Countering False Beliefs: An Analysis of the Evidence and Recommendations of Best Practices for the Retraction and Correction of Scientific Misinformation

Man-pui Sally Chan, Christopher Jones, and Dolores Albarracín

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Abstract and Keywords

Although false beliefs about science are at the core of theory and practice in the field of scientific communication, correction and retraction of misinformation entail a complex and difficult process. This chapter first provides a review of trends in scientific retraction and correction notes failures in the fundamental communicative function of signaling that a published finding has been invalidated. It describes the recent practical communication developments that are increasing the transparency and visibility of retractions and corrections of fraudulent or incorrect scientific findings and examines the final barrier to correction of misbelief: the continued influence effect. The chapter reviews the results of a meta-analysis of the continued influence effect and present psychology-based recommendations in the form of decision trees to guide the work of scientists and practitioners and provides eight best practice recommendations for science communication scholars and practitioners as they continue their battle against misinformation.

Keywords: misinformation, retraction, correction, continued influence, beliefs, meta-analysis, science communication

The recent increase in retractions of scientific articles is likely due to the rise of public awareness and a greater attention paid by the scientists. Such a change does not necessarily imply an increase in scientific misconduct.

> Autism has become an epidemic. Twenty-five years ago, 35 years ago, you look at the statistics, not even close. It has gotten totally out of control. … Just the other day, 2 years old, 2 and a half years old, a child, a beautiful child went to have the

> vaccine, and came back, and a week later got a tremendous fever, got very, very sick, now is autistic.
>
> (Donald Trump, Republican presidential debate, CNN 2015)

Despite repeated demonstrations that the asserted link between the vaccination against measles, mumps, and rubella (MMR) and autism is a bogus one, the false belief was reinforced in a national debate on September 16, 2015, by Donald Trump, the 2016 Republican presidential candidate (CNN 2015). The example illustrates one way in which false belief can expose a sizable segment of the population to unnecessary health risks and create serious challenges in science communications (Lewandowsky 2016; Ranney and Clark 2016).

The resilience of the discredited association between the MMR vaccine and autism is a well-documented instance of the potential permanence of misinformation (i.e., knowledge that has been invalidated or demonstrated to be false). The troubling association was posited in a 1998 paper in *The Lancet* by Wakefield and colleagues and persists (p. 342) today despite methodological problems that invalidate the original results (Chen and DeStefano 1998) and research debunking the purported relation (e.g., Honda et al. 2005; Fombonne and Cook 2003). An investigation performed by O'Brien and colleagues (1998) revealed a nondivulged conflict of interest pertaining to the first author in 2004 (Deer 2004). Further, a number of scientists presented overwhelming evidence to refute the vaccine–autism link (Elliman and Bedford 2007), resulting in some of the article's authors partially retracting the piece before *The Lancet* finally issued a blanket retraction in 2010. The retraction, however, only occurred after the British General Medical Council revoked Wakefield's medical license following an investigation into his ethical lapses (Deer 2011).

Misbeliefs about the effects of the vaccine and refusals to vaccinate continue to drive a regrettably high incidence of these entirely preventable diseases (Centers for Disease Control and Prevention 2015), clearly showing that scientific consensus on an issue is insufficient to produce public consensus. Belief (i.e., subjective probability) in the specious vaccine–autism link peaked in the early 2000s alongside prominent journalistic coverage (Brainard 2013; Lewis and Speers 2003). To a lesser extent, the belief persists today, with 6% of US Gallup respondents indicating that vaccines cause autism and over half being unsure about the presence or absence of a relationship (Newport 2015). Despite the importance of scientific evidence, the misinformation effect could be magnified because of the existence of high-profile advocates who exert a more direct and far-fetching influence on a credulous public than do scientists. These erroneous beliefs likely contributed to a 1.7 time increase in refusal to vaccinate children in the US and a 7% drop of the MMR vaccine coverage in the UK in recent years (Smith et al. 2008), with evident local associations between nonmedical vaccination exemptions and outbreaks of infectious disease preventable by vaccination (Majumder et al. 2015; Atwell et al. 2013).

The stubborn persistence of discredited scientific findings poses an increasing challenge for science communication, as well as for the process of scholarly retraction (i.e., the declaration of a previously reported finding as false, the declaration of infringement of ethical conduct, or the change of authorship and proprietary interests) and correction (i.e., the statement of the true nature of the evidence concerning a previously communicated false claim when the amendment of the text does not influence the actual findings). In the past decade, the number of notices of retraction of scientific articles has increased tenfold, outpacing overall publication growth, with nearly 67% of the retractions stemming from misconduct (Marcus and Oransky 2014; Davis 2012; Fang et al. 2012; Budd et al. 2011; Steen 2011; Van Noorden 2011). This problem has attracted increased attention among practitioners and led to efforts to increase the integrity of scientific research and its dissemination. In this chapter, we examine evidence justifying the conclusion that retractions have sometimes failed in their most basic informational function—to signal that a piece of published research is unreliable. We then note a number of ways in which practitioners may increase the likelihood that a corrected or retracted finding will no longer be cited as reliable, examine the theories explaining the persistence of misinformation before and even after correction, and describe the results of a meta-analysis from which we draw suggested ways to uproot discredited information.

Communication Strategies to Reduce the Persistence of Retracted Findings in the Scholarly Literature

The challenge of correcting misinformation and retracting incorrect or fraudulent scientific findings involves communication that should include prompt retraction, issuing detailed retractions, widely disseminating retraction, linking the retraction or correction to the misinformation, and developing monitoring and alert systems.

Prompt Retraction and Correction

Although we located no research confirming the fact, it seems reasonable to assume that prompt retraction of discredited work will minimize its subsequent influence. Despite the fact that scholarly teams repeatedly failed to replicate the Wakefield finding, it took *The Lancet* twelve years to retract the fraudulent Wakefield paper. Lacking a clear signal from the journal that the finding was unsupported, reporters were more likely to report on the controversy in terms that suggested a two-sided debate when instead the science clearly and unequivocally located no evidence of the association Wakefield had alleged (see Hall-Jamieson 2015; Brainard 2013). This example raises questions regarding the sufficiency of the current system in which, in the absence of consent of the authors, the editors of journals alone hold the power to retract articles but have no resources or authority beyond threat of retraction to investigate allegations of misconduct, and the journal publishers execute the retraction but (p. 343) have no procedures to guide the retraction notice in a timely and efficient manner. Such allegations are pursued by research or regulatory institutions, and journals depend on their outcomes.

However, in some cases only the content of the publication itself may demonstrate misconduct. One analysis of retractions found that almost half were due to publishing misconduct, which refers to plagiarism (including self-plagiarism) and to duplication, the publication of the same data in multiple outlets in violation of journal policy (Grieneisen and Zhang 2010). One recent technical development may help speed the identification of publishing misconduct: in 2008 new plagiarism detection software called CrossCheck was introduced, which compares submitted manuscripts to a database of over 25 million published articles. New statistical procedures may also speed the identification of problematic publications by isolating suspicious patterns of reported results (Simonsohn et al. 2014).

Recommendation 1: Issue retractions and corrections promptly, as soon as the delivery of misinformation has been confirmed.

Timeliness can reduce exposing large audiences to erroneous and fraudulent information and is likely the best remedy to minimize misconceptions. Naturally, there are justifiable reasons underlying journals' delays in issuing retractions, such as a lengthy legal consultation process surrounding an allegation of misconduct (see *Nature* [2014] for discussion). However, journals should publish an expression of concern to alert readers in the interim (Wager et al. 2009).

Ensuring that Retractions Are Detailed

As increasing attention has been paid to whether the practices of research journals are adequate, changes in how retractions themselves are issued have been recommended and in some instances instituted. A study of Medline retractions from 1988 to 2008 found: journals' retraction practices are not uniform. Some retractions fail to state the reason and therefore fail to distinguish error from misconduct (Wager and Williams 2011). Organizations have responded by pressuring journals to address retractions more comprehensively. For example, the International Committee of Medical Journal Editors specifies the ways in which retractions should be publicized within journals, including the retraction, so labeled, should appear in a prominent section of the journal, be listed in the contents page, and include in its heading the title of the original article. These structural changes are likely to increase visibility of retractions by rendering retracted articles more likely to be tagged as such in Web searches.

In addition, other recommendations address the problem of vagueness: "[the] text of the retraction should explain why the article is being retracted and include a bibliographic reference to it" (International Committee of Medical Journal Editors 2015; Wager et al. 2009). Still another class of recommendations argues for a distinction among types of retractions to avoid conflating honest error caught by a scholar with fraudulent science and in the process incentivizing cover up and disincentivizing correction (Alberts et al. 2015). One study of citations to researchers' prior work following retractions of a paper suggests that the scientific community's treatment of these authors is largely well calibrated. Lu and colleagues (2013) found that retractions overall led to citation loss for prior papers but that this effect was not present for retractions due to self-reported error. However, other research has indicated that publications relating to entire areas of inquiry may suffer citation loss following high-profile retractions (Azoulay et al. 2015), which might harm researchers who have done nothing wrong.

Recommendation 2: Make retractions and corrections detailed, distinguish honest error from fraud, and avoid casting doubt over a research area as a whole.

As already described, an in-depth explanation is necessary to facilitate the acceptance of retractions. Publishers can obtain precise information for retractions through a form that is publicly available online. This check-box based retraction form follows the Retraction Watch checklist and the COPE guidelines and includes the following: (a) when the journal was first alerted to potential problems, (b) whether other papers by the same group will be affected, and (c) whether there was an institutional investigation and, if so, the result. Specific information should serve to better discount false beliefs, without calling into question an entire area of scholarly inquiry. Lack of sufficient details increases reluctance to correct information and may increase the chances that false beliefs persist in audiences exposed to the retraction (Johnson and Seifert 1994; Wilkes and Leatherbarrow 1988).

Wide Dissemination of Retractions

Another communication dimension of retractions is the adequacy of journals' efforts to publicize them. Underlying this concern is the possibility that the journal's interest in preserving its reputation might override its interest in (p. 344) communicating that an article has been retracted. Some have suggested that research journals are too slow to retract and too reluctant to provide relevant information when they do (Marcus and Oransky 2014). Research is needed on how the public learns about retractions, what it makes of them, and how journalists can most effectively cover them. Very little is known about how often individuals in different nonscholarly populations are exposed to information about retractions or how exposure influences perceptions of science. Given that most individuals are unlikely to peruse academic journals, they probably hear about retractions only in accounts in popular media (see Chapter 8 in this volume). Research on the impact of retractions should examine whether the original publication was widely publicized and, if so, whether the retraction received as much news play as the original finding. Scholarship on ways to increase the effectiveness of news corrections of false advertising may be instructive here. It is possible to minimize unwanted propagation of misinformation on social media such as Facebook by providing related links. Individuals who read a post containing misinformation on Facebook but also a related story to correct the misinformation reported significantly reduced misperceptions (Bode and Vrage 2015). In these cases, the false or suspect information should not be repeated as if true and then followed with contradictory commentary but rather should be introduced as dubious and overlaid with corrective information. The superimposed *RETRACTED* watermark on the PDF of the original article is used to signal retraction by the journal publishers and easily identified in Google Scholar searches. This kind of technique is comparable to the one found effective in debunking false claims in advertisements.

Recommendation 3. Disseminate corrections and retractions widely and clearly.

Oransky (2015) has reported a surprising continuation of citations of retracted research articles, probably due to lack of dissemination of the retractions. When a finding has been widely publicized by the press, the same popular media not only should cover the retraction of it but should do so in a fashion likely to dislodge the discredited information. When corrections come to the media's attention, they should seek to publish corrections promptly. The clarifications and corrections should be clear to anyone who reads the news article by providing information on what the mistake was, why it occurred, and how it has been corrected.

Linking the Retraction or the Correction to the Misinformation

A retraction should ideally ensure that decertified article is rarely if ever cited again and that any citation acknowledges the retraction. Yet an early study found that more than two hundred retracted articles had been cited 2,034 times after retraction, usually with no mention of the retraction (Budd et al. 1998). The problem has apparently persisted in recent decades as well (Neale et al. 2010). A retracted article about the insulin effects of a protein supposedly secreted by visceral fat was cited 776 times after retraction, about

three times more than before its retraction (Oransky 2015). In addition, a retracted article of the only controlled study on the supposed effect of giving omega-3 supplements to patients with chronic obstructive pulmonary disease has been cited fifty-two times since being retracted, with only two citations mentioning the retraction (Fulton et al. 2015). To address difficulties in eliminating citations, new laudable efforts are underway. The use of CrossMark gives scholars the information they need to verify that they are using the most recent and reliable versions of a document. Readers simply click on the CrossMark logos on PDF or HTML documents, and a status box tells them if the document is current or if updates are available. By linking corrections to retractions, CrossMark updates scholars on recent developments and minimizes reliance on retracted work. We urge journal publishers to install CrossMark and to provide detailed information about corrections and retraction, such as what information is in error and why, as part of the live record; the innovative use of technology leads to our fourth best practice recommendation.

Recommendation 4. Permanently link corrections and retractions to the misinformation.

Because the repetition of information can increase the perceived familiarity and coherence of related materials (Ecker et al. 2011; Schwarz et al. 2007), practitioners should recontextualize the false conclusion with the corrective information whenever possible. This practice would not just strengthen the link between misinformation and retractions but also avoid enhancing the familiarity of the misinformation.

Establishing Monitoring and Alert Systems to Track Retractions

Founded in 2010 by Ivan Oransky and Adam Marcus to provide open access to information about scientific corrections and retractions, Retraction (p. 345) Watch has diligently addressed the problems of retraction exposure and opacity. Apart from publishing retraction notices, the Retraction Watch staff contacts corresponding authors and editors to obtain more information about each case. The Web blog, together with the transparency index, serve an important translational function between science and journalism by providing journalists and the interested public with a way to keep track of retractions across all areas of science, thus our next recommendation is therefore that such systems be encouraged and supported.

Recommendation 5. Create and sustain monitoring and alert systems to track retractions.

An ongoing monitoring system to track retractions can provide readers with the latest notices of any retraction. The follow-up investigations and interviews can serve as an alert system for retracted articles and maintain an open dialogue for readers to work through the inconsistencies and invalidate the misinformation. Retraction Watch, together with other retraction monitoring platform such as PubPeer, should become a

permanent part of the scholarly dialogue with journalists and the public. Journal publishers should link up with such platforms and list all relevant retracted news reported for readers.

Psychological Mechanisms and Communication Strategies for Overcoming False Beliefs

Even if communication efforts disseminate retractions, research has demonstrated that information that is retracted or corrected can continue to exert an influence on outcomes such as judgment and behavior when logically the information should have no further impact (Lewandowsky et al. 2012; Seifert 2002). A recent study (Greitemeyer 2014) demonstrated how this continued influence can occur for invalidated scientific results. Participants were first exposed to a research hypothesis that was ostensibly supported in an actual research paper. Despite then being informed that the study had been retracted, the participants subsequently reported higher belief in the hypothesis than did control participants. The reason for the misinformation persistence was apparently that individuals generated their own causal explanations consistent with the existence of the hypothesized relation. These explanations continued to seem subjectively valid and therefore, despite the retraction, led to a persistent belief in the retracted article's hypothesis. In short, the retraction failed to dispel acceptance of an idea expressed in the retracted publication (Greitemeyer 2014).

Despite public and scholarly concern about the diffusion of false information, a comprehensive understanding of the persistence of false beliefs—misinformation, retraction, and continued influence—has been elusive. We draw on a meta-analysis reported in detail elsewhere (Chan et al. n.d.) to evaluate two theories that have been put forward to explain belief perseverance: Mental Model Theory and Dual Process Theory.

Mental Model Theory and Generating Arguments in Support of the Misinformation

One conceptualization of the mental model of reasoning (Johnson-Laird 1994; Johnson-Laird and Byrne 1991) states that people construct a web of mental models from which they draw causal conclusions. As fresh information emerges, information recipients set up new models or extend existing ones but are often unwilling to discard key information when no plausible alternative exists to fill the gap (Johnson and Seifert 1994; Wilkes and Leatherbarrow 1988). This theory would suggest that those who elaborate on false claims are likely to have mental models of causal conclusions about misinformation. If so, the higher the likelihood of generating explanations for the misinformation, the greater the persistence of misinformation and the lesser the retraction effect. Moreover, correct information is not sufficient for a causal explanation to fill the discrepancy in the mental

models (Johnson and Seifert 1994; Wilkes and Leatherbarrow 1988). Thus corrections that simply label an informational source as *incorrect* may be unable to fill the void and integrate the corrections into a network of coherent mental models to reduce falsification of misinformation (Johnson and Seifert 1994; Wilkes and Leatherbarrow 1988).

A meta-regression analysis (Chan et al. n.d.) did indeed show a negative association with generation of explanations for misinformation. The greater the elaboration or mental model of misinformation, the weaker the achieved retraction. Moreover, the more recipients who generated explanations in line with the misinformation, the stronger the persistence of the false beliefs or attitudes based on that misinformation. Providing new and credible information had a stronger retraction effect than labeling previous information as incorrect.

This analysis suggests that individuals persist in their false beliefs because of mental models of (p. 346) misinformation, often strengthened by the process of generating arguments supporting it. Retraction is less effective when people are more likely to generate explanations for the misinformation than when they are not. In line with this finding, the influence of misinformation was more persistent when recipients were more likely to generate explanations for it; the retraction effect weaker when misinformation was simply labeled as incorrect and stronger when the correction introduced new and credible information.

Recommendation 6: Reduce the generation of arguments in line with the misinformation and correct misinformation with new information.

The reviewed findings suggested that generating explanations that legitimize the misinformation reduces the later acceptance of the correction. Elaborating on the reasons for a particular event allows recipients to form a mental model that later biases processing of new information and makes falsification of the initial belief more difficult. Therefore, media and policymakers should ensure that the coverage of misinformation at no point presents it without corrective information. Uncorrected repetition of misinformation opens the opportunity to generate thoughts in agreement with it. Further, simple negation may be insufficient: the false information should be supplanted with new substantiated information.

Dual Process Theory and Generating Counterarguments to the Misinformation

Another theory that accounts for belief perseverance was formulated within a dual-process framework (Evans 2008). System I processes include a fast, instinctive, and emotional thinking style, whereas system II processes involve slower and more deliberative reasoning (see Croskerry et al. 2013; Kahneman 2003 for review). Consistent with this model, a controlled and careful dissection of incorrect ideas generally facilitates the acquisition of correct information (Kowalski and Taylor 2009). In a naturalistic experiment, the direct refutation of false information was more successful in changing

attitudes and beliefs than was the nonrefutational approach (Kowalski and Taylor 2009). Furthermore, in-depth processing of information and corrections may assist people in working through inconsistencies and ultimately accepting the corrections (Osborne 2010).

Another study demonstrated that detailed corrections of misinformation provided by political candidates are effective at decreasing undue influence (Jerit 2008). An analysis of more than forty opinion polls indicated that engaging an opponent in a dialogue is an effective political debate strategy, probably because the speaker can counter argue the point of view in greater detail. These findings would lead one to suspect that conditions that increase the probability of generating alternatives to the misinformation should increase retraction effects and reduce continued influence. The meta-analysis revealed that the higher the likelihood of counterarguing the misinformation, the stronger the retraction effect. In other words, the retraction effect indeed was stronger when recipients of the misinformation were likely to counterargue it than when they were not.

Recommendation 7: Create conditions that facilitate scrutiny and counterarguing of misinformation.

Because counterarguing the misinformation enhances the likelihood that the correction will be accepted, when retractions or corrections are issued, facilitating understanding and generating detailed counterarguments of the misinformation should yield optimal retraction. Thus corrections should counterargue the misinformation in detail.

Additional Findings about Domains of Misinformation and Correction

The meta-analysis found substantial differences in the effects of misinformation and correction depending on information domain. A meta-regression analysis with type of news reports (i.e., political vs. social) examined these effects. Political news includes information about political candidates or their opinions on policies, whereas social news includes information about fire accidents, burglaries, or crimes. The results were in line with the notion that the misinformation and retraction effects in the political domain were about two to five times higher than the effects in the social domain, whereas the influence of social news was more persistent than that of political news.

Recommendation 8. Develop alert systems in different domains.

Policymakers should be aware of the likely persistence of misinformation about social events such as crime or accidents. Thus although many alert systems exist in the political domain, such as Factcheck.org, PolitiFact, and *The Washington Post*'s FactChecker, there is a need to expand this kind of activity to include monitoring and correction in the social domain as well. Sites such as Snopes.com that serve this function should be supported and publicized. **(p. 347)**

Summary of Recommendations to Reduce False Beliefs after Exposure to Corrections and Retractions

We have telegraphed these recommendations in the decision trees in Figure 36.1, including (1) issuing retractions and corrections promptly, (2) making retractions and corrections detailed, (3) disseminating corrections and tractions widely and clearly, (4) permanently linking corrections and retractions to the misinformation, (5) creating monitoring and alert systems to track retractions, (6) reducing the generation of arguments in line with the misinformation, (7) creating conditions that facilitate scrutiny and (8) developing, supporting, and publicizing alert systems in different domains. Of course, implementing these recommendations may have minimal effects if any on those who already hold strong beliefs in false claims, (e.g., cultural misbeliefs) Moreover, no single set of recommendations can protect every person from falling into the trap of misinformation. Nevertheless, the research summarized here does suggest that increased efforts that are theoretically driven and guided by scholarly work can debunk some false beliefs of at least some of the people some of the time. Moreover, improvements in the retraction process have the potential to reduce the likelihood that the public will be exposed to bogus information in the first place.

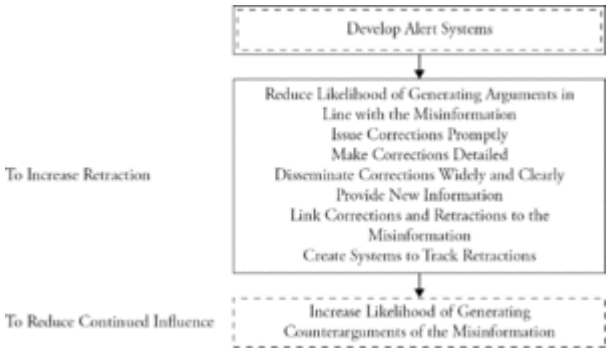

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Figure 36.1 **Decision trees of countering false beliefs.** Solid line indicates the relative importance of the tasks to counter false beliefs in the political domain; dashed line indicates the relative importance of the tasks to counter false beliefs in the social domain.

Conclusion

Our recommendations appear in Figure 36.1. Scientific misinformation persists when retractions and corrections are not promptly issued, are not sufficiently detailed, and fail to connect to the misinformation. Our review also noted moderating characteristics of the misinformation and the recipients' cognitive activity that are consistent with psychological theories of cognition and information processing. We argued that corrections will be less effective for recipients who have previously developed mental models about the misinformation. Recent studies have suggested that the presence of conspiratorial thinking also accounts for the persistence of erroneous beliefs. Conspiratorial ideation refers to the cognitive tendency to explain a significant political or social event as a secret plot by powerful individuals or organizations and the incapacity to label some information as a scam (Lewandowsky et al. 2015; Sunstein and Vermeule 2009). Conspiracy theories likely provide very strong and difficult to dismantle mental models that decrease falsification and can even reinforce misconceptions as time goes by (Lewandowsky et al. 2015). The effects of conspiratorial thinking provide an obvious departure point for future work on the link between ideologies and misinformation effects.

Finally, it is important to consider the role of emerging media, in rapidly disseminating and reinforcing (mis)information online and through electronic social networks. The Internet has become an unsupervised environment for the massive diffusion of unsubstantiated or false information. In fact, a search for "MMR vaccine and autism" in Google Trends reveals declining but still strong interest in this false scientific claim, particularly in New York and California. Further, antivaccine forums such as http://vaccineresistancemovement.org remain alive and well, particularly in the United States and the United Kingdom. Recent analyses of public Facebook pages have shown that network properties (p. 348) (e.g., homogeneity and polarization) strongly influence the stickiness of false beliefs (Del Vicario et al. 2016). As scholars study these network characteristics, as well as individual differences in the aggregated communities, a more complete take on the variables at play in the persistence and uprooting of uncorrected and corrected false information will emerge.

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Man-pui Sally Chan

Man-pui Sally Chan, PhD, has a background in information systems and received her doctoral degree in psychology. She has been a postdoctoral fellow at the University of Cambridge and is currently a research associate at the University of Illinois at Urbana-Champaign. Dr. Chan's interests are in incorporating the data science approach to address social and health psychology research questions and examining the influences of social media on individuals' beliefs and attitudes as well as mental and physical well-being in various settings (e.g., by conducting meta-analyses and laboratory experiments).

Christopher Jones

Christopher Jones majored in psychology at Miami University and obtained his PhD in social psychology at The Ohio State University with his mentor Russ Fazio. Much of Dr. Jones's work has concerned attitude change and has often fallen at the intersection of social cognition and mental health. His postdoctoral work at the Annenberg Public Policy Center involved a meta-analysis of experiments on the lingering, pernicious effects of misinformation even after retraction and/or correction.

Dolores Albarracín

Dolores Albarracín is a professor of psychology and business at the University of Illinois at Urbana-Champaign. She studies attitudes, motivation, and behavior change, in relation to both basic psychological processes and applications to health promotion. She is the lead editor of the Handbook of Attitudes, a coeditor on a behavior-prediction book, and the author of approximately 130 journal articles and chapters. Dr. Albarracín serves on several national and international committees, including the National Institutes of Health Behavioral and Social Science Approaches to Preventing HIV/AIDS Study Section.