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The Effects of Media Coverage of Scientific Retractions on Risk Perceptions

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Abstract

Media coverage of scientific studies identifying technological risks generally amplifies public risk perceptions. Yet, if subsequent media coverage reports that those studies have been retracted, are risk perceptions reversed or attenuated? Or, once amplified, do risk perceptions remain elevated? Answering such questions may improve our understanding of risk perceptions of some publicly controversial technologies, for example, childhood vaccines and genetically modified (GM) food. We engage with the social amplification of risk framework, especially scholarship on news media as a risk amplification (or attenuation) station. In a between-subjects experiment, we examine the extent to which perceived risk of GM food is influenced by (a) news of a study reporting that eating GM food causes cancer and/or (b) news of its retraction. Whereas initial news coverage amplified all measured risk perceptions, news of the study's retraction effectively reversed them to nonamplified levels.

Keywords

GM food, risk perception, social amplification of risk, news media, scientific retraction

Introduction

According to the social amplification of risk framework (SARF), news media serve as an important "social amplification station," intensifying signals about risks and risk events (Burns et al., 1993; Kasperson, 1992; Kasperson & Kasperson, 1996; Kasperson et al., 1988; Pidgeon, Kasperson, & Slovic, 2003; Renn, 1991; Renn, Burns, Kasperson, Kasperson, & Slovic, 1992). Lacking relevant personal experience with certain risks, individuals mainly learn about them from print and electronic media—as well as other avenues, such as peer networks. Continued exposure to media coverage of risks and risk events (especially featuring dramatized symbolic connotations like "Terminator technology" or "Frankenfood") tend to heighten laypeople's risk perceptions—irrespective of technical risk assessments and expert viewpoints.

If media coverage of scientific and medical studies that seemingly provide compelling evidence for significant technological and health risks tends to amplify public risk perceptions, then what happens when further media coverage criticizes those same studies as deeply flawed and even publicizes that they have been retracted? Does such later media coverage reverse or at least attenuate risk perceptions? Or, once amplified, do risk perceptions stay elevated? While SARF scholars intimate that it is often easier to increase concern and stoke fears than it is to reduce them (Kasperson et al., 1988), we simply lack much research to understand these dynamics.

This knowledge gap is unfortunate given the recent rise in scientific article retractions (Steen, Casadevall, & Fang, 2013; Van Noorden, 2011) and, more on point, the few high-profile cases where eventually discredited and retracted peer-reviewed studies on the health risks of childhood vaccines (Wakefield et al., 1998) and genetically modified organisms (GMOs; Séralini et al., 2012) seem to have inflated public risk perceptions of these technologies. Indeed, often sensationalized media coverage, content sharing via social media, and the claims-making activities of opponents of these technologies have amplified public worry about childhood vaccines (Largent, 2012) and GMOs (Stephan, 2015).

To extend SARF scholarship on the news media as a social station of risk amplification (and attenuation) and to examine how news coverage of scientific retractions may influence risk perceptions, we focus on a recent case of the retraction of a well-publicized scientific study that seems to have amplified risk perceptions of GM food. The study (Séralini et al., 2012) reported that rats fed GM corn developed tumors, heightening concern about the health effects of

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GM food. Yet, many in the scientific community challenged the rigor and veracity of this study, which then was retracted from the Elsevier journal *Food and Chemical Toxicology* (Elsevier, 2013). In a between-subjects messaging experiment, we investigate the extent to which risk perceptions about GM crops and food are influenced by (a) news coverage of this study and/or (b) news coverage of its retraction.

In the next section, we briefly review (a) the relevant SARF scholarship on the news media as an amplification station, (b) selected findings from GM food risk perception studies, and (c) key aspects of our specific case study of the retraction of Séralini et al. (2012). After describing our experimental design and subjects, we explain the variables and analytical techniques we employed in our study. We then discuss our results and conclude with some potential implications of our findings for SARF scholarship and suggestions for furthering this research agenda.

Relevant Literature and Background

The SARF

SARF is an integrative conceptual framework that combines theoretical arguments and empirical findings from media research, cultural scholarship, psychometric research, and studies of organizational responses to risk (Kasperson, Kasperson, Pidgeon, & Slovic, 2003). As it was first introduced in 1988, SARF scholars have engaged in clarifying and providing empirical support for the framework, for example, by investigating how the framework applies to both amplification and attenuation of risk (Kasperson & Kasperson, 1996; Pidgeon et al., 2003). The framework provides a structural description of how various hazardous events interact with psychological, social, institutional, and cultural processes, leading to intensification or attenuation of risk perceptions and related risk behaviors (Burns et al., 1993; Kasperson, 1992; Kasperson & Kasperson, 1996; Kasperson et al., 1988; Pidgeon et al., 2003; Renn, 1991; Renn et al., 1992).

SARF explains how public reactions to risk often differ from technical risk assessments. Some hazards and events assessed by experts as relatively low-risk generate great social attention (risk amplification), while other hazards and events judged as higher risk generate much less social attention (risk attenuation; Kasperson et al., 2003; Kasperson et al., 1988). According to SARF, amplification or attenuation begins either with an event or awareness of a hazard (Renn et al., 1992). The signals generated during such events—which often combine facts, values, and symbolic meanings—are intensified or attenuated during a signal transmission process, as those signals pass through various individual and social stations (Kasperson & Kasperson, 1996; Kasperson et al., 1988; Pidgeon et al., 2003).

This process leads to subsequent individual-level and group-level behavioral responses, which in turn can lead to broader societal impacts. Such impacts spread beyond those who are directly affected by a risk experience (Kasperson & Kasperson, 1996; Kasperson et al., 1988; Renn et al., 1992), sometimes causing financial losses, regulatory action, litigation, organizational change, and loss of confidence in institutions that govern risk (Kasperson et al., 1988). In the case of GM food, broader societal impacts may include enduring mental images and attitudes (e.g., anti-GM sentiments), impacts on businesses and sales (e.g., aversion to GM food, increased demand for organic produce), political and social pressure (e.g., calls for labeling GM food, such as the 2014 Proposition 37 in California), contentious action (e.g., anti-GM protests, destruction of GM agricultural land), and distrust in science and scientists. As individuals and groups continue to experience these broader societal impacts, the effects may spread to distant locations and even future generations (Kasperson et al., 1988; Renn et al., 1992).

The News Media as a Social Station of Amplification and Attenuation

In SARF, the news media is depicted as a key social station of risk amplification and attenuation that influences public perception of risk and likely behavioral responses (Burns et al., 1993; Kasperson et al., 1988). The news media provides mental shortcuts for citizens who have little or no experience with new technologies (Scheufele & Lewenstein, 2005). This is especially the case for technologies (such as genetic engineering) that cannot be directly observed (Donk, Metag, Kohring, & Marcinkowski, 2012).

As a social station of risk amplification, the news media engages in several key amplification steps: filtering and decoding of risk signals, processing risk information, and attaching social values to the information (Kasperson et al., 1988). These steps lead to transformation of risk signals, which in turn increases or decreases the salience of certain aspects of risk messages (Pidgeon et al., 2003). Typical signal transformation processes include giving disproportionate, long-term attention to some risks while ignoring others (Combs & Slovic, 1978; Freudenburg, Coleman, Gonzales, & Helgeland, 1996; Mazur, 1984, 1990; McCabe & Fitzgerald, 1991), vocalizing and legitimizing some points of view more or less than others (Hornig, 1993), and dramatizing the nature of some risks but not others (Bauer, Kohring, Gutteling, & Allansdottir, 2001; Johnson & Covello, 1987). These different media responses play key roles in structuring the overall public debate about risk events and hazards (Hornig, 1993). Regardless of the accuracy of information presented by the news media, large volumes of information and/or repeated stories are known to mobilize latent fears and serve as risk amplifiers (Kasperson et al., 1988). Also important are the symbols, metaphors, and discourses used to depict and characterize risk in the news media (Kasperson & Kasperson, 1996). Indeed, including or excluding certain

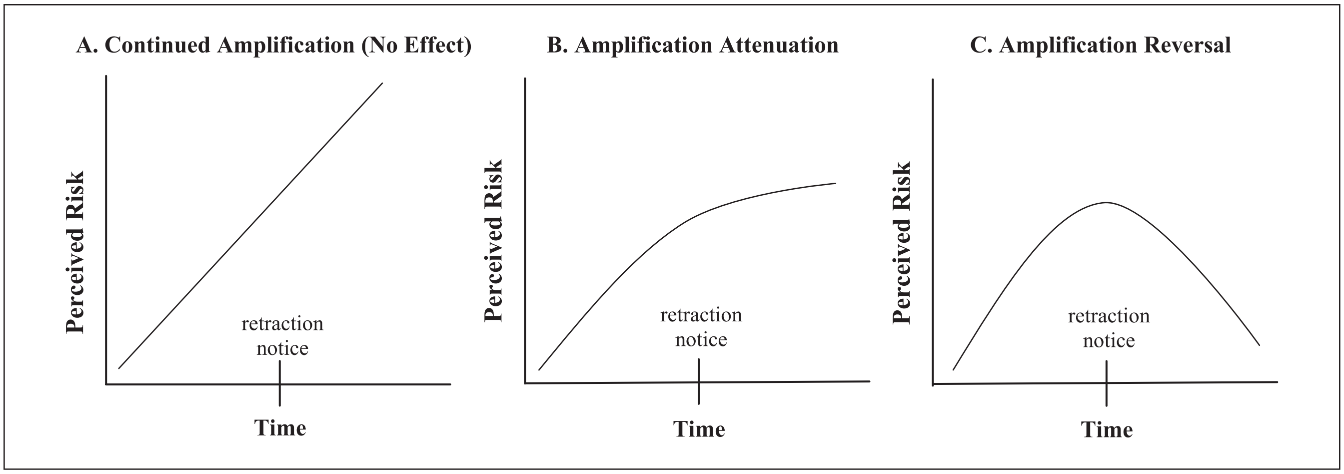

Figure 1. Possible effects of exposure to a study's retraction on amplified public risk perception.

cultural symbols (especially those with strong value implications) is one of the most powerful means of amplification or attenuation of risk (Kasperson et al., 1988).

While empirical evidence demonstrates that exposure to media coverage of hazards and technological risks does amplify risk perceptions, it is unclear whether subsequent media coverage downplaying the hazards and reassuring the safety of the technology can counteract the effects of original risk messages (Kasperson et al., 1988). Indeed, as the name of the model implies, most SARF scholarship examines risk amplification, while processes of risk attenuation are under-investigated. Yet, the standing question is important. Do risk perceptions, initially heightened through social amplification processes, stay elevated in the face of later, well-publicized, counterfactual evidence?

Scientific retractions provide us with an avenue to empirically examine this. While scientific retractions hold substantial interest for the public and the media (Tobin, 2000), media coverage of scientific retractions has not been the subject of much investigation (Rada, 2007). Most empirical studies on retractions focus on identifying why journals retract articles and why the incidence of retractions has increased over time. A few studies find that press releases for article retractions do garner measurable levels of media attention (Rada, 2005, 2007) but also that the political agendas of journalists and media outlets influence their coverage (Winsten, 1985). While scholars obliquely discuss the potential implications of retractions (such as reduced trust in science), we found no empirical studies that have directly examined such claims. We simply lack scholarship to explain how news coverage of scientific retractions may affect public risk perceptions—or public perceptions of science in general.

To fill these gaps in the literature and extend the SARF scholarship on the news media as a social station of amplification and attenuation, we examine how risk perceptions are influenced by exposure to news coverage of a scientific study and by exposure to news coverage of its retraction. Specifically, we examine how perceived risks of GM food are influenced by news coverage of the Séralini et al. (2012) study—which reported that rats fed GM corn developed tumors—and by news coverage of its later retraction. SARF expects that exposure to news coverage of the original study amplifies perceived risk of GM food. We propose that news coverage of an article's retraction can affect amplified risk perception in one of three ways, as depicted in Figure 1.

Proposition 1: Retraction news coverage has no effect on amplified risk perception.
Proposition 2: Retraction news coverage attenuates amplified risk perception.
Proposition 3: Retraction news coverage reverses the amplification of risk perception.

GM Food Risk Perceptions

Since the mid-1990s, social scientists have investigated factors that influence public risk perceptions of GMOs. Much of that includes publics in the United States or Western Europe. While some scholars investigate overall perceived risk of GMOs (Frewer, Miles, & Marsh, 2002; Gaivoronskaia & Hvinden, 2006; Ganiere, Chern, & Hahn, 2006), others distinguish between perceived health risks of "GM food consumption" and perceived environmental, regulatory, and social risks of "GM crop cultivation" (Allum, 2007; Costa-Font & Gil, 2008; Frewer, Howard, Hedderley, & Shepherd, 1999; Pidgeon et al., 2005).

Several of the patterns detected in GM food risk perception are consistent with those of the broader risk perception literature; furthermore, such patterns correspond to the amplification and attenuation mechanisms of SARF (Frewer et al., 2002). Research finds that women express greater concern about GM organisms and are less likely to approve of GMOs for consumption than are men (Hallman, Hebden, Aquino, Cuite, & Lang, 2003; Siegrist, 2000; Torgersen &

Seifert, 1997). Level of education is positively associated with perceived benefits of GM crops (Hallman et al., 2003; Traill et al., 2004). Support for GM crops increases with income (Torgersen & Seifert, 1997), but decreases with age (Hallman et al., 2003; Torgersen & Seifert, 1997). Lack of trust in scientists, governments, and regulatory agencies is associated with heightened risk perceptions (Allum, 2007; Costa-Font & Gil, 2008; Lang & Hallman, 2005; Poortinga & Pidgeon, 2005; Siegrist, 2000). Also, variation in GM food risk perceptions aligns with the intensity of media coverage over time (Bauer et al., 2001; Frewer et al., 2002; Gutteling et al., 2002; Vilella-Vila & Costa-Font, 2008).

The Séralini et al. Affair

The past few decades have seen a sharp increase in the percentage of scientific articles that are retracted (Steen et al., 2013; Van Noorden, 2011). While most retractions of scientific articles rarely register outside of the scientific community, a few generate considerable media coverage and garner public attention. Some prominent retractions that have captured considerable public attention in the recent past include articles on the side effects of childhood vaccines (Wakefield et al., 1998), the social cognition of nonhuman primates (Hauser, Weiss, & Marcus, 2002), the creation of multipurpose stem cells (Hwang et al., 2004; Obokata et al., 2014), the health risks of GM crops (Séralini et al., 2012), and change in attitudes about same-sex marriage (LaCour & Green, 2014).

We chose to focus on the Séralini et al. (2012) study and its retraction for two reasons. First, this study provides a recent and timely case that has not yet garnered much social scientific attention. Second, we anticipated that potential participants would be less familiar with the Séralini et al. affair than with earlier retractions (such as Wakefield et al., 1998), thus reducing concerns about preexisting exposure.

The Séralini et al. study was first published in 2012 in the journal *Food and Chemical Toxicology*. A research team led by French molecular biologist Gilles-Eric Séralini reported the results of an experiment in which researchers fed Monsanto's Roundup-resistant GM corn and Roundup herbicide to rats over their 2-year life span. The researchers found that this GM corn and herbicide treatment produced higher rates of cancer and premature death in rats in the experimental group than in those in the control group.

Upon publication, this study was heavily criticized by the larger scientific community for its low methodological rigor and limited statistical power (Butler, 2012). Some scientists argued that the particular strain of rats used in the study is prone to cancer even under normal conditions (Butler, 2012), a fact that had long been established (Suzuki, Mohr, & Kimmerle, 1979). Several national food safety and regulatory organizations (e.g., European Food Safety Authority, Germany's Federal Institute for Risk Assessment) questioned the validity of the study (Butler, 2012). Other groups, such as the European Federation of Biotechnology lobby, also questioned the legitimacy of the scientific peer-review process (Butler, 2012).

In response to this intense criticism, Elsevier retracted the article in November 2013. In its retraction notice, the editor in chief stated that although there was no evidence of fraud or intentional misrepresentation of data, the legitimacy of the results was questionable due to the small sample size and the breed of rats used. The editor in chief concluded that the results presented were inconclusive and did not meet the threshold for publication in *Food and Chemical Toxicology* (Elsevier, 2013).[1]

The Study

Subjects

We administered an experiment online with Qualtrics to subjects recruited via Amazon Mechanical Turk (AMT), a crowdsourcing website where "requesters" solicit "workers" to perform "human intelligence tasks" (HITs) for pay. AMT has emerged as a practical way for recruiting a large number of subjects from a reasonably wide cross section of the general public either for conducting online experiments (e.g., Clements, McCright, Dietz, & Marquart-Pyatt, 2014) or for designing and testing new measurement instruments (e.g., Allen, McCright, & Dietz, 2015) across the social sciences (e.g., Goodman, Cryder, & Cheema, 2013; Levay, Freese, & Druckman, 2016; Weinberg, Freese, & McElhattan, 2014).[2]

To solicit a broad cross section of research subjects and minimize self-selection by AMT workers highly interested in GMOs, we advertised a HIT titled "Your Attitudes About Important Social Issues in the US." We limited participation to adults residing in the United States. We paid subjects US$0.50 for completing the experiment, which took, approximately, 7 min and 30 s on average. The final sample includes those 423 subjects who completed the full questionnaire (of the 439 who began it) during March 27 to 30, 2015 and who correctly answered a comprehension check question and a manipulation check question.[3] These correct answers and the average completion time indicate that subjects had an adequate level of attentiveness during the experiment. Our convenience sample is more demographically, socially, politically, and geographically diverse than are the traditional experiment recruitment pools of university undergraduates, yet it also is more male, younger, more highly educated, and more liberal than would be a representative sample of the U.S. general public. As such, the external validity of our results is likely higher than if we had simply recruited university undergraduates, but it is also likely lower than if we had drawn a nationally representative sample.

The Experiment

Our experiment had three experimental conditions and a control condition. To achieve reasonable equivalence of cognitive engagement across the four conditions, all subjects read news coverage of a scientific study conducted by a team of French scientists. As we discuss below, the topic of the scientific study in the control condition was a potential functional cure for HIV, while the topic of the scientific study in the experimental conditions was potential health risks of consuming GM food. We aimed to optimize external validity by explicitly creating a factual narrative reconstructed from actual news coverage, and we aimed to optimize internal validity by designing mock news stories with similar formats and lengths.

Even though some news coverage of scientific research is rather sensationalized (especially that of research on publicly controversial topics, such as GM food), we intentionally chose to craft fact-laden news stories that avoided obvious hype and provocation. We primarily did this to guard against unintentionally including persuasive elements that would unduly bolster message strength and surreptitiously inflate experimental effects—which would not be reproduced in other contexts or outside of experimental settings. As such, the resulting messages likely underestimate the influence that actual news coverage of this type has on risk perceptions. Pages 2 to 5 in the Supplementary Materials contain the news stories presented to the subjects in each of the four conditions.

Subjects in the control condition read a brief news story, titled "Study Raises Hope for a 'Functional Cure' for HIV," about an actual study first publicized in early August 2012—around the time of the Séralini et al. study. Subjects in the first experimental condition read a brief news story, titled "Study Reveals Rats Fed GM-Corn Develop Tumors," that described the findings of the Séralini et al. study, which was first publicized in mid-September 2012. Subjects in the second experimental condition read the brief news story from the previous condition and another one, titled "Controversial GM-Corn Study by French Scientists Retracted," that described the limitations of the study, the negative reaction it received within the scientific community, and its eventual retraction—which was first publicized in late November 2013. Subjects in the last experimental condition only received the news story about the Séralini et al. retraction.

After providing their consent to participate in our study, subjects were randomly assigned to one of the four conditions above. Pages 6 to 8 in the Supplementary Materials contain the full experimental questionnaire. After reading their assigned news story, subjects answered two open-ended questions: one comprehension check and one manipulation check. On the next page, subjects answered several sets of questions about their risk perceptions, policy preferences, and behavioral intentions about food from GM crops. On a subsequent page, subjects answered a set of conventional questions about their demographic, social, and political characteristics. On the final page, we thanked subjects for their participation and debriefed them about our research question.

Variables

Table SM1 on page 9 in the Supplementary Materials displays key information about the wording and coding of the items we used to create the three composite outcome variables in our analyses. Informed by the relevant literature, our three outcome variables measure perceived risk of GM food in general, perceived risk of growing and harvesting GM crops, and perceived risk of consuming GM food.

Relative perceived risk of GM food is a ratio of the perceived riskiness (*not risky at all* = 1 to *extremely risky* = 7) of GM food to the average perceived riskiness of four mundane technologies: chainsaws, elevators, medical X-rays, and microwave ovens.[4] This relative measure helps to account for and neutralize general tendencies toward risk aversion or risk acceptance, helping us more precisely gauge perceived risk of GM food.[5] This variable ranges between 0.22 and 2.80 with a mean of 1.00.

For our other two outcome variables (*perceived dangerousness of GM crops* and *perceived dangerousness of GM food*), we used Cronbach's alpha scores and the results of a principal components analysis (PCA) with Promax rotation with Kaiser normalization to justify creating two scales (Table SM2 on page 10 in the Supplementary Materials presents the PCA results). *Perceived dangerousness of GM crops* (Cronbach's α = .94) is a five-item scale that measures the average perceived dangerousness (*not dangerous at all* = 1 to *extremely dangerous* = 7) that the growing and harvesting of GM crops poses for the following: farmers and farm-workers, farm livestock (e.g., cows, pigs, etc.), pollinator insects (e.g., butterflies, bees, etc.), wild animals (e.g., deer, birds, etc.), and local groundwater quality. *Perceived dangerousness of GM food* (Cronbach's α = .97) is a four-item scale that measures the average perceived dangerousness (*not dangerous at all* = 1 to *extremely dangerous* = 7) of the following four behaviors: eating raw GM fruit or vegetables, eating cooked GM fruit or vegetables, eating processed food made from GM fruit or vegetables, and using GM food (e.g., vegetable oil) in the baking or cooking process.

Our key predictors are two dummy variables, *exposed to news about study* and *exposed to news about retraction*, that represent whether or not subjects were exposed to the initial news coverage of the Séralini et al. study or the later news coverage of its retraction, respectively. To fully capture the effect of being exposed both to the news about the study and to the news about the retraction, we created an interaction term using centered scores (mean – value): Exposed to news about study × Exposed to news about retraction. Utilizing a higher order (e.g., interaction) term in a regression model often leads to multicollinearity problems. As our interaction term is based on centered scores, it has a different scale than do the original variables; thus, these multicollinearity problems are reduced (e.g., Aiken, West, & Reno, 1991).

We also employ four demographic, social, and political variables as statistical controls in our analyses. *Female* is a dummy variable for sex: *male* = 0 and *female* = 1. Slightly more than 60% of our subjects were male. *Age* is measured with seven categories: *18-19* = 1 to *70 or older* = 7. Approximately, 75% of our subjects were aged younger than 40 years. *Education* is measured by the highest degree earned: *less than high school diploma or equivalent* = 1 to *graduate/professional degree* = 6. Approximately, 55% of our subjects had a bachelor's degree. *Political ideology* is measured on a 7-point scale from *very conservative* = 1 to *very liberal* = 7, with *moderate* = 4 in the middle. Approximately, 55% of our subjects identified as slightly to very liberal.

Analytical Techniques

After inspecting the descriptive statistics for each of our outcome, independent, and control variables, we employed ordinary least squares (OLS) regression analyses to examine the extent to which exposure to news coverage of the Séralini et al. study and its retraction have an influence on the three outcome variables, while controlling for four demographic, social, and political variables. We performed all of our analyses with IBM SPSS 24.

Table 1. Unstandardized Coefficients (and Standard Errors) From OLS Regression Models Explaining Risk Perceptions About GM Food (*N* = 423).

Predictors	Relative perceived risk of GM food		Perceived dangerousness of GM crops		Perceived dangerousness of GM food	
Exposed to news about study	0.22***	(0.05)	0.41**	(0.16)	0.44**	(0.17)
Exposed to news about retraction	−0.12*	(0.05)	−0.39*	(0.16)	−0.24	(0.17)
Exposed to news about study × Exposed to news about retraction	−0.31**	(0.10)	−0.73*	(0.31)	−1.04**	(0.33)
Female	0.11*	(0.05)	0.70***	(0.17)	0.72***	(0.18)
Age	−0.00	(0.02)	0.19**	(0.07)	0.28***	(0.08)
Education	−0.03	(0.02)	−0.24**	(0.07)	−0.25**	(0.08)
Political ideology (conservative to liberal)	0.00	(0.02)	−0.01	(0.05)	−0.06	(0.06)
Constant	1.09***	(0.14)	3.77***	(0.43)	3.42***	(0.45)
Adjusted R^2	.06		.09		.11	

Note. OLS = ordinary least squares; GM = genetically modified.
*p < .05. **p < .01. ***p < .001.

Results

Table 1 presents the unstandardized coefficients and standard errors from OLS regression models predicting each of our three outcome variables. The magnitudes of the statistically significant effects of key theoretical variables are not large, and the total amount of variance explained across the models is low. Yet, as we are investigating the influence of a single exposure to brief and intentionally weak experimental messages, we believe that these small effect sizes nevertheless are substantively compelling.

To fully capture the effects of exposure to news coverage of the Séralini et al. study and/or news coverage of its retraction, we must account for the influence of the two experimental dummy variables and their interaction term. We do this by calculating the predicted values of the three outcome variables when *exposed to news about study* is 0 or 1 and when *exposed to news about retraction* is 0 or 1, while holding the demographic, social, and political variables at their means.

Figure 2 displays these predicted values from the OLS regression models in Table 1 for those subjects who were exposed neither to the study story nor the retraction story (white bars), subjects exposed only to the study story (red bars), and subjects exposed both to the study story and retraction story (green bars). The error bars represent 95% confidence intervals to clearly indicate statistically significant differences across predicted values. The results in Figure 2 offer a cross-sectional between-subjects parallel of the longitudinal within-subjects models displayed in Figure 1.

The results in Figure 2 are relatively clear and fairly consistent across the three risk perception outcome variables. Subjects exposed to news coverage of the Séralini et al. study perceive greater risk of GM food relative to that of four mundane technologies, greater dangerousness of GM crops, and greater dangerousness of GM food than do subjects who did not receive this experimental message. These effects on risk perceptions from a single dose of a value-neutral mock news story provide moderate support for SARF, which characterizes the news media as a key risk amplification station.

Does exposure to news coverage of the study *and* of its retraction have no effect on (Proposition 1), attenuate (Proposition 2), or reverse (Proposition 3) risk perceptions amplified by news coverage of the study alone? The patterns displayed in Figure 2 offer clear and consistent support for Proposition 3. For each risk perception outcome variable, subjects exposed to news stories about the study and its retraction reported risk perceptions (a) significantly lower than those of the group who received only the study story and (b) statistically indistinguishable from those of the control group who received neither news story.

Finally, consistent with much research in the risk perception literature, gender has a statistically significant effect on all three risk perception measures. Females perceive GM food and GM crops to be riskier and more dangerous than do their male counterparts. Also, age and educational attainment have a statistically significant effect on the last two risk perception measures. Briefly, older adults and lesser educated adults perceive GM crops and GM food to be more dangerous than do their respective counterparts. Political ideology is not associated with perceived risks of GM crops or GM food.

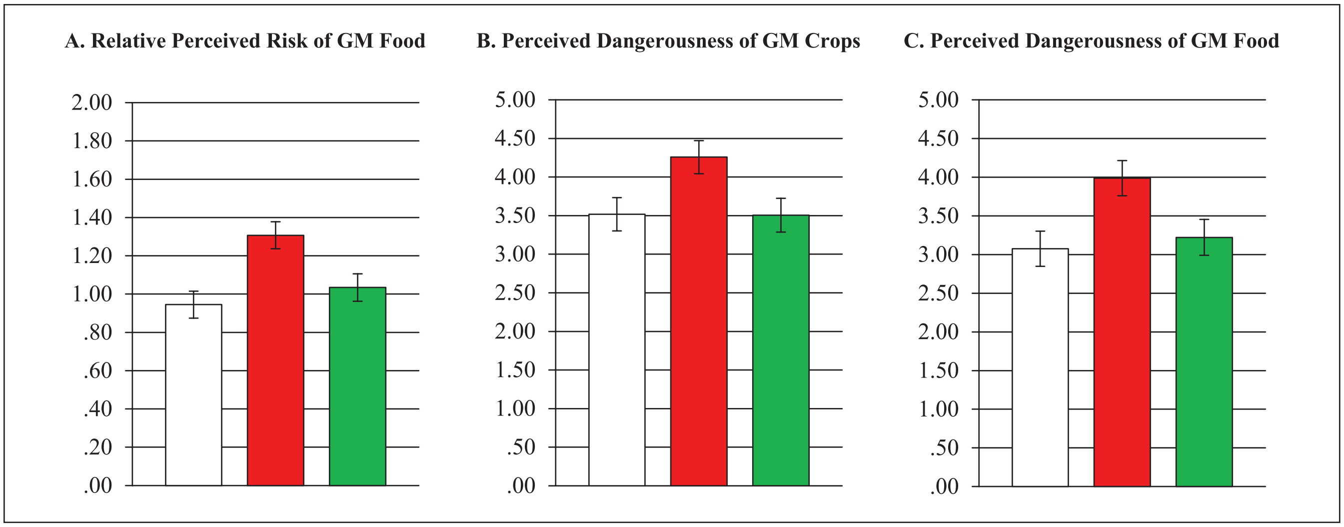

Figure 2. Predicted values from OLS regression models explaining risk perceptions about GM food for subjects exposed neither to the study nor the retraction (white), subjects exposed only to the study (red), and subjects exposed both to the study and retraction (green).
Note. Error bars represent the 95% confidence interval for the predicted values. OLS = ordinary least squares; GM = genetically modified.

Discussion and Conclusion

We administered a between-subjects messaging experiment to investigate how risk perceptions of GM food are influenced by exposure to news coverage of a scientific study highlighting significant GM food risks and/or news coverage of the study's retraction. We found that news coverage of a scientific study's retraction consistently reversed amplified risk perceptions, regardless of the specific risk perception measure. Briefly, exposure to retraction news coverage reversed relative perceived risk of GM food, perceived dangerousness of GM crops, and perceived dangerousness of GM food.

Our study fills a crucial gap in SARF research, which has been criticized for predominantly characterizing the news media as a "social station of amplification" and only occasionally considering it as a "social station of attenuation." Our empirical analysis overcomes this criticism by examining both amplification and attenuation processes simultaneously. Also, our study is particularly timely due to the recent rise in scientific article retractions (Steen et al., 2013; Van Noorden, 2011) and coverage of high-profile cases where eventually discredited and retracted peer-reviewed studies seem to have stoked public risk perceptions of certain technologies, causing long-term societal impacts.

While the rate of scientific article retractions and their subsequent news coverage have increased over the past few decades, scholars have been slow to investigate how such retraction news coverage may affect public perceptions and/or behaviors. Yet, many important questions remain. For instance, does the influence of retraction news coverage on risk perceptions depend upon the reason for the retraction (e.g., honest mistakes vs. intentional misconduct; Steen et al., 2013)? Also, is the effect of retraction news coverage on risk perceptions influenced by how polarized public attitudes are on the technological or scientific development in question? Furthermore, to what extent does retraction news coverage produce broader impacts or "ripple effects" (e.g., increased distrust in science) and how might these effects vary across different demographic, social, and political groups?

Beyond the SARF literature, our findings also carry implications for the larger scientific community and for those involved in science communication. As our results suggest that exposure to retraction news coverage affects public perception of scientific and technological developments, journal editors, publishers, and journalists should be more cognizant of such potential effects when reporting retractions. Clarifying the reason for a retraction (e.g., honest mistakes vs. intentional misconduct) likely may influence how journalists cover the story and how the public perceives the development. Furthermore, if such a distinction helps to destigmatize retractions due to honest mistakes, then scientists may be more likely to admit their own mistakes—which, in turn, may lead to rectification of the scientific record through "self-correction" (Grens, 2015).

Beyond this, science writers may more actively educate the general public about the peer-review process, helping to increase scientific literacy throughout society. A more scientifically informed public would be better able to engage in a nuanced assessment of science news, including the causes and implications of retractions to science and society. Although fraudulent research and retractions represent only a small fraction of all scientific publications, the potential decline in public trust of science that may result from increased awareness of these wrongdoings is troubling. This situation demands a concerted effort by authors, editors, publishers, funding agencies, and journalists to manage these risks.

We end by outlining the limitations of our single study and identifying further avenues to move this emerging scholarship forward. First, our study examined data from a convenience sample, which is typical of many social science experiments. While random assignment satisfies many concerns about internal validity, atypical samples may limit the degree to which findings should be generalized. If future studies examine data from high-quality representative samples, scholars not only could reasonably estimate population characteristics but also would increase the external validity of results about the effectiveness of different experimental messages and messengers on risk perceptions across the general public.

Second, scholars also may examine a range of message and/or messenger characteristics. For instance, how does the inclusion of editorial or value-laden content (e.g., perhaps denouncing the credibility of the retracted article's authors or intimating that the retraction does not discount the technology's riskiness) influence the predictive power of message exposure? Also, how do different messengers' identities influence the impact of the message? For instance, how does it matter if the messenger is a trusted scientist or science communicator versus a well-known advocate for or opponent of the technology?

Third, scholars may investigate how the potential amplification and attenuation effects of media coverage of scientific articles and their retractions vary across types of traditional media (e.g., newspapers, television, radio) and newer social media (e.g., Facebook, Twitter, YouTube). While traditional news outlets operate via journalistic norms that regularly help produce generally accurate and reliable coverage of scientific topics, the relative normlessness of social media platforms produces a mélange of credible scientific knowledge, intentional misinformation, and benign ignorance. It seems reasonable to expect that a newspaper article about a scientific retraction may be judged as more trustworthy than would a Facebook post about that same retraction. Yet, opting into communication networks on social media tends to produce self-contained "echo chambers" ripe for perpetuating motivated cognition (e.g., Colleoni, Rozza, & Arvidsson, 2014). Thus, exposure to social media posts about a scientific study and/or its retraction may be more impactful than newspaper coverage.

Fourth, while we employed a cross-sectional between-subjects design in this initial study, we recommend that at least some follow-up studies employ a longitudinal within-subjects design. The latter allows for investigation of possible changes in individuals' risk perceptions over time. Indeed, scholars may include the time dimension (the length of time between exposure to news coverage of the scientific study and exposure to news coverage of its retraction) as an experimental condition. This is particularly salient as there often is a considerable time lag between the publication of a scientific article and its subsequent retraction. Fifth, additional research should aim to replicate this study to more completely assess the consistency and generalizability of our results. For instance, future research could explore a wider array of established technologies (e.g., childhood vaccines) and emerging technologies (e.g., multipurpose stem cells) that have experienced high-profile retractions in recent years.

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Notes

1. Séralini and his research team (2013) strongly objected to the retraction. A few scientists criticized the journal's decision to retract the study, arguing that this decision sets a problematic precedent for the use of "inconclusive data" as a reason for retraction (Portier, Goldman, & Goldstein, 2014). In June 2014, the Séralini et al. article was republished in *Environmental Sciences Europe* (Séralini et al., 2014) with minor wording changes and without further peer review (Casassus, 2014; Grens, 2014).
2. While Amazon Mechanical Turk (AMT) and similar platforms for crowdsourcing participation in scientific research are less than a decade old, analyses suggest that the quality of data from such sources is similar to, or even slightly better than, the quality of data from professionally managed online panels (Paolacci, Chandler, & Ipeirotis, 2010; Weinberg, Freese, & McElhattan, 2014). All subject recruitment methods have trade-offs (e.g., the representativeness of samples, timeliness and cost of data collection, and data quality). Scholars may address those weaknesses specific to subject recruitment with AMT by careful experimental design (Paolacci et al., 2010), transparency about the study materials, and use of tools for recruiting subjects who are attentive and/or provide higher quality responses (Paolacci & Chandler, 2014).
3. The open-ended comprehension check question assessed whether subjects could accurately summarize the main point of their assigned news story. The open-ended manipulation check question assessed whether subjects understood the scientific community's overall reception of the study as largely positive or negative.
4. Cronbach's alpha for these four items was .71.
5. Many risk perception studies over the last three decades document that some social groups are more risk averse than others—regardless of whether the studies focus on risks in technological, public health, or environmental domains. Our preliminary analyses find that perceived risk of each of the five technologies we used to create our relative risk measure is positively related to all others. All 10 bivariate correlations in the correlation matrix for these five technologies are statistically significant and vary from $r = .14$ and $r = .72$, with an average of $r = .36$. We were concerned that a simple, direct indicator of perceived risk of

genetically modified (GM) food (e.g., how risky is GM food?) would merely tap this general tendency rather than more precisely measuring perceived risk about GM food. The results of preliminary analyses using this simple, direct indicator as our dependent variable validated this concern. That is, females, older adults, and lesser educated adults perceive GM food as riskier than their respective male, younger, and higher educated counterparts—replicating patterns found widely across the risk perceptions literature. To address this, we selected four commonplace technologies that have been examined in the risk perception literature. We then created our composite measure (of the perceived risk of GM food relative to the perceived risk of these four technologies) to more fully distinguish perceived risk of GM from perceived risk more broadly.

Supplementary Material

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References

Aiken, L., West, S., & Reno, R. (1991). *Multiple regression*. Thousand Oaks, CA: Sage.

Allen, S., McCright, A. M., & Dietz, T. (2015). Measuring household energy efficiency behaviors with attention to behavioral plasticity. *Energy Research & Social Science*, *10*, 133-140.

Allum, N. (2007). An empirical test of competing theories of hazard-related trust: The case of GM food. *Risk Analysis*, *27*, 935-946.

Bauer, M. W., Kohring, M., Gutteling, J., & Allansdottir, A. (2001). The dramatization of biotechnology in the elite mass media. In G. Gaskell & M. W. Bauer (Eds.), *Biotechnology 1996-2000: The years of controversy* (pp. 35-52). London, England: Science Museum.

Burns, W. J., Slovic, P., Kasperson, R. E., Kasperson, J. E., Renn, O., & Emani, S. (1993). Incorporating structural models into research on the social amplification of risk: Implications for theory construction and decision making. *Risk Analysis*, *13*, 611-623.

Butler, D. (2012). Hyped GM Maize study faces growing scrutiny. *Nature*, *490*, 158.

Casassus, B. (2014, June 24). Paper claiming GM link with tumors republished. *Nature*. doi:10.1038/nature.2014.15463

Clements, J. M., McCright, A. M., Dietz, T., & Marquart-Pyatt, S. T. (2014). An experiment on hypothetical and actual willingness to donate. *Environmental Sociology*, *1*, 27-37.

Colleoni, E., Rozza, A., & Arvidsson, A. (2014). Echo chamber or political sphere? Predicting political orientation and measuring political homophily in twitter using big data. *Journal of Communication*, *64*, 317-332.

Combs, B., & Slovic, P. (1978). Newspaper coverage of causes of death. *Journalism Quarterly*, *56*, 837-843.

Costa-Font, M., & Gil, J. M. (2008). Consumer acceptance of genetically modified food (GM) in Spain: A structural equation approach. *Risk Management*, *10*, 194-204.

Donk, A., Metag, J., Kohring, M., & Marcinkowski, F. (2012). Framing emerging technologies: Risk perceptions of nanotechnology in the German press. *Science Communication*, *34*, 5-29.

Elsevier. (2013, November 28). Elsevier announces article retraction from journal food and chemical toxicology. *Elsevier*. Retrieved from http://www.elsevier.com/about/press-releases/research-and-journals/elsevier-announces-article-retraction-from-journal-food-and-chemical-toxicology

Freudenburg, W. R., Coleman, C. L., Gonzales, J., & Helgeland, C. (1996). Media coverage of hazard events: Analyzing the assumptions. *Risk Analysis*, *16*, 31-42.

Frewer, L. J., Howard, C., Hedderley, D., & Shepherd, R. (1999). Reactions to information about genetic engineering: Impact of source characteristics, perceived personal relevance, and persuasiveness. *Public Understanding of Science*, *8*, 35-50.

Frewer, L. J., Miles, S., & Marsh, R. (2002). The media and genetically modified foods: Evidence in support of social amplification of risk. *Risk Analysis*, *22*, 701-711.

Gaivoronskaia, G., & Hvinden, B. (2006). Consumers with allergic reaction to food: Perception of and response to food risk in general and genetically modified food in particular. *Science, Technology, & Human Values*, *31*, 702-730.

Ganiere, P., Chern, W. S., & Hahn, D. (2006). A continuum of consumer attitudes toward genetically modified foods in the United States. *Journal of Agricultural and Resource Economics*, *31*, 129-149.

Goodman, J. K., Cryder, C. E., & Cheema, A. (2013). Data collection in a flat world: The strengths and weaknesses of Mechanical Turk samples. *Journal of Behavioral Decision Making*, *26*, 213-224.

Grens, K. (2014, June 24). Retracted GMO study republished. *The Scientist*. Retrieved from http://www.the-scientist.com/?articles.view/articleNo/40342/title/Retracted-GMO-Study-Republished

Grens, K. (2015, December 1). Self-correction: What to do when you realized your publication is fatally flawed. *The Scientist*. Retrieved from http://www.the-scientist.com/?articles.view/articleNo/44594/title/Self-Correction/

Gutteling, J. M., Olofsson, A., Fjaestad, B., Kohring, M., Goerke, A., Bauer, M. W., & Rusanen, T. (2002). Media coverage 1973-1996: Trends and dynamics. In M. W. Bauer & G. Gaskell (Eds.), *Biotechnology: The making of a global controversy* (pp. 95-128). Cambridge, UK: Cambridge University Press.

Hallman, W. K., Hebden, W. C., Aquino, H. L., Cuite, C. L., & Lang, J. T. (2003). *Public perceptions of genetically modified foods: A national survey of American knowledge and opinion*. New Brunswick, NJ: Food Policy Institute, Cook College, Rutgers University.

Hauser, M. D., Weiss, D., & Marcus, G. (2002). Rule learning by cotton-top Tamarins. *Cognition*, *86*, B15-B22. (Retraction published October 2010, *Cognition*, 117(1), p. 106)

Hornig, S. (1993). Reading risk: Public response to print media accounts of technological risk. *Public Understanding of Science*, *2*, 95-109.

Hwang, W. S., Young, J. R., Park, J. H., Park, E. S., Lee, E. G., Koo, J. M., . . . Moon, S. Y. (2004). Evidence of a pluripotent human embryonic stem cell line derived from a cloned blastocyst. *Science*, *303*, 1669-1674. (Retraction published January 2006, *Science, 311*, p. 335)

Johnson, B. B., & Covello, V. T. (1987). *The social and cultural construction of risk*. Dordrecht, The Netherlands: D. Reidel.

Kasperson, J. X., Kasperson, R. E., Pidgeon, N., & Slovic, P. (2003). The social amplification of risk: Assessing fifteen years of research and theory. In N. Pidgeon, R. E. Kasperson,

& P. Slovic (Eds.), *The social amplification of risk* (pp. 13-46). Cambridge, UK: Cambridge University Press.

Kasperson, R. E. (1992). The social amplification of risk: Progress in developing an integrative framework in social theories of risk. In S. Krimsky & D. Golding (Eds.), *Social theories of risk* (pp. 53-178). Santa Barbara, CA: Praeger.

Kasperson, R. E., & Kasperson, J. X. (1996). The social amplification and attenuation of risk. *The Annals of the American Academy of Political and Social Science*, *545*, 95-105.

Kasperson, R. E., Renn, O., Slovic, P., Brown, H. S., Emel, J., Goble, R., & Ratick, S. (1988). The social amplification of risk: A conceptual framework. *Risk Analysis*, *8*, 177-187.

LaCour, M. J., & Green, D. P. (2014). When contact changes minds: An experiment on transmission of support for gay equality. *Science*, *346*, 1366-1369. (Retraction published May 2015, *Science, 348*, p. 1100)

Lang, J. T., & Hallman, W. K. (2005). Who does the public trust? The case of genetically modified food in the United States. *Risk Analysis*, *25*, 1241-1252.

Largent, M. A. (2012). *Vaccine: The debate in modern America*. Baltimore, MD: Johns Hopkins University Press.

Levay, K. E., Freese, J., & Druckman, J. N. (2016). The demographic and political composition of Mechanical Turk samples. *SAGE Open*, *6*, 1-16. doi:10.1177/2158244016636433

Mazur, A. (1984). The journalist and technology: Reporting about love canal and three mile island. *Minerva*, *22*, 45-66.

Mazur, A. (1990). Nuclear power, chemical hazards, and the quantity of reporting. *Minerva*, *28*, 294-323.

McCabe, A. S., & Fitzgerald, M. R. (1991). Media images of environmental biotechnology: What does the public see? In G. S. Sayler, R. Fox, & A. Blackburn (Eds.), *Environmental biotechnology for waste treatment* (pp. 15-24). New York, NY: Plenum.

Obokata, H., Wakayama, T., Sasai, Y., Kojima, K., Vacanti, M. P., Niwa, H., . . . Vacanti, C. A. (2014). Stimulus-triggered fate conversion of somatic cells into pluripotency. *Nature*, *505*, 641-647. (Retraction published July 2014, *Nature, 511*, p. 112)

Paolacci, G., & Chandler, J. (2014). Inside the Turk: Understanding Mechanical Turk as a participant pool. *Current Directions in Psychological Science*, *23*, 184-188.

Paolacci, G., Chandler, J., & Ipeirotis, P. G. (2010). Running experiments on Amazon Mechanical Turk. *Judgment and Decision Making*, *55*, 411-419.

Pidgeon, N. F., Kasperson, R. E., & Slovic, P. (Eds.). (2003). *The social amplification of risk*. Cambridge, UK: Cambridge University Press.

Pidgeon, N. F., Poortinga, W., Rowe, G., Jones, T., Walls, J., & O'Riordan, T. (2005). Using surveys in public participation processes for risk decision making: The case of the 2003 British GM nation? Public debate. *Risk Analysis*, *252*, 467-479.

Poortinga, W., & Pidgeon, N. (2005). Trust in risk regulation: Cause or consequence of the acceptability of GM food? *Risk Analysis*, *25*, 199-209.

Portier, C. J., Goldman, L. R., & Goldstein, B. D. (2014). Inconclusive findings: Now you see them, now you don't! *Environmental Health Perspectives*, *122*, A36.

Rada, R. F. (2005). A case study of a retracted systematic review on interactive health communication applications: Impact on media, scientists, and patients. *Journal of Medical Internet Research*, *7*(2), e18.

Rada, R. F. (2007). Retractions, press releases, and newspaper coverage. *Health Information & Libraries Journal*, *24*, 210-215.

Renn, O. (1991). Risk communication and the social amplification of risk. In R. E. Kasperson & P. J. M. Stallen (Eds.), *Communicating risks to the public* (pp. 287-324). Dordrecht, The Netherlands: Springer.

Renn, O., Burns, W. J., Kasperson, J. X., Kasperson, R. E., & Slovic, P. (1992). The social amplification of risk: Theoretical foundations and empirical applications. *Journal of Social Issues*, *48*, 137-160.

Scheufele, D. A., & Lewenstein, B. V. (2005). The public and nanotechnology: How citizens make sense of emerging technologies. *Journal of Nanoparticle Research*, *7*, 659-667.

Séralini, G. E., Clair, E., Mesnage, R., Gress, S., Defarge, N., Malatesta, M., . . . de Vendômois, J. S. (2012). Long term toxicity of a roundup herbicide and a roundup-tolerant genetically modified maize. *Food and Chemical Toxicology*, *50*, 4221-4231. (Retraction published November 2014, *Food and Chemical Toxicology*. doi:10.1016/j.fct.2012.08.005)

Séralini, G. E., Clair, E., Mesnage, R., Gress, S., Defarge, N., Malatesta, M., . . . de Vendômois, J. S. (2014). Republished study: Long-term toxicity of a roundup herbicide and a roundup-tolerant genetically modified maize. *Environmental Sciences Europe*, *26*(1), 1-17.

Séralini, G. E., Mesnage, R., Defarge, N., Gress, S., Hennequin, D., Clair, E., . . . de Vendômois, J. S. (2013). Answers to Critics: Why there is a long term toxicity due to a roundup-tolerant Genetically Modified Maize and to a roundup herbicide. *Food and Chemical Toxicology*, *53*, 476-483.

Siegrist, M. (2000). The influence of trust and perceptions of risks and benefits on the acceptance of gene technology. *Risk Analysis*, *20*, 195-203.

Steen, G. R., Casadevall, A., & Fang, F. C. (2013). Why has the number of scientific retractions increased? *PLoS ONE*, *8*(7), e68397.

Stephan, H. R. (2015). *Cultural politics and the transatlantic divide over GMOs*. New York, NY: Palgrave Macmillan.

Suzuki, H., Mohr, U., & Kimmerle, G. (1979). Spontaneous endocrine tumors in Sprague-Dawley rats. *Journal of Cancer Research and Clinical Oncology*, *952*, 187-196.

Tobin, M. J. (2000). Reporting research, retraction of results, and responsibility. *American Journal of Respiratory and Critical Care Medicine*, *162*, 773-774.

Torgersen, H., & Seifert, F. (1997). Aversion preceding rejection: Results of the Eurobarometer survey 39.1 on biotechnology and genetic engineering in Austria. *Public Understanding of Science*, *6*, 131-1142.

Traill, W. B., Jaeger, S. R., Yee, W. M. S., Valli, C., House, L. O., Lusk, J. L., . . . Morrow, J. L., Jr. (2004). Categories of GM risk-benefit perceptions and their antecedents. *AgBioForum*, *7*, 176-186.

Van Noorden, R. (2011). The trouble with retractions. *Nature*, *478*, 26-28.

Vilella-Vila, M., & Costa-Font, J. (2008). Press media reporting effects of risk perceptions and attitudes towards genetically modified (GM) food. *The Journal of Socio-Economics*, *37*, 2095-2106.

Wakefield, A. J., Murch, S. H., Anthony, A., Linnell, J., Casson, D. M., Malik, M., . . . Walker-Smith, J. A. (1998). Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children. *The Lancet*, *351*, 637-641. (Retraction published, *Lancet*. doi:10.1016/S0140-6736(97)11096-0)

Weinberg, J. D., Freese, J., & McElhattan, D. (2014). Comparing data characteristics and results of an online factorial survey between a population-based and a crowdsource-recruited sample. *Sociological Science*, *1*, 292-310.

Winsten, J. A. (1985). Science and the media: The boundaries of truth. *Health Affairs*, *4*, 5-23.

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