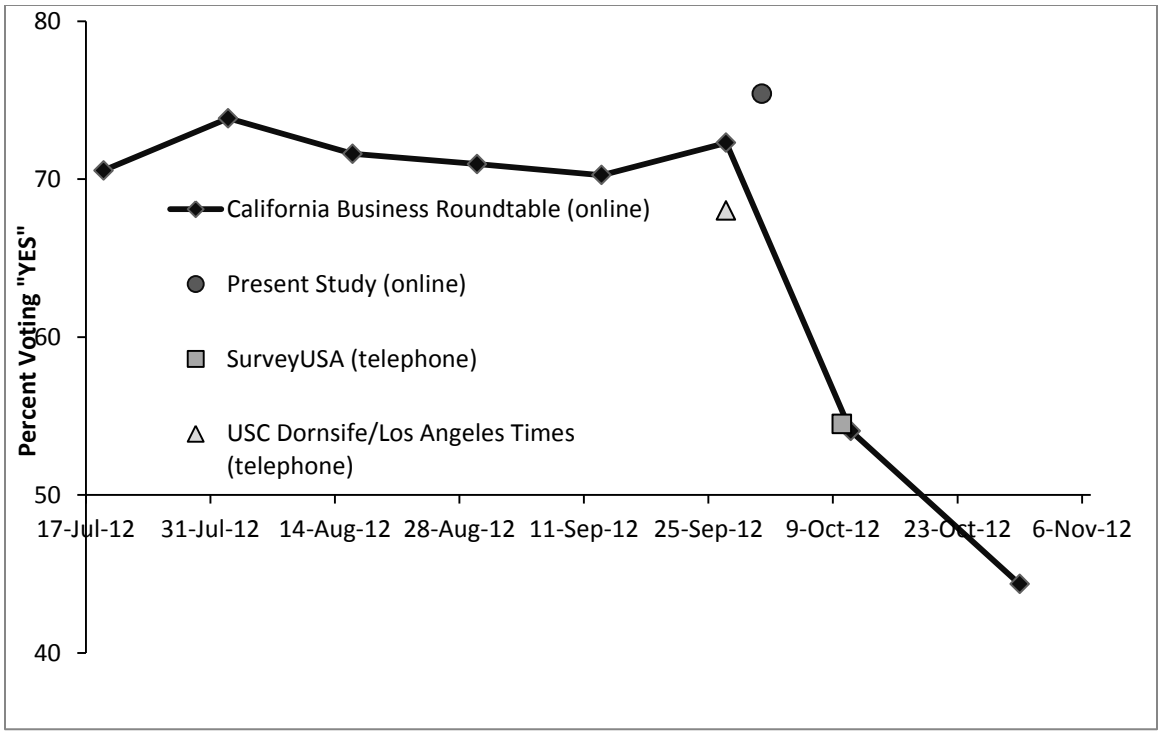


Figure 2.1 Prop 37 Polls Leading Up to Election Day

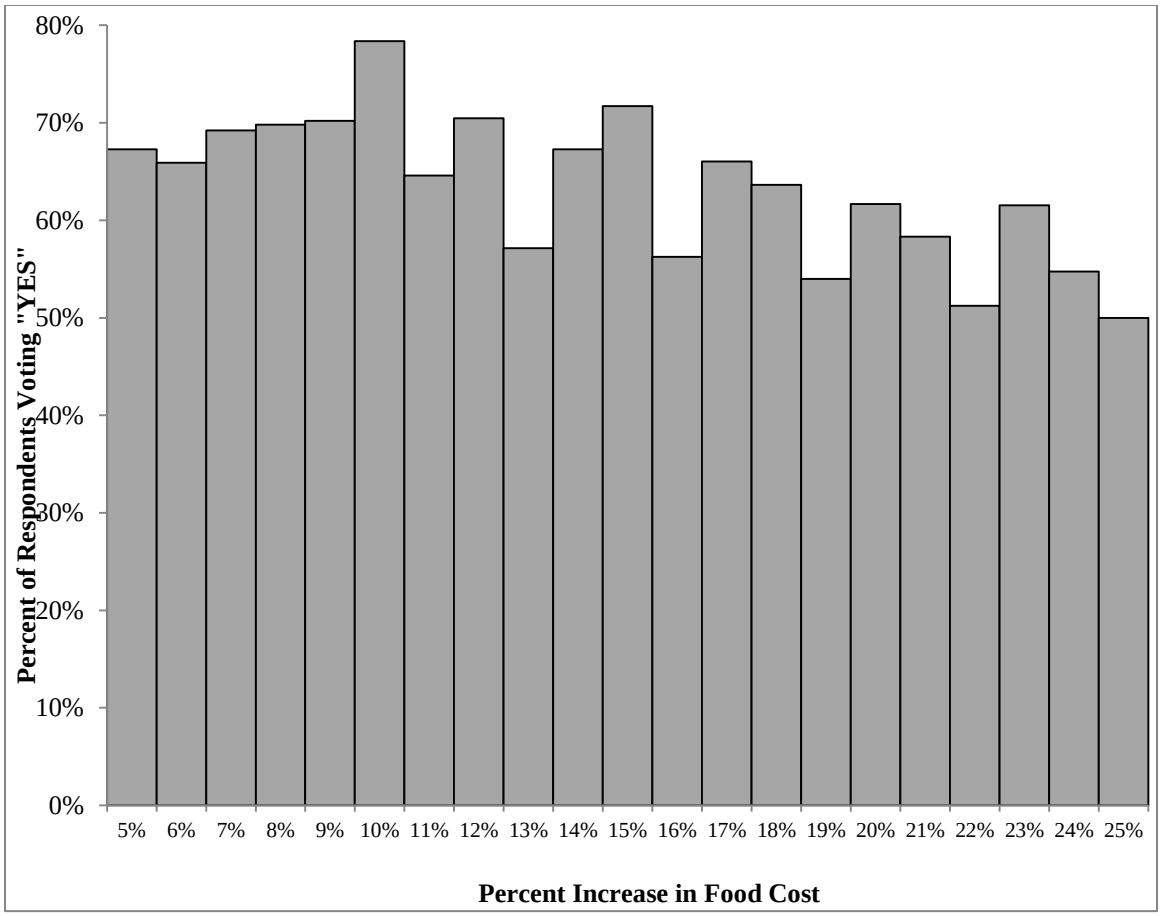


Figure 2.2 Proportion of Consumers Who Intending to Vote "YES" after WTP Question

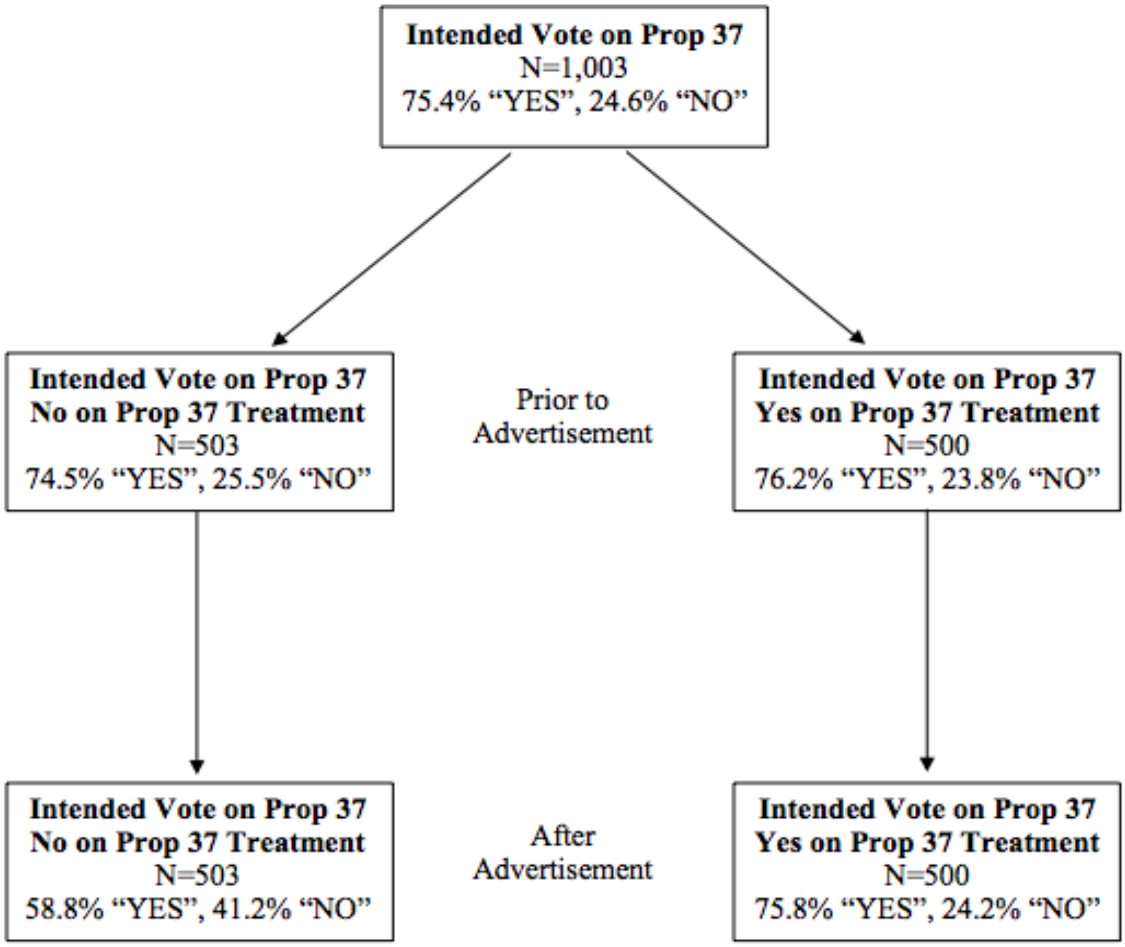


Figure 2.3 Effect of Television Advertisements on Intentions to Vote for Prop 37

CHAPTER III

COGNITIVE BIASES IN THE ASSIMILATION OF SCIENTIFIC INFORMATION ON GLOBAL WARMING AND GENETICALLY MODIFIED FOOD

The possible negative outcomes associated with societal risks such as genetically modified (GM) crops/foods and global warming (GW) are unclear, particularly for the general public. Therefore, individuals' decisions of whether to support or oppose GM crops or policies aimed to mitigate GW are made under uncertainty. Such decisions require individuals to assign subjective probabilities to possible outcomes, and these subjective measures may vary for two reasonable individuals (Savage, 1954).

Bayesian decision theory posits that an individual has a prior belief, receives new information, and then combines the prior belief with new information to form a posterior belief. The posterior belief is essentially an updated belief formed by allocating weights to a prior belief and the new information. Thus, a Bayesian approach provides a way of explaining how individuals incorporate new information to make decisions under uncertainty.

The Bayesian approach has been applied in a wide array of contexts such as game theory (e.g., Myerson, 1991), determining the economic value of weather information to agricultural producers (e.g., Doll, 1971; Baquet, Halter, and Conklin, 1976 ; Byerlee and

Anderson, 1982; Marshall, Parton, and Hammer, 1996), projecting the evolution of agricultural yield expectations (e.g, Krause, 2008), determining returns of using soil sample information (e.g., Pautsch, Babcock, and Breidt, 1999), and understanding how individuals update beliefs about GW from fluctuations in local weather (Deryugina 2013), just to give a few examples. An implicit assumption when employing a Bayesian approach is that individuals process information optimally. However, information processing does not always conform to Bayesian decision theory. Posterior beliefs do not always converge to new information and may diverge in some instances. For example, while there appears to be a consensus in the scientific community about the safety of GM foods, the same cannot be said about public opinion. This disconnect implies that many people do not receive or accept of scientific information, or it could be that they place greater weight on other types of non-scientific information.

Violations of the assumptions of Bayesian decision theory are thought to arise through a variety of heuristics and cognitive biases in decision making (e.g., Tversky and Kahneman, 1971, 1973, 1974; Kahneman and Tversky, 1972; Grether, 1980; El-Gamal and Grether 1995; Zizzo et al., 2000; Charness and Levin, 2005; Charness, Karni, and Levin, 2007). In the present study, we are interested in the effects of subjective prior beliefs on the acceptance of scientific information. Prior beliefs may affect how an individual processes new information; new information that is contrary to a prior belief is often met with skepticism. Distrust in information may result in an individual assigning more weight than is appropriate to a prior belief – conservatism – or possibly even reaffirm a prior belief contrary to new information – confirmation bias – when forming a posterior belief.

The purpose of this study is to determine how the public assimilates scientific information on GW and GM food and examines cognitive biases that cause belief perseverance or biased information assimilation. The objectives of this study are to determine whether: 1) information processing is independent of prior beliefs; and 2) previous theories about information processing are observed empirically in this context. Understanding how the public responds to scientific information is important because substantial resources are invested to mitigate societal risks. The economic value of scientific information is dependent on the ability of scientists to communicate with the general public in a way that scientific knowledge is received and understood.

The next section reviews the literature on information assimilation and derives some research hypotheses. Then, our research design and data collection approach are described. The following section presents the results, and the last section concludes.

Background

Conservatism bias occurs when an individual over-weighs a subjective prior belief and under-weighs new information. Conservatism has been observed in previous experiments by comparing posterior probabilities estimated by research participants to the predicted posterior probability estimate of an optimal Bayesian decision-maker (e.g, Phillips, Hays, and Edwards, 1966; Phillips and Edwards, 1966). Prior research suggests a tendency to underestimate the strength of new information, and people require more certainty than Bayesian decision theory would predict to alter posterior beliefs sufficiently. Probability estimation may be too complex for the average research participant and thus may not be an appropriate measure to formulate meaningful

conclusions about belief perseverance (Pitz, Downing, and Reinhold, 1967). Nevertheless, individuals often overestimate scientific support for prior beliefs, and Kahan, Jenkins-Smith, and Braman (2011) posited that failure of scientific consensus to temper public disagreement was due to individuals perceiving expert support for a prior belief and rather than a lack of willingness to adopt scientific evidence. In the present study, we specifically define conservatism as an individual giving no weight to new information and relying solely on a prior belief.[9]

Confirmation bias occurs when an individual biasedly assimilates new information to form a posterior belief that diverges from new information and converges to a prior belief. Previous experiments have observed confirmation bias for complex issues like capital punishment (e.g., Lord, Ross, and Lepper, 1979) and nuclear energy (e.g., Plous, 1991). Both experiments prescreened and separated participants into two groups dependent on prior beliefs (i.e., pro versus anti capital punishment or pro versus anti-nuclear energy) and then provided participants with information. Lord, Ross, and Lepper (1979) provided two sets of information to all participants; one set of information indicated that capital punishment lowered murder rates and another set of information indicated that capital punishment increased murder rates. Plous (1991) provided identical ambiguous information to all participants. The majority of participants in both studies interpreted information to confirm a prior belief. Moreover, posterior beliefs diverged for the two groups; meaning that a pro participant formed a posterior belief more in favor of an issue and an anti participant formed a posterior belief less in favor of an issue. Based

[9] Our specific definition of conservatism is not to be confused with *anchoring*, another cognitive bias, where estimates are biased toward initial or induced values (Tversky and Kahneman, 1974).

on this literature, we hypothesize that individuals will assimilate information, whether that assimilation be biased or unbiased, to confirm a prior belief.

Rabin and Schrag (1999) posited that confirmation bias can be attributed to the misinterpretation of new information rather than a violation of Bayesian updating *per se*. Such a phenomenon could explain the findings of Plous (1991), as ambiguous information is open to interpretation by research subjects. However, scientific information about GM foods and human involvement in GW has emerged on a consensus. Credible scientific sources, and identical source in some instances, agree that GM foods are safe to consume and human activities are causing GW and it is an increasing threat to society. Thus, these societal risks and accompanying scientific information provide an appropriate scenario to examine the hypothesis that individuals misinterpret new information when displaying confirmation bias.

Rabin and Schrag (1999) also conjectured that information-processing problems, specifically selectively scrutinizing evidence and illusionary correlation, contribute to confirmation bias. Participants who received identical information in the Lord, Ross, and Lepper (1979) study did indeed more closely dissect information that did not conform to a prior belief. Illusionary correlation occurs when an individual believes a correlation to exist between two events that uncorrelated, correlated but to a lesser extent than believed, or correlated in an opposite direction than believed (Chapman, 1967). Examples of illusionary correlation are some individuals believe that GM foods are responsible for recent increases in autism or food allergies. We posit that such illusionary correlation is related to the manner in which people process scientific information on GW and GM

foods; greater illusionary correlation is expected to be associated with a departure from optimal Bayesian updating.

It is possible that variations in familiarity, or knowledge, about a societal risk have some effect on information processing across individuals. Jang (2013) examined whether participants selected to read scientific information that confirmed or contradicted a prior belief about stem cell, evolution, GM foods, and GW. He concluded that participants who had a high level of perceived science knowledge were more likely to read scientific information that confirmed a prior belief. Participants with a high level of perceived knowledge also allocated more time reading confirming scientific information as opposed to contradicting scientific information. Conversely, participants with a high level of actual scientific knowledge, not just perceived, did not display confirmation bias when selecting scientific information to read. However, both perceived scientific knowledge and actual scientific knowledge variables were created by asking questions about science in general, not questions about the specific societal risks included in this study. Based on this literature, we hypothesize that individuals with higher levels of perceived knowledge are more likely to suffer from biased assimilation and individuals with higher levels of actual knowledge are more likely to Bayesian update.

A contemporaneous discussion about differences in acceptance of scientific evidence across political affiliations has emerged and there are conflicting conclusions. The point of contention in the literature is whether belief preservation is uniform for Democrats, or liberals, and Republicans, or conservatives. It has been argued that Republicans are more likely to deny scientific evidence (i.e., Mooney, 2005; Mooney, 2012) or not fully understand possible impacts of societal risks (Hamilton, Cutler, and

Schaefer, 2012); however, it has also been argued that Republicans and Democrats are equally susceptible to biased assimilation of scientific information (Kahan, 2013). Complicating the issue, McCright et al. (2013) argued that differences in acceptance of scientific evidence across political affiliations could be explained by the Anti-Reflexivity Thesis. The Anti-Reflexivity Thesis posits that conservatives will trust science that provides innovations for economic production (i.e., GM crops) and distrust science that identifies negative impacts of economic production (i.e., GW), and liberals will behave in an opposite manner. From the Anti-Reflexivity Thesis, we hypothesize that Democrats and Republicans will be more accepting of scientific information about GW and GM crops, respectively.

The method in which information is assimilated may depend on whether an individual processes information in a deliberative cognitive style, as presumed by a Bayesian approach, or in a more heuristic and subconscious style. Stanovich and West (2000) formally defined two generic modes of cognitive function, System 1 and System 2. System 1 is associated with fast, largely unconscious, and often emotionally charged cognitive functions; while System 2 is associated with slower, deliberately controlled, and usually rule governed functions. System 1 and 2 can be thought of more generally as intuition and reasoning, respectively (Kahneman, 2003). Stanovich and West (2000) conjectured that the two systems likely interact in concert when processing information; however, System 2 may act as an override system for automatic information-processing results occurring from System 1. In commentary to Stanovich and West (2000), Ball and Quayle (2000) speculated that System 1 may serve as an escape hatch when processing demands increase and for information processing that is not automatic. Thus, we

hypothesize that an individual's predisposition to rely on System 1 or System 2 affects information processing related to GM and GW information, with System 2 thinkers being more likely to update information in a manner consistent with Bayesian decision theory than System 1 thinkers.

Kahan (2013) used the Cognitive Reflection Test (CRT) to determine the extent to which an individual's predisposition to rely on System 1 or System 2 caused biased assimilation, and we follow his lead. The CRT, introduced by Frederick (2005), is a three-question test designed to generate incorrect intuitive answers and has been used to measure the ability of an individual to engage in higher forms of reasoning. Kahan (2013) concluded that individuals relying on System 2 were more prone to biased assimilation.

Methods

Subjects

To address the research questions, an internet survey was developed and administered to a representative sample of the U.S. population. The survey was sent to a sample of 961 participants enrolled in an online panel maintained by Qualtrics© and their associated partners. The survey was fielded from April 24, 2013 through April 27, 2013. Qualtrics© prescreened participants by gender, education, and income to ensure the sample was representative of the U.S population. According to the 2012 U.S. Census Bureau, females represented 50.8% of the population, 28.2% of persons age 25+ held a Bachelor's degree, and the median household income was $52,762. Our sample closely matched these population statistics. Fifty-one percent of the survey sample was

comprised of females (*SD* = 0.50), 29% percent held a Bachelor's degree (*SD* = 0.46), and the median income category was $40,000 to $59,999.

Survey Overview

After participants consented to take the survey, a variety of questions about the safety of GM foods and human involvement in GW were asked. Questions about the two societal risks were asked in blocks, and the blocks were counterbalanced across respondents to eliminate an order effect. Questions within a block were as follows: 1) two questions to measure a participant's prior belief; 2) a question to determine if a participant believed scientific research supported a prior belief; 3) three questions to determine if a participant held illusionary correlations; 4) three questions to determine knowledge of the issue; 5) presentation of scientific information; 6) a question to measure if a participant correctly interpreted the information; and 7) a question to measure how the scientific information changed a belief. After completing both blocks, participants were asked if the scientific information provided was accurately presented and were asked political party affiliation. Participants finished the survey by completing the CRT. It is important to note that none of our questions ask about with *preferences* – e.g, whether people want or will eat GM food; rather, our questions deal solely with *beliefs* – e.g., whether people think GM food is safe to eat. Details on each of the questions are presented in the following sub-sections.

Prior Beliefs

A participant's prior belief for a societal risk was measured by asking the level of agreement with two statements. Statements about the safety of GM foods were:

"Genetically modified crops are safe to eat" and "Food that has genetically modified ingredients is safe to eat." Statements about human involvement in GW were: "The Earth is getting warmer because of human actions" and "Human actions are a cause of global warming." Participants chose a level of agreement for each statement from a symmetric five-point scale with response options: Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, and Strongly Agree.

Answers were coded from one (Strongly Disagree) to five (Strongly Agree) and were summed across the two statements; so that a prior belief score for each societal risk could range from two to ten. Based on a prior belief score, prior beliefs for each societal risk were categorized into one of the following groups: *Believer*, *Denier*, or *Neutral*. For example, a participant whose prior belief score was in the two to five range was categorized in the *Denier* group, in the seven to ten range was categorized in the *Believer* group, and a score of six was categorized in the *Neutral* group. While it is not always desirable to create a discrete variable from a continuous measure, defining prior beliefs as a categorical better served the purposes of this study as we expected to observe differential effects for each category.

Presentation of Scientific Information

The scientific information provided to participants about GM foods and GW is shown in figures 1 and 2, respectively. Scientific information was collected from several authoritative sources (American Association for the Advancement of Science, 2007; American Association for the Advancement of Science, 2012; American Medical Association, 2012; Food and Agriculture Organization of the U.N., 2000;

Intergovernmental Panel on Climate Change, 2007; National Research Council, 2001; National Research Council, 2004; Royal Society, 2010) and constrained to a sentence or two per source to minimize the reading efforts of participants. The screen displaying a scientific information sheet forced participants to view the information for at least 30 seconds before moving on in the survey. As much as possible, we attempted to maintain symmetry in the GM and GW information statements insofar as the sources utilized and the type of information conveyed.

Assimilation of Information

Similar to Lord, Ross, and Lepper (1979), information-processing outcomes were measured by asking how the presented information changed beliefs. Participants were asked if they now believed GM foods were: Much Less Safe, Slightly Less Safe, Neither More Safe nor Less Safe, Slightly More Safe, or Much More Safe; and if they now believed human involvement in GW was: Much Less Involved, Slightly Less Involved, Neither More Involved nor Less Involved, Slightly More Involved, or Much More Involved. Answers to the change in belief questions for each societal risk were categorized as one of the following information-processing outcomes: *Conservative, Convergent*, or *Divergent*. For example, a participant who believed GM foods were Much Less Safe or Slightly Less Safe was categorized in the *Divergent* group, a participant who indicated Slightly More Safe or Much More Safe was in the *Convergent* group, Neither More Safe nor Less Safe was categorized in the *Conservative* group. Like the prior belief variables, defining information-processing outcomes as a category better served the purposes of this study; as will be discussed momentarily, separate regression

coefficients are estimated for each group, and the assumption of a linear effect is clearly violated.

Rabin and Schrag (1999) Hypotheses

Six questions were asked to measure illusionary correlation, three for GM and three for GW. For GM foods the agree/disagree questions were: "Genetically modified foods have caused an increase in food allergies"; "Genetically modified foods have caused an increase in incidence of Autism"; and "Genetically modified foods were invented by Monsanto and are ruining humanity." GW illusionary correlation agree/disagree statements were: "The Earth is not warming, the Earth is actually cooling"; "The warming of the Earth is just a natural cycle"; and "Global warming is a conspiracy to redistribute wealth from the United States to other countries." Similar to the prior belief variables, aggregated variables were created by summing answers to multiple agreement statements measuring illusionary correlations for both societal risks (*Illusionary Correlation*). A higher score indicates greater illusionary correlation for a given societal risk.

Immediately after receiving scientific information, participants were asked level of agreement to the statements, "The information I just read indicated that genetically modified foods are safe to consume"; and "The information I just read indicated that the Earth is warming due to human activities." These questions were asked to test the hypothesis by Rabin and Schrag (1999) that participants who display confirmation bias misinterpret information. The variables *Correct Interpretation* were created from

answers to the agreement statements and a greater *Correct Interpretation* indicated that a participant more correctly interpreted the scientific information for a given societal risk.

Individuals displaying confirmation bias are often believed to selectively choose and scrutinize scientific evidence. In the present study, scientific information was provided and thus a participant could not selectively choose information. However, to determine if a participant scrutinized the scientific information provided, participants were asked, "Do you think the scientific research about genetically modified crops (global warming) was accurately presented in the Genetically Modified Foods <<Global Warming>> Information Sheet?" If a participant answered "Yes" to the GM crop/foods or GW question, the variable *Information Accuracy* was equal to one for a given societal risk and zero otherwise.

Perceived and Actual Knowledge

Before receiving scientific information, participants were asked level of agreement to a statement measuring perceived knowledge. The statements used were: "Scientific research supports my views about the safety of genetically modified crops" and "Scientific research supports my views about human activity and global warming." Answers were used to create a *Perceived Knowledge* variable for each societal risk; the greater a *Perceived Knowledge* variable the more a participant believed scientific evidence supported their prior belief.

To measure actual scientific knowledge, three true/false questions were asked for each societal risk. Questions measuring actual scientific knowledge about GM foods were retrieved from Gaskell et al. (1999), a study examining public opinion differences

between Europe and the U.S., and included the true/false questions: "Ordinary tomatoes do not contain genes while genetically modified tomatoes do"; "By eating a genetically modified fruit a person's gene could become modified"; and "Genetically modified animals are always bigger than ordinary ones." Questions measuring actual scientific knowledge about GW included: "Climate often changes from year to year"; "Changes in local weather indicate changes in climate"; and "The greenhouse effect is the same thing as global warming." The correct answer to all questions was false and correctly answered questions were coded as a one, zero otherwise. The score from the three answers were combined for each societal risk to create *Actual Knowledge* variables. Higher *Actual Knowledge* indicates that a participant had a greater objective knowledge about scientific information regarding GM crop/foods or GW.

Political Affiliation

To account for the effects of political affiliation on variation in information-processing outcomes for GM crop/foods and GW, participants were asked to questions that measured political party affiliation. Participants chose political affiliation from the following response options: Strong Democrat, Democrat, Independent Lean Democrat, Independent, Independent Lean Republican, Republican, Strong Republican, I don't know, and Other. Indicator variables *Democrat* and *Republican* were created and set equal to one for participants that chose any of the three Democrat or Republican response options, respectively, and set equal to zero otherwise.

Cognitive Reflection Test

Questions asked by the CRT are: 1) "A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?"; 2) "If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?", and 3) "In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half the lake?" The questions are designed to elicit the intuitive answers: $0.10, 100 minutes, and 24 days, respectively; however, the correct answers are: $0.05, 5 minutes, and 47 days, respectively. A correct answer to a CRT question was coded as a one, zero otherwise. A variable (*CRT*) was created by summing the number of correct answers for a participant. A higher *CRT* indicates that a participant was more likely to engage in System 2 processing and less likely to rely on intuitive, System 1.

Results

We begin by examining summary statistics, and if information processing is independent of prior beliefs. We then investigate whether previous theories about information processing are observed empirically in the context of GM food and GW.

Summary Statistics

Table 3.1 shows the relative frequencies of prior beliefs and information-processing outcomes for both societal risks. Approximately 64% of the sample believed human actions are causing GW prior to receiving information, approximately 18% were unsure, and the remaining 18% did not believe humans are to blame. The sample was almost

evenly distributed across the three prior belief categories about the safety of GM foods. Thus, the safety of GM foods was more divisive than human involvement in GW.

Participants were more accepting of scientific information about human involvement in GW; however, only about 50% and 45% of participants' posterior beliefs converged to information about human involvement in GW and safety of GM foods, respectively. Therefore, about half of the sample did not update a belief in the fashion assumed Bayesian decision theory. Even more astonishing, 12% of participants formed a posterior belief *opposite* of the scientific information provided about the safety of GM foods.

Table 3.2 shows descriptions and means of explanatory variables used in econometric analysis. GM foods models and GW models were estimated using 946 and 954 observations, respectively, because some participants failed to provide answers to all questions used to create explanatory variables.

Information Processing and Prior Beliefs

The first objective of this study was to determine if information processing was dependent on prior beliefs. The null hypotheses that assimilation of scientific information about GM foods or GW is independent of prior beliefs was tested using a Pearson's Chi-squared test. A rejection of a null hypothesis indicates that an information-processing outcome (*Conservative*, *Convergent*, or *Divergent*) was dependent on a participant's prior belief (*Believer*, *Denier*, or *Neutral*) for the given societal risk.

The null hypothesis that assimilation of scientific information was independent of prior beliefs was rejected ($p < 0.001$) for both GM foods and GW. Figures 3 and 4 illustrate the assimilation of scientific information for people with different prior beliefs for GM foods and GW, respectively (error bars represent 95% confidence interval bounds).

After receiving the GM foods scientific information, a participant in the *Believer* or *Denier* prior belief category was most likely to be in the *Convergent* or *Conservative* information-processing outcome category, respectively. That is, people who previously believed GM foods were safe to eat were most likely to respond that the scientific information made them believe GM foods were more safe; while the beliefs of people who previously believed GM foods were not safe to eat were most likely unchanged after receiving scientific information. A participant in the *Neutral* prior belief category was equally more likely to be in the *Conservative* or *Convergent* information-processing outcome categories, indicating that people who previously were indifferent about the safety of GM foods were more likely to hold beliefs that were unchanged or believe that GM foods were safer after the scientific information was provided.

Results for prior belief categories after participants received the GW scientific information demonstrated a nearly identical pattern of results as with GM food. The exception is the *Neutral* prior belief category. After receiving the GW scientific information sheet, a participant in the *Neutral* category was most likely to be in the *Conservative* category, then the *Convergent* category, and least likely to be in the *Divergent* category.

Participants in *Believer* prior belief category were less likely to be in the *Conservative* category than the *Denier* or *Neutral* prior belief categories. This appears logical, as you would expect people who receive information that does not align with a prior belief to discredit the information more than people who hold a prior belief aligning with the information. Participants in the *Denier* category were less likely to be in the *Convergent* category and more likely to be in the *Divergent* category than participants in the *Believer* or *Neutral* prior belief categories. It makes intuitive sense that people who do not agree with information would be less accepting of it; however, it is not clear why anyone would form a posterior belief opposite of information, regardless of prior belief. These findings appear to be robust as the ordering of prior belief categories were identical for both GM foods and GW for all information-processing outcome categories.

Determinants of Information Processing

The second objective of this study was to test the aforementioned hypotheses about information processing. To complete this objective, information-processing outcome categories were used as dependent variables to estimate six binary logistic regression models (three for each societal risk). For example, participants in the *Convergent* information-processing outcome category were coded as a one and all other participants were coded as a zero, for a given societal risk. This process was repeated for the other two information-processing outcomes (*Conservative* and *Divergent*) for both societal risks.

Marginal effect estimates for the GM foods models and GW models are shown in tables 3.3 and 3.4, respectively. Relative to participants who were in the *Neutrals* prior

belief category, participants in the *Believers* and *Deniers* categories were less likely to be in the *Conservative* information-processing category; as both variables were negative and significant for both societal risks. Participants in the *Deniers* category were less likely to converge posterior beliefs to scientific information about the safety of GM foods. *Deniers* were more likely to diverge posterior beliefs from scientific information about both societal risks. These finding further confirmed our hypothesis that people assimilate information to confirm a prior belief.

The hypotheses posited by Rabin and Schrag (1999) were confirmed in both *Divergent* models, as the variable *Illusionary Correlation* was significant and positive, and the *Correct Interpretation* and *Information Accuracy* variables were significant and negative for both societal risks. Thus, participants suffering from confirmation bias (forming a posterior belief that diverged from scientific information) were more likely to misinterpret new information and experience information-processing problems (i.e., holding illusionary correlations and scrutinizing scientific information provided). Interestingly, participants who were conservative when forming a posterior belief also misinterpreted and scrutinized the information provided, as *Correct Interpretation* and *Information Accuracy* were significant and negative in both *Conservative* information-processing outcome models. However, participants in the *Conservative* information-processing category were less likely to hold illusionary correlations about GM foods; *Illusionary Correlation* was significant and negative, and thus these participants did not believe GM foods were linked to negative outcomes that have been disputed by scientific evidence. Not surprisingly, participants who Bayesian updated by forming a posterior belief that converged to scientific information were more likely to correctly interpret the

information provided and believe it to be accurately presented as indicated by *Correct Interpretation* and *Information Accuracy* variables being significant and positive in the *Convergent* information-processing outcome models.

For the *Conservative* information-processing category, *Actual Knowledge* was significant and positive for the GM foods model. The results indicated that people who were conservative, i.e., gave the scientific information no weight, had a high level of scientific knowledge about GM foods. Participants whose posterior beliefs did not converge to scientific information about GM foods had a low level of scientific knowledge about GM crops; *Actual Knowledge* was significant and negative for the GM foods model. Participants who Bayesian updated were more likely to believe scientific research supported a prior belief about GW. However, these participants were also more likely to have a lower level of actual scientific knowledge about GM foods; *Perceived Knowledge* was significant and positive for the GW model, while *Actual Knowledge* and was significant and negative. These findings rejected our hypotheses that individuals with higher levels of perceived knowledge are more likely to suffer from biased assimilation and individuals with higher levels of actual knowledge are more likely to Bayesian update.

Democrats were more accepting of scientific information for both GM foods and GW; *Democrat* was significant and positive in both *Convergent* information-processing outcome models. It should be noted that these estimates were relative to a base of participants that self-identified as not belonging to a political party, not knowing their political affiliation, or belonging to a party other than the two major parties. Thus, the results do not imply that Republicans deny science; rather, Democrats were more

accepting of scientific information relative to the base. This finding does appear to contradict the Anti-Reflexivity Thesis; as it would suggest that conservatives would be more accepting of scientific information about GM foods and liberal would be more accepting of scientific information about GW. *Democrat* was significant and negative in the GW model for the *Conservative* information-processing category; indicating that people whose posterior and prior beliefs about human involvement in GW were equivalent after receiving scientific information were less likely to self-identify as a Democrat.

Participants who were conservative when forming a posterior belief about GW were more likely to have a higher CRT score; *CRT* was significant and positive for the GW model for the *Conservative* information-processing category. Conversely, participants who Bayesian updated were more likely to have a lower CRT score; *CRT* was significant and negative for both societal risks for the *Conservative* information-processing category. These findings confirm Kahan (2013), which concluded that individuals relying on System 2 were more prone to biased assimilation, and seem to further corroborate Ball and Quayle (2000) hypothesis that System 1 serves as an escape hatch for information processing that is not automatic.

For the *Divergent* information-processing category, *Age* was significant and negative for the GM foods model. In the GW models, *Income* was significant and positive for the *Conservative* category and significant and negative for the *Divergent* category. There were no hypotheses, *a priori*, about the effects of demographic characteristics on information processing.

Conclusions

Bayesian decision theory assumes that people update a belief by allocating weights to a prior belief and new information to form a posterior belief. In theory, the weights allocated to a prior belief and new information is a function of variance, and whichever has the lowest variance is allocated a greater weight. We found, however, that a prior belief clearly affects how people assimilate information, and weight allocation is more than a function of just variance. This conclusion suggests caution in adopting conventional Bayesian decision theory as a prescriptive model for how consumers process scientific information on controversial agricultural and environmental issues. Results suggest that the extent to which new information is adopted depends on the extent to which it conforms to prior belief.

Participants who did not Bayesian update misinterpreted the information provided. Rabin and Schrag (1999) asserted that people suffering from confirmation bias misinterpret evidence to conform to a prior belief. The results here confirmed that people suffering from confirmation bias do indeed misinterpret information, and suggest that people conserving a prior belief misinterpret information. This is more evidence that assuming optimal Bayesian updating may only be appropriate when new information is somewhat aligned with a prior belief.

Future research may provide more insights into the kinds of information that are likely to be most influential. In the present study, only declarative scientific information was provided from top scientific organizations. Stories, emotional appeals, or alternative formatting may have more pronounced effects on how people update prior beliefs.

Table 3.1 Descriptions and Relative Frequencies of Prior Beliefs and Information Processing Categories

Variables	Descriptions	Relative Frequencies	
		GM	GW
Believers	Participants who believe GM foods are safe to eat or human actions are causing GW.	0.319	0.639
Deniers	Participants who deny GM foods are safe to eat or human actions are causing GW.	0.366	0.183
Neutrals	Participants who neither believe nor deny GM foods are safe to eat or human actions are causing GW.	0.315	0.178
Conservative	Participants whose beliefs about safety of GM foods or human involvement in GW was unchanged after scientific information.	0.434	0.441
Convergent	Participants whose beliefs about safety of GM foods or human involvement in GW converged to scientific information.	0.444	0.511
Divergent	Participants whose beliefs about safety of GM foods or human involvement in GW diverged from scientific information.	0.122	0.048
Number of Observations		961	961

Table 3.2 Descriptions and Means of Variables Used in Logit Model Estimations

Explanatory Variables	Descriptions	Means GM	Means GW
Believers	1 if a participant believed GM foods are safe to eat or human actions are causing GW, 0 otherwise.	0.316	0.642
Deniers	1 if a participant denied GM foods are safe to eat or human actions are causing GW, 0 otherwise.	0.368	0.182
Illusionary Correlation	An integer variable ranging from 3 (strongly disagree) to 15 (strongly agree), determined by the sum of three level of agreement questions measuring illusionary correlations about GM crops/foods or GW.	8.982	7.715
Correct Interpretation	An integer variable ranging from 1 (strongly disagree) to 5 (strongly agree), determined by the level of agreement that the scientific information provided indicated that GM crops/foods are safe to consume or human actions are causing global warming.	3.863	4.055
Information Accuracy	1 if a participant believed the scientific information provided about the safety of GM crops/foods or human involvement in GW was accurately presented, 0 otherwise.	0.665	0.732
Perceived Knowledge	An integer variable ranging from 1 (strongly disagree) to 5 (strongly agree), determined by the level of agreement that scientific research supported a prior belief about the safety of GM crops/foods or human involvement in GW.	3.277	3.662
Actual Knowledge	An integer variable ranging from 0 to 3, determined by the number of correctly answered true/false questions about GM crops/foods or GW.	2.049	1.061
Democrat	1 if a participant self-identified as a Democrat, 0 otherwise.	0.388	0.392
Republican	1 if a participant self-identified as a Republican, 0 otherwise.	0.293	0.290
CRT	An integer variable ranging from 0 to 3, determined by the number of correctly answered Cognitive Reflection Test questions.	0.321	0.319
Age	Age in years.	26.716	26.753
Bachelors	1 if Bachelor's degree or higher, 0 otherwise.	0.291	0.294
Female	1 if female, 0 if male.	0.512	0.512
Income	An integer variable ranging from 1 to 8, used to represent income categories (1=$0-19,999, 2=$20,000-$39,999…8=$140,000 or more).	3.359	3.355
Number of Observations		946	954

Table 3.3 Marginal Effect Estimates for Genetically Modified Crops/Foods Logit Models

Explanatory Variables	Dependent Variables		
	Conservative	*Convergent*	*Divergent*
Believers	-0.090**	0.020	-0.044
	(0.043)	(0.037)	(0.034)
Deniers	-0.074*	-0.073*	0.081***
	(0.039)	(0.038)	(0.024)
Illusionary Correlation	-0.024***	0.001	0.023***
	(0.008)	(0.007)	(0.005)
Correct Interpretation	-0.059***	0.150***	-0.047***
	(0.017)	(0.019)	(0.008)
Information Accuracy	-0.277***	0.346***	-0.042**
	(0.038)	(0.035)	(0.020)
Perceived Knowledge	-0.029	0.029	-0.014
	(0.020)	(0.019)	(0.009)
Actual Knowledge	0.061***	-0.042***	-0.015*
	(0.017)	(0.016)	(0.009)
Democrat	-0.051	0.069**	-0.008
	(0.036)	(0.033)	(0.022)
Republican	-0.045	0.036	0.015
	(0.039)	(0.035)	(0.023)
CRT	0.035	-0.048**	0.012
	(0.025)	(0.023)	(0.016)
Age	0.000	0.000	-0.001*
	(0.001)	(0.001)	(0.001)
Bachelors	-0.017	0.039	-0.027
	(0.037)	(0.034)	(0.021)
Female	0.043	-0.017	-0.007
	(0.032)	(0.029)	(0.019)
Income	0.003	0.001	-0.004
	(0.010)	(0.009)	(0.006)
Log Likelihood	-586.81	-490.06	-231.78

Note: Estimates are from binary logit using 946 observations. Standard errors are reported in parenthesis. Standard errors are reported in parenthesis. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level.

Table 3.4 Marginal Effect Estimates for Global Warming Logit Models

	Dependent Variables		
Explanatory	*Conservative*	*Convergent*	*Divergent*
Believers	-0.100***	0.055	0.002
	(0.048)	(0.045)	(0.023)
Deniers	-0.093**	-0.047	0.055**
	(0.047)	(0.055)	(0.027)
Illusionary	-0.007	0.003	0.006*
	(0.008)	(0.007)	(0.003)
Correct	-0.059***	0.099***	-0.017***
	(0.018)	(0.019)	(0.006)
Information Accuracy	-0.291***	0.342***	-0.036**
	(0.044)	(0.042)	(0.017)
Perceived Knowledge	-0.033	0.034*	-0.005
	(0.021)	(0.021)	(0.006)
Actual Knowledge	0.019	-0.027	0.006
	(0.018)	(0.017)	(0.008)
Democrat	-0.063*	0.060*	-0.004
	(0.037)	(0.034)	(0.018)
Republican	-0.044	0.041	-0.004
	(0.038)	(0.037)	(0.015)
CRT	0.098***	-0.098***	-0.005
	(0.026)	(0.025)	(0.011)
Age	-0.002	0.001	0.000
	(0.001)	(0.001)	(0.001)
Bachelors	-0.021	0.008	0.006
	(0.036)	(0.034)	(0.016)
Female	0.001	0.008	-0.005
	(0.031)	(0.029)	(0.014)
Income	0.015*	-0.007	-0.009**
	(0.009)	(0.009)	(0.004)
Log Likelihood	-574.95	-520.23	-135.29

Note: Estimates are from binary logit using 954 observations. Standard errors are reported in parenthesis.

Genetically Modified Crops/Food Information Sheet

The following are statements and information on genetically modified crops from the American Association for the Advancement of Science, American Medical Association, Food and Agriculture Organization of the U.N., and National Research Council.

“Foods containing ingredients from genetically modified (GM) crops pose no greater risk than the same foods made from crops modified by conventional plant breeding techniques.”

- American Association for the Advancement of Science

“To date, no evidence has supported an increased degree of allergenicity of bioengineered foods compared to their non-bioengineered counterparts. This is due in part to the safety assessments to which bioengineered foods are subjected prior to marketing.”

-American Medical Association

“It could lead to higher yields on marginal lands in countries that today cannot grow enough food to feed their people."

-Food and Agriculture Organization of the U.N.

“To date, no adverse health effects attributed to genetic engineering have been documented in the human population.”

-National Research Council (National Academies of the United States)

Figure 3.1 GM Foods Scientific Information Sheet Provided to Participants

Global Warming Information Sheet

The following are statements and information on genetically modified crops from the American Association for the Advancement of Science, Intergovernmental Panel on Climate Change, National Research Council, and Royal Society.

"The scientific evidence is clear: global climate change caused by human activities is occurring now, and it is a growing threat to society."
- American Association for the Advancement of Science

"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level."
- Intergovernmental Panel on Climate Change

"Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. Temperatures are, in fact, rising."
- National Research Council (National Academies of the United States)

"There is strong evidence that the warming of the Earth over the last half-century has been caused largely by human activity, such as the burning of fossil fuels and changes in land use, including agriculture and deforestation."
-Royal Society

Figure 3.2 GW Scientific Information Sheet Provided to Participants

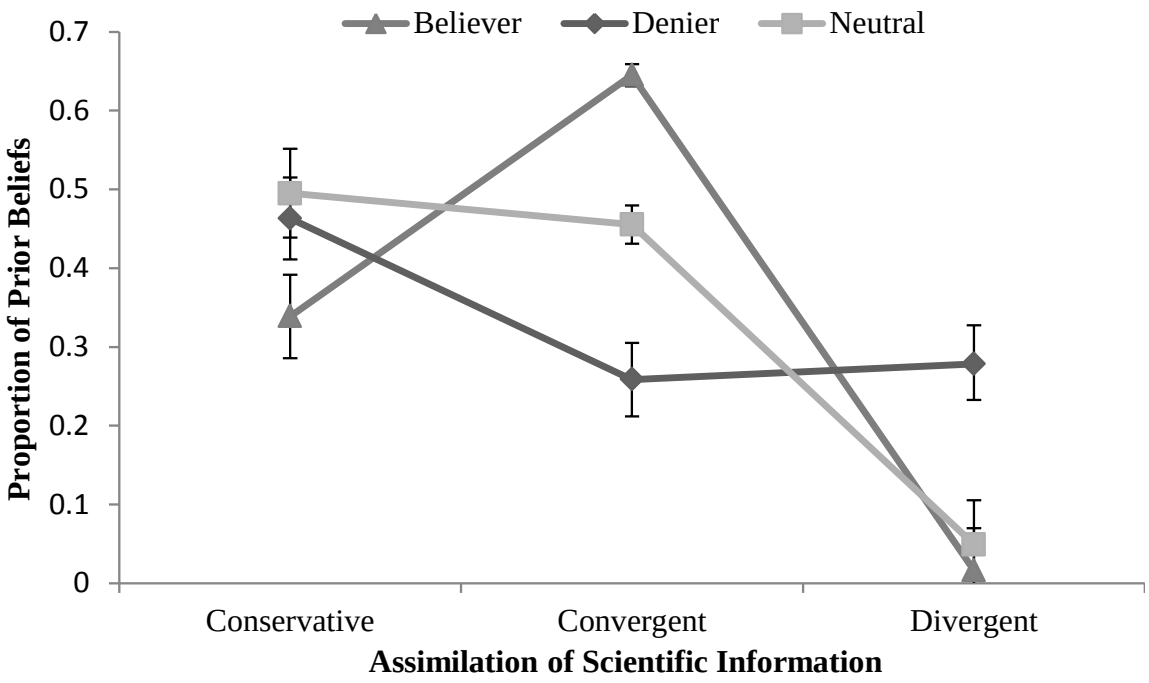


Figure 3.3 Assimilation of Scientific Information about GM Foods by Proportion of Prior Beliefs

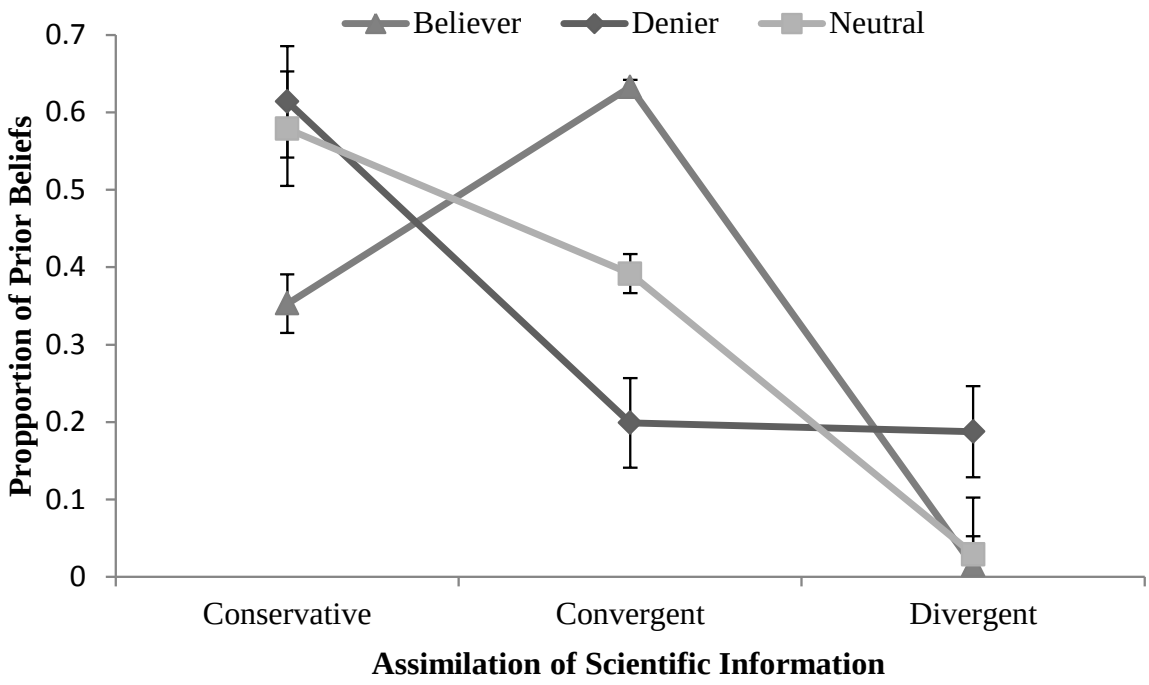


Figure 3.4 Assimilation of Scientific Information about GW by Proportion of Prior Beliefs

CHAPTER IV

CAN NEURAL ACTIVATION IN THE DLPFC PREDICT RESPONSIVENESS TO INFORMATION? AN APPLICATION TO EGG PRODUCTION SYSTEMS AND PROPOSITION 2 ADVERTISING

The goal of neuroeconomics is to supplement traditional economic models by providing a mechanistic explanation of how choices are made (Glimsher and Rustichini, 2004; Camerer, 2013). A better understanding of why choices are made may improve predictions of choices and responses to information. In the case of multi-attribute choice, economists have proposed several models, such as the random utility and expected utility models, to describe how consumers arrive at a given choice (the interested reader is referred to the discussion and literature in Webb et al. 2013). Findings from neuroscience have given empirical support for these theoretical constructs, show that individuals making choices between two options that vary in multiple attributes assign values to the individual attributes and sum them to obtain an overall value for each option (Bettman, Luce, and Payne, 1998; Hare, Malmaud, and Rangel, 2011; Camus et al., 2009; Kahnt et al., 2011; Linder et al., 2010). Values of each option are compared and an optimal choice is made by choosing the option that provides the greatest value.

Other neuroeconomic research has shown that multi-attribute options with conflicting individual attribute values increase the uncertainty of value prediction (Kahnt et al., 2011). For example, people prefer higher quality *and* lower prices; however, this is not a realistic option; in the marketplace, people must make tradeoffs between individual attributes. This conflict between quality and price increases uncertainty of value prediction for a choice decision when there is not an overwhelming preference for one attribute over another.

The dorsolateral prefrontal cortex (dlPFC) is an area of the brain involved in cognitive control and plays a key role in working memory (Curtis and D'Esposito, 2003). Working memory refers to active maintenance and manipulation of information stored in long-term memory. Previous research demonstrates that dlPFC plays a casual role in valuation (e.g., Camus et al., 2009; Hare et al., 2009; Hutcherson et al., 2012) and makes comparisons between different values (Wallis and Miller, 2003). The role of dlPFC is also instrumental in the processing of uncertainty (e.g., Bach et al., 2009; Huettel et al., 2006; Volz et al., 2005) and dlPFC may encode uncertainty in valuation of choices (Kahnt et al., 2011).

These findings suggest that activation in the dlPFC may play a role in multi-attribute decision making, and in resolving situations in which an individual must tradeoff quality and price. Moreover, if the dlPFC relates to uncertainty in desirability of one choice option over another, it may serve as a useful predictor of responsiveness to information. An individual who is (nearly) indifferent in making a choice between, say, a high-quality/high-price option and a low-quality/low-price option is more likely to be swayed by information about quality, than is a person who has a strong preference for

quality or for price. Whether the dlPFC plays these roles, and to what extent such findings might apply to controversial food technologies remains an open question.

In the present study, participants were placed in a functional magnetic resonance imaging (fMRI) machine and made non-hypothetical choices between two options that varied by multi-attributes (i.e., production method and price) and single-attributes (i.e., production method or price). In the single-attribute choices, we expected participants to consistently choose the option that increased animal welfare or had a lower price. Outcomes of the multi-attribute choices, where participants were forced to make tradeoffs between preferences for animal welfare and price, were more ambiguous. Difficulty in decision-making has been measured by response time (RT) (Kahnt et al., 2011) and we expected RT to be longer when choosing between options that varied by production method and price compared to choices between options that varied by production method or price alone.

Linder et al., (2010) evaluated neural activity for food labeled organic versus conventionally produced and determined that dlPFC showed increased activity during the presentation of the organic label. dlPFC has also been identified as a correlate with willingness-to-pay (WTP) for food (Plassmann, O'Doherty, and Rangel 2007; 2010). It is difficult to determine if dlPFC activation when making multi-attribute choices comes from valuation of options, comparison of options, or uncertainty in conflicting attributes, or possibly all of these. Nevertheless, we hypothesized that activation in the left and right dlPFC (ldlPFC and rdlPFC) would be greater when making multi-attribute choices compared to single-attribute choices.

Concerns about the impact of confined agricultural production systems on farm animal welfare have increased in recent decades. This is evident by California's 2008 passing of the state-wide ballot initiative Proposition 2, the Prevention of Farm Animal Cruelty Act, establishing minimum space requirements for laying hens. Despite the popularity of legislation regulating confined production systems, however, consumers show less willingness or ability to pay for such practices in the marketplace, with fewer than 5% of eggs coming from cage-free systems (e.g. Norwood and Lusk, 2011b). Dissonance in buying preferences and voting behavior has large implications for egg producers, as it forces the adoption of production methods that consumers are not willing to support in the marketplace. The dissonance may arise from people having little knowledge about egg production methods and effective information campaigns from animal rights advocacy groups. For example, consumers believe a much higher share of eggs are produced using cage-free systems than actually are (Norwood and Lusk, 2011b) and information from advocacy groups surrounding Proposition 2 led to an increase in demand for organic eggs (Lusk, 2010).

Previous economic research has determined consumers' WTP for eggs from various production methods (e.g., Baltzer, 2004; Karipidis et al., 2005; Norwood and Lusk, 2008; Change, Lusk, and Norwood, 2010; Allender and Richards, 2010), and examined the effects of information on WTP (e.g., Tonsor, Wolf, and Olynk, 2009), however, little is known about *why* some people are more responsive to information than others. There is a need to better understand the factors affecting how people respond to advocacy information and employing a neuroeconomic approach may be useful for gaining a better understanding of responsiveness to advocacy information.

After making non-hypothetical choices, participants were shown video information in support or opposition of Proposition 2 and repeated the non-hypothetical choices. We hypothesized that the proportion of times participants chose the option that increased animal welfare but had a higher price when making multi-attribute choices would increase or decrease after viewing the Proposition 2 video that supported or opposed, respectively. Brosch et al. (2013) demonstrated that dlPFC activated when situational information was integrated into evaluations of the behaviors of others, and did not activate when situational information was not integrated. While it has been demonstrated that dlPFC may process and integrate information, it is unknown if dlPFC activation is an indicator of response to information. To the extent that the dlPFC encodes uncertainty, we would expect dlFPC activation observed prior to activation to correlate to responsiveness to information. Specifically, we hypothesized that people with increased activation in dlPFC were more susceptible to advocacy information.

Materials and Methods

Participants

A sample of 44 healthy, right-handed, English-speaking, adult participants (23 females; mean age = 29.6 ± 0.21, SEM; age range, 21-55 years) were recruited from the Kansas City metropolitan area to participate in a functional magnetic resonance imaging (fMRI) study. Exclusion criteria included current use of psychotropic medication, current or past substance abuse, diagnosis of severe psychopathology (e.g., depression, schizophrenia), and vegan diet. While 50 participants completed the experiment, four participants were excluded from the analyses due to invalid test administration and two participants were

excluded due to making choices that implied confusion. Thus, analyses were conducted using observations from 44 participants.

Stimuli

Participants underwent two fMRI scans while performing a food choice task — one functional scan before viewing a 30-second video and one functional scan after viewing a video. Participants were presented with the following instructions: "In this phase of the experiment, you will make a series of choices between two food products. To choose the option on the left, use your index finger. To choose the option on the right, use your middle finger. Please choose carefully, as you will receive one of the food products you choose at the end of the experiment. In the middle of this phase, there will be a brief pause while the scanner restarts. When you are ready, we will begin."

The two options presented included an identical image of a dozen eggs accompanied by text indicating the production system and price information for each option. Each option differed according to three experimental conditions: 1) a "method" condition, in which the method used to produce one option was "closed" (i.e., labeled "caged" or "confined"), and the method used to produce the other option was "open" (i.e., labeled "cage-free" or "free-range"), but the prices for both options were equal; 2) a "price" condition, in which the price of one option was higher than the other option but the production methods were identical; and 3) a "combination" condition, in which the production methods and prices of the two options differed in a manner that the open method was always accompanied with a higher price. Thus in the "combination" condition, participants were forced to make a tradeoff between animal welfare and price.

Price information began at "$0.99" and varied by $0.50 increments up to "$4.49." Figure 1 illustrates examples of the three experimental conditions.

Task

Respondents made 84 choices during the first functional scan prior to information: 28 choices per experimental condition (i.e., combination, method, and price). The presentation order of the choices was randomized across respondents. The choices were made non-hypothetical by informing respondents that one of their choices would be randomly selected as binding and would actually be given to them at the conclusions of the experiment. After undergoing the first functional scan, participants viewed a thirty-second educational video. Participants were randomly shown one of three videos; one video advocated for Proposition 2 (Yes on Prop37, 2008), one video advocated against Proposition 2 (No on Prop 37, 2008), and a control video that depicted a flowing stream. The egg-advocacy videos were actual commercials that aired in California prior to the vote on Proposition 2. Immediately following the video, the functional scan described previously was repeated so that there were two functional scans of 84 choices; 168 choices in total (84 prior to information and 84 after information). A choice was presented on screen until the participant chose. If the participant chose in under 3,000 milliseconds, the participant's choice was confirmed until 3,000 milliseconds had elapsed since the time the choice was presented, and then for an additional 500 milliseconds, if the choice took longer than 3,000 milliseconds, the choice was confirmed for an additional 500 milliseconds from the time of the choice.

fMRI Data Acquisition

All fMRI scans were performed at the University of Kansas Medical Center's Hoglund Brain Imaging Center on a 3-Tesla Siemens Skyra (Siemens, Erlangen, Germany) scanner. Participants' heads were immobilized with head cushions. Following automated scout image acquisition and shimming procedures performed to optimize field homogeneity, a structural scan was completed. T1-weighted, three-dimensional, magnetization-prepared rapid acquisition with gradient echo (MPRAGE) structural images were acquired (repetition time/echo time [TR/TE] = 23/4 ms, flip angle = 8º, field of view [FOV] = 256 mm, matrix = 256 x 192, slice thickness = 1 mm). Then, two gradient-echo blood-oxygen-level-dependent (BOLD) functional scans were acquired in fifty contiguous, oblique, 40º axial slices (TR/TE = 3000/25 ms, flip angle = 90º, FOV = 232 mm, matrix = 80 x 80, slice thickness = 3 mm, in-plane resolution = 2.9 x 2.9 mm, 176 data points). To optimize the signal in ventromedial prefrontal regions of interest in the present study, and to minimize susceptibility artifacts, all participants were positioned such that the angle of the anterior commissure-posterior commissure (AC-PC) plane fell between 17º and 22º in scanner coordinate space, as verified by a localization scan. This careful positioning, utilized by Bruce and colleagues (2013; 2014), ensured the 40º acquisition angle was applied uniformly for all participants, again, minimizing susceptibility artifacts while standardizing the head positions of participants of divergent body sizes.

fMRI data were analyzed using BrainVoyager QX, version 2.4 (Brain Innovation, Maastricht, Netherlands, 2012). Preprocessing steps included trilinear, three-dimensional motion correction, sinc-interpolated slice scan time correction, two-dimensional spatial

smoothing with a four-millimeter Gaussian filter, and high-pass filter temporal smoothing. Functional images were realigned to fit structural images obtained during each scanning session, then normalized to the BrainVoyager template image, which conforms to the space defined by Talairach and Tournoux's (1988) stereotaxic atlas. Neural activation maps were analyzed using statistical parametric methods (Friston et al., 1995) included with the BrainVoyager QX software. Statistical contrasts of neural activation in the experimental conditions of interest (i.e., method, price, and combination conditions) were conducted using multiple-regression analysis. Regressors representing neural activation in these conditions, as well as regressors of non-interest (e.g., head motion), were modeled with a hemodynamic response filter. Next, group analysis was performed by entering data into the multiple-regression analysis using a random effects model. Finally, a region of interest (ROI) analysis was performed using a cube centered in left dlPFC (-43, 13, 24) with a diameter of 10mm and a cube centered in right dlPFC (41,25,33), also with a diameter of 10mm. And an assessment of contrasts between the experimental conditions, expressed in terms t statistics, was conducted.

Data Analysis and Results

Behavioral Data Analysis and Results

In the single-attribute experimental conditions, averaged across video treatments, the open option (cage-free; free range) was chosen 99.9% of the time in the method condition and the low price option was chosen 98.6% of the time in the price condition. This result confirms that people prefer open production to closed production methods and lower

prices to higher prices; it also shows people were paying attention to the choices and taking the task seriously.

We focused analysis on combination decisions to investigate the effect of video information on how often participants choose the open method, high price option instead of the closed method, lower price option. The proportion of choices the open method, high price option was chosen before and after video treatment is shown in Figure 2. In the anti-Proposition 2 video treatment, participants chose the open method, high price option 57% of the time before video information and 56% of the time after video information. The one-percent decrease was not a significant change (t=-0.73, p = 0.48), thus the anti-Proposition 2 video was not effective. Participants in the control video treatment chose the open method, high price option 42% and 44% of the time before and after video information, respectively. We did not expect the control video to affect choices and indeed the two-percent increase was not a significant change (t=1.13, p = 0.28). The pro-Proposition 2 video, however, significantly increased the proportion of decisions the open method, high price option was chosen from 50% to 61% (t=2.66, p = 0.02). That is, participants who viewed the pro-Proposition 2 video were more likely to choose the high price, open method option after receiving video information (i.e., they were more likely to be willing to pay a premium for cage free and free range eggs).

Combination choices were made between options with conflicting individual attributes, and those choices were likely more difficult relative to choices in the method and price conditions. We used an analysis of variance (ANOVA) comparison of the experimental condition choice RT means and performed orthogonal contrasts to examine pairwise differences between specific experimental condition choice RT means.

Before receiving video information, RT was significantly longer when making combination choices than method choices (F=30.94, p<0.01) or price choices (F=23.83, p<0.01). Using paired t-test, we found that RT for choices in all experimental conditions decreased after information for all video treatments (p<0.01 for all experimental conditions and video treatments). However, it is impossible to know how much of the decreased RT is attributable to video information as the choices made after information were repetitive. Differences in RT between multi-attribute and single-attribute choices decreased slightly after receiving video information, nevertheless, RT remained significantly longer when making combination choices compared to method choices (F=4.96, p=0.03) and price choices (F=5.21, p=0.02). These findings suggest the combination choices were more challenging and align with the findings of Kahnt et al. (2011). Further corroborating this hypothesis, RT was not significantly different when making choices between options that varied by only method or price before video information (F=0.46, p=0.50) or after video information (F=0.00, p=0.96).

Imaging Data Analysis and Results

To examine our hypotheses that activation in the ldlPFC and rdlPFC was greater for the combination choices, we contrasted percent blood-oxygen-level-dependent (BOLD) activation during combination decisions with BOLD activations during both the method and price choices to create the contrast variables $ldlPFC_{Combo}$–$ldlPFC_{Method}$, $ldlPFC_{Combo}$–$ldlPFC_{Price}$, $rdlPFC_{Combo}$–$rdlPFC_{Method}$, and $rdlPFC_{Combo}$–$rdlPFC_{Pricee}$. Importantly, these activations were observed only before video information. Within-subject t-tests were

used to test the null hypotheses that differences in activations for experimental conditions were equal to zero.

Contrary to our hypothesis, participants did not exhibit greater activation in ldlPFC when making combination choices compared to either method choices (t=-0.64 p=0.52) or price choices (t=0.55, p=0.58). However, confirming our hypothesis, activation in the rdlPFC was significantly greater while making combination choices compared to both method choices (t=2.88, p<0.01) and price choices (t=2.50, p=0.02). Therefore, in rdlPFC, there does appear to be more activation when making choices between multi-attribute choices than single-attribute choices.

Change in proportion of times the open method, high price option was chosen before and after receiving video information signals a response to information. Correlation coefficients were estimated to examine the relationship between activation contrast variables and the change in proportion the open method, high price option was chosen for each video treatment. Coefficient estimates are shown in table 2. Several activation contrast variables were significantly correlated in all video treatments. There does not appear to be a strong relationship between the proportion of open method, high price selection after receiving video information and activation contrast variables, as none of the coefficient estimates are significant. This result does not support our hypothesis that activation in dlPFC pre-video would indicate change in choice after video information, at least linearly.

To further explore these results at the disaggregate choice level, a binary logistic regression model was estimated to further analyze the effects of pre-video activation in dlPFC on choice before and after video information. The dependent variable was equal

to one if a subject chose the open method, high price option in the combination condition, zero otherwise. Thus, the dependent variable indicates whether a subject was willing to pay a premium for the cage free/free range option for a given choice. Subjects made 28 choices in the combination condition before and after information, therefore, there were 56 observations for each of the 44 participants. Explanatory variables for the logistic regression model included: BOLD activation contrasts (i.e, $ldlPFC_{Combo}–ldlPFC_{Method}$, $ldlPFC_{Combo}–ldlPFC_{Price}$, $rdlPFC_{Combo}–rdlPFC_{Method}$, and $rdlPFC_{Combo}–rdlPFC_{Price}$); indicator variables for the anti-Proposition 2 video (*Anti*) and pro-Proposition 2 video (*Pro*); an indicator variable for after information (*After*); two-way interactions between *After* and BOLD activation contrasts, two-way interactions between *After* and video variables; and three-way interaction between *After*, BOLD activation contrasts, and video variables. Standard errors were corrected for repeated measures across participants.

Estimation results from the logistic regression are shown in table 2. None of the coefficient estimates for the activation variables were significant before video information. This indicates that activation in ldlPFC and rdlPFC, when making combination choices relative to method and price choices, did not affect the probability that a subject chose the open method, high price option prior to receiving information. *Anti* and *Pro* were not significant; indicating that participants were randomly assigned to video information treatments with respect to the probability of choosing the open method, high price option. However, *After* was significant, as were the interaction of *Anti* and *Pro* with *After*. These results indicate information changed the probability of choosing the open method, high price option when accounting for variation in dlPFC activation.

Activation in rdlPFC before information affects the probability of choosing the open method, high price option after viewing video information. This effect was most evident when comparing BOLD activations during the combination and method conditions, as all coefficient estimates for interactions between $rdlPFC_{Combo}$–$rdlPFC_{Method}$ (mean = 0.117) and *After* were significant. The activation variable $rdlPFC_{Combo}$–$rdlPFC_{Price}$ (mean = 0.084) was significant when interacted with *After* for the anti-Proposition 2 video treatment.

Figure 2 shows the effect of the activation variable *rCombo – rMethod* on the probability of choosing the open method, high price option before and after viewing video information. Prior to video information participants in the anti-Proposition 2 and Control treatments were most and least likely to choose open method, high price option, respectively. This is consistent with the data. For the lowest values of *rCombo – rMethod*, the anti and pro-Proposition 2 increased the probability of choosing the high price, open method option; however, the probability of choosing the open method, high price option decreased as *rCombo – rMethod* increased. The effect was opposite in the Control video treatment and appears to be large. It is possible that the Control video, that depicted a flowing stream, had an unanticipated effect on decisions.

Discussion

This study used fMRI to examine whether brain activation in bilateral dlPFC predicted non-hypothetical purchasing decisions before and after advocacy information about Proposition 2 in California in 2008. Proposition 2 passed with 63% of voters voting in favor of increasing animal confinement space. The results here suggest that the

pro-Proposition video was more effective in persuading consumers, confirming Lusk's (2010) work that determined Proposition 2 advertising increased consumer demand for organic eggs. It is possible voters' were similarly persuaded when in the voting booth as in the marketplace.

Using response time values, we demonstrated it was more difficult for participants to make choices that varied by production method and price compared to choices that varied by method or price alone. Also, participants experienced greater activation in right dlPFC when making combination choices compared to method choices and price choices. These together seem to imply that participants were contemplating the tradeoff between animal welfare and price. If a participant were not concerned with one attribute, whether it be animal welfare or price, the options would be reduced to a single-attribute choice. Given that participants were concerned about both attributes, the longer RT and greater activation in the dlPFC may confirm Kahnt et al. (2011) and indicate that there was more uncertainty in the valuation for the combination choices as the individual attribute values were conflicting.

Increased activation in dlPFC during combination choices did not indicate susceptibility to advocacy information in support or opposition to Proposition 2. Nevertheless, there does appear to be some relationship between activation in the rdlPFC before receiving information and choices after information. This study was, to a degree, limited by sample size, notably when estimating correlation coefficients, as the sample was split into three video treatments to include a control group. Future research could supplement the current study by examining the effects of different information and determining if other neural areas indicate responsiveness to information.

Table 4.1 Correlation Coefficients between Change in High Price, Open Method Proportion and Activation Contrast Variables for each Video Treatment

anti-Proposition 2 Video Treatment

	Change in High Price, Open Method Option	$lDLPFC_{Combo} - lDLPFC_{Method}$	$lDLPFC_{Combo} - lDLPFC_{Price}$	$rDLPFC_{Combo} - rDLPFC_{Method}$	$rDLPFC_{Combo} - rDLPFC_{Price}$
Change in High Price, Open Method Option	1				
$lDLPFC_{Combo} - lDLPFC_{Method}$	-0.01 (0.97)	1			
$lDLPFC_{Combo} - lDLPFC_{Price}$	-0.40 (0.13)	0.55 (0.03)	1		
$rDLPFC_{Combo} - rDLPFC_{Method}$	0.11 (0.68)	0.27 (0.31)	0.13 (0.62)	1	
$rDLPFC_{Combo} - rDLPFC_{Price}$	0.04 (0.89)	0.24 (0.37)	0.40 (0.12)	0.68 (0.00)	1

Control Video Treatment

	Change in High Price, Open Method Option	$lDLPFC_{Combo} - lDLPFC_{Method}$	$lDLPFC_{Combo} - lDLPFC_{Price}$	$rDLPFC_{Combo} - rDLPFC_{Method}$	$rDLPFC_{Combo} - rDLPFC_{Price}$
Change in High Price, Open Method Option	1				
$lDLPFC_{Combo} - lDLPFC_{Method}$	0.13 (0.68)	1			
$lDLPFC_{Combo} - lDLPFC_{Price}$	-0.26 (0.41)	0.47 (0.12)	1		
$rDLPFC_{Combo} - rDLPFC_{Method}$	-0.35 (0.26)	0.73 (0.01)	0.35 (0.26)	1	
$rDLPFC_{Combo} - rDLPFC_{Price}$	-0.12	0.59	0.39	0.71	1

	(0.71)	(0.04)	(0.22)	(0.01)	

pro-Proposition 2 Video Treatment

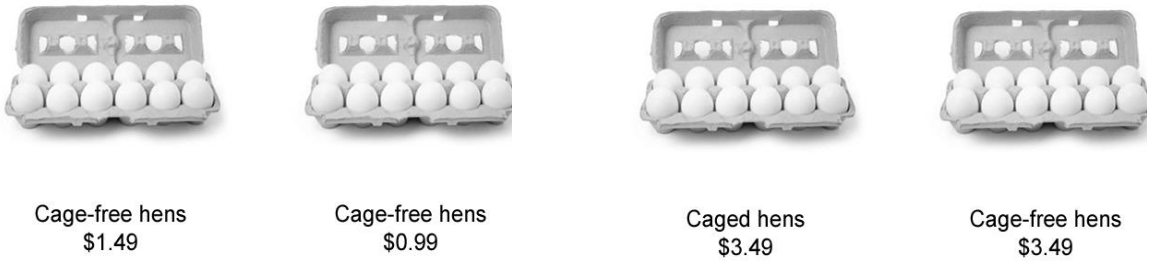
	Change in High Price, Open Method Option	$lDLPFC_{Combo} - lDLPFC_{Method}$	$lDLPFC_{Combo} - lDLPFC_{Price}$	$rDLPFC_{Combo} - rDLPFC_{Method}$	$rDLPFC_{Combo} - rDLPFC_{Price}$
Change in High Price, Open Method Option	1				
$lDLPFC_{Combo} - lDLPFC_{Method}$	-0.37 (0.16)	1			
$lDLPFC_{Combo} - lDLPFC_{Price}$	-0.29 (0.28)	0.56 (0.02)	1		
$rDLPFC_{Combo} - rDLPFC_{Method}$	0.04 (0.87)	0.51 (0.04)	0.00 (1.00)	1	
$rDLPFC_{Combo} - rDLPFC_{Price}$	-0.01 (0.98)	0.56 (0.03)	0.52 (0.04)	0.66 (0.01)	1

Note: Correlation coefficients were estimated using 16, 12, 16 observation for the anti-Proposition 2, control, and pro-Proposition 2 video treatments, respectively. *P*-values are in parenthesis.

Table 4.2 Logistic Regression Estimation Results

	Dependent Variable: *P*(*High Price, Open Method Option =1*)		
Explanatory Variables	Coefficient Estimate	Standard Error	p-Value
Intercept	-0.707	0.486	0.146
lCombo – lMethod	-2.379	1.621	0.142
lCombo – lPrice	1.824	1.469	0.214
rCombo – rMethod	0.669	1.505	0.657
rCombo – rPrice	1.046	1.791	0.559
Anti	0.875	0.566	0.122
Pro	0.474	0.596	0.427
After	-1.114*	0.609	0.067
After(*lCombo – lMethod*)	-3.646	4.375	0.405
After(*lCombo – lPrice*)	-2.819	2.812	0.316
After(*rCombo – rMethod*)	5.462***	1.937	0.005
After(*rCombo – rPrice*)	-0.607	2.550	0.812
AfterAnti	1.070*	0.650	0.100
AfterPro	1.400**	0.654	0.032
AfterAnti(*lCombo – lMethod*)	5.480	5.333	0.304
AfterAnti(*lCombo – lPrice*)	3.982	3.881	0.305
AfterAnti(*rCombo – rMethod*)	-10.472***	2.104	<.001
AfterAnti(*rCombo – rPrice*)	6.928**	3.448	0.045
AfterPro(*lCombo – lMethod*)	-0.723	5.555	0.897
AfterPro(*lCombo – lPrice*)	1.582	3.753	0.674
AfterPro(*rCombo – rMethod*)	-6.699**	3.369	0.047
AfterPro(*rCombo – rPrice*)	1.159	3.849	0.763
Log Likelihood	-1705		

Note: Estimates are from a binary logistic regression using based on 28 choices from 44 participants. Standard errors are clustered at the subject-level. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level.



Example of a price choice

Example of a production method choice

Example of a combination choice

Figure 4.1 Examples of decisions in the three experimental conditions

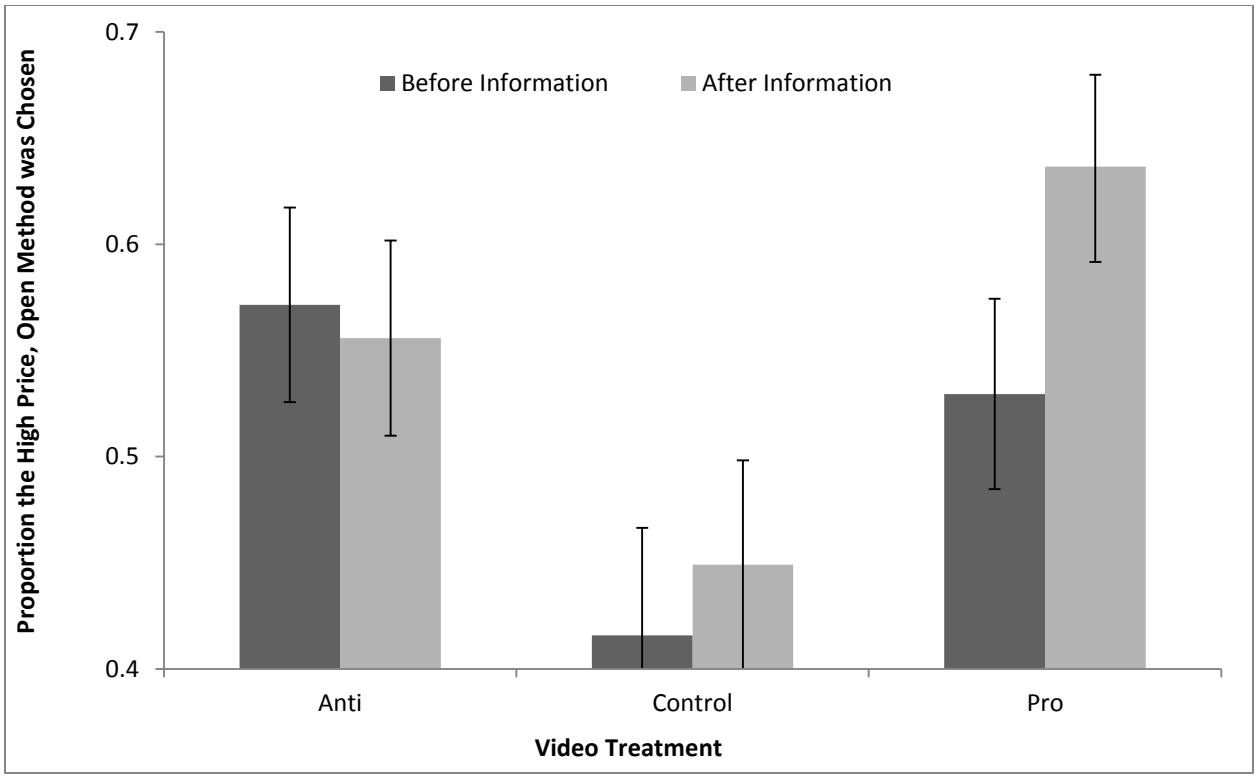


Figure 4.2 The effect of activation variable $rDLPFC_{Combo}$–$rDLPFC_{Method}$ on the probability of choosing high price, open method option before and after video information

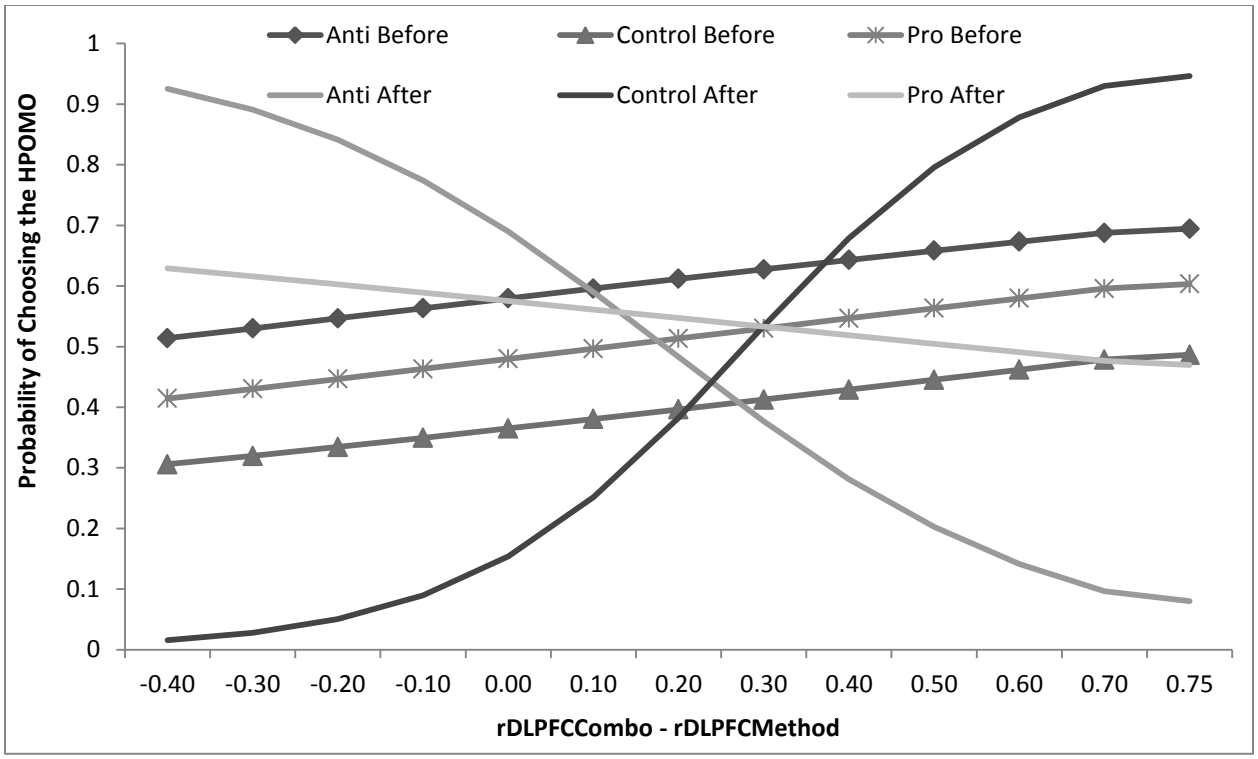


Figure 4.3 The effect of activation variable $rDLPFC_{Combo}$–$rDLPFC_{Method}$ on the probability of choosing high price, open method option before and after video information

CHAPTER VI

Discussion

This dissertation sought to examine public and private beliefs and preferences for crop biotechnology and agricultural production methods and determine the effectiveness of advocacy and scientific information. Results imply that consumers are unaware of current agricultural practices. It is possible that the public is unaware of current agricultural practices for many reasons: population shifts to urban areas, fewer people directly involved with farm operations by the way of concentrations of production, etc. No matter the causes, public unawareness has opened a door for shock media to enlighten then public of what is happening on corporation farms. Undoubtedly, possible outcomes arising from some facets of modern agricultural production are not beyond reproach. Nevertheless, some media reports overstate the probability of negative outcomes and portray modern agricultural to be insidious.

Public unawareness would not appear to be a problem for agricultural producers; however, a weak prior likely makes the first piece of information extremely important and as the title of Rabin and Schrag (1999) indicates, "First Impressions Matter." While it is unknown if agricultural corporation prefer the public to be ignorant of modern production practices, funding of Proposition 37 in 2012 ($44.4 million) signals that

biotechnology companies are concerned about the implications of a label that provides information to consumers in the marketplace. Results suggest that once a prior belief is formed, it clearly affects how people assimilate information; thus, it appears as though providing information to the public would be beneficial for agricultural corporations.

This dissertation examined the effectiveness of advocacy information surrounding Proposition 37 and scientific information about GM foods. Scientific information about the benefits of GM foods was not as persuasive as advocacy information against mandatory labeling of GM foods. It is not clear why people are more responsive to advocacy information than scientific information; however, results indicated that people who diverged from scientific information were more likely to misinterpret information. Thus, it is possible that advocacy information is easier to understand for the average person.

Making a purchasing decision between choices that vary by production method and price are more difficult for consumers than decision between choices that vary by price alone, measured both by response time and activation in the right dorsolateral prefrontal cortex. While consumer demand for increases in animal welfare has lagged citizen concern, it appears that consumers are deliberating paying higher prices to increase animal welfare. Results suggested that advocacy information against Proposition 2 was ineffective and advocacy information against Proposition 37 was effective, and these results mirrored the outcomes observed for the actual votes. It is unknown why a commercial against Proposition 37 was more effective than a

commercial against Proposition 2. It is possible that people are more sensitive to concerns about animal welfare than crop biotechnology.

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APPENDICES

Oklahoma State University Institutional Review Board

Date:	Thursday, September 20, 2012
IRB Application No	AG1248
Proposal Title:	Californians and Proposition 37
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved **Protocol Expires: 9/19/2013**

Principal Investigator(s):

Brandon McFadden
423 Ag Hall
Stillwater, OK 74078

Jayson Lusk
411 Ag Hall
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval. Protocol modifications requiring approval may include changes to the title, PI, advisor, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Shelia K. Kennison

Shelia Kennison, Chair
Institutional Review Board

Oklahoma State University Institutional Review Board

Date:	Thursday, September 20, 2012
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Sincerely,

Shelia H. Kennison

Shelia Kennison, Chair
Institutional Review Board

VITA

Brandon R. McFadden

Candidate for the Degree of

Doctor of Philosophy/Education

Thesis: THREE ESSAYS EXAMINGING THE EFFECTS OF INFORMATION ON CONSUMER RESPONSE TO CONTEMPORARY AGRICULTURAL PRODUCITON

Major Field: Agricultural Economics

Biographical:

Education:

Completed the requirements for the Doctor of Philosophy in Agricultural Economics at Oklahoma State University, Stillwater, Oklahoma in May, 2014.

Completed the requirements for the Master of Science in Agricultural Economics at University of Arkansas, Fayetteville, AR in 2009.

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Instructor of Quantitative Methods at Oklahoma State University, Fall 2012 and Spring 2013

Instructor of Quantitative Methods at University of Arkansas, Spring 2010

Instructor of Principles of Microeconomics at University of Arkansas, Spring 2010

Professional Leadership:

Chair, Graduate Student Section of Agricultural & Applied Economics Association, December 2012 – August 2013