Misinformation and its Correction: Cognitive Mechanisms and Recommendations for Mass Communication

In. B. Southwell, E. A. Thorson, & L. Sheble. (Eds), *Misinformation and Mass Audiences.* Austin, TX: University of Texas Press.

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In 2007, a man in the United Kingdom posted a photograph on his website of a "mummified fairy" which he created as an April Fools' prank. After receiving 20,000 visitors to the site in one day, he explicitly revealed that he had fabricated the scenario, yet many accused him of covering up the truth and vehemently insisted that the fairy was real ("Fairy fool", 2007). This anecdote highlights a valid concern to mass communicators: regardless of how ridiculous information seems, once it is in the public sphere, it can take on a life of its own and may never be fully retractable.

It has become a societal norm that the media and the internet provide vast quantities of information, placing the onus on the individual to sort fact from fiction. However, individuals have limited time, cognitive resources, or motivation to understand complex topics such as scientific findings or political developments, and misconceptions are commonplace. Unfortunately, once inaccurate beliefs are formed, they are remarkably difficult to eradicate (Ecker, Lewandowsky, Swire, & D. Chang, 2011a). Even after people receive clear and credible corrections, misinformation continues to influence their reasoning: in cognitive psychology, this is known as the *continued influence effect of misinformation* (H. Johnson & Seifert, 1994; Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012). The mummified fairy is a benign example, but the ramifications can be serious. Belief in misinformation can adversely impact decision making, and the continued influence effect has real-world implications in areas as disparate as education, health, and the economy.

One prominent example is the misconception that the measles, mumps, rubella (MMR) vaccine causes autism. This falsehood has been repeatedly—and convincingly—retracted by the

media and scientific community over a number of years since the original myth was disseminated in a fraudulent article. Despite these debunking efforts, the myth has led to a drop in vaccination rates, and an increase in vaccine-preventable disease (Poland & Spier, 2010). The economic burden of 16 measles outbreaks in the US in 2011 alone has been estimated somewhere between $2.7 million and $5.3 million (Ortega-Sanchez, Vijayaghavan, Barskey, & Wallace, 2014). Thus, developing evidence-based recommendations on how to adequately communicate corrections and minimize reliance upon inaccurate information is not only important for individual decision making but also has ramifications for society as a whole.

The most important recommendation for both traditional mass media such as newspaper and television, as well as more recent technologies such as Twitter—which have essentially transformed ordinary citizens into would-be journalists—is to take greater care to ensure that information is *correct to begin with.* However, this is not always realistic due to the fast pace of modern information consumption and dissemination, and the fact that ordinary citizens are not bound by rules of journalistic integrity. Social media is thus an ideal breeding ground for the propagation and transition of misinformation, which can be exemplified by its role in rumors surrounding the Boston Marathon bombing in 2013. For example, a well-intentioned Reddit thread was created to help find the perpetrators, yet the accusation of an innocent and deceased Brown University student subsequently went viral (Guzman, 2013). Information shared through social media is usually disseminated without fact-checking, based merely on its potential to elicit emotional responses or support a personally motivated argument (Peters, Kashima, & Clark, 2009).

This chapter focuses on cognitive mechanisms and theories accounting for the continued influence of misinformation. In particular, we will discuss what drives belief in

inaccurate information, why certain individuals are predisposed to refrain from belief change even in the face of good corrective evidence, and how corrections can be designed to maximize impact. We therefore provide six practical recommendations based upon our current knowledge of cognitive processes. We first discuss theoretical accounts for the continued influence effect such as mental models, dual processing theory, the necessity of co-activation of misinformation and new information, and the impact of the information's source. We then discuss individual predispositions to the continued influence effect, in particular a person's worldview and skepticism.

Mental Models

When people initially encounter information, a situation model of integrated memory representations is built, and this model is continuously updated as new information becomes available and relevant (Bower & Morrow, 1990). If the required changes are small, they can be integrated into the situational model incrementally (Bailey & Zacks, 2015), yet if a larger change is required, a "global" update is necessary, which involves discarding the old mental model and creating a new one (Kurby & Zacks, 2012). However, even if there are sufficient cognitive resources to notice a difference between one's mental model and the current environment, people are often quite inadequate at assimilating new information or mapping it onto existing memory representations (van Oostendorp, 2014). It is possible that the continued influence effect occurs when people update incrementally when in fact a global update is called for. Reliance on inaccurate information is less likely in instances when there is an alternative to replace the

inaccurate information in a person's mental model, as a readily available alternative explanation facilitates global updating (Ecker, Lewandowsky, Cheung, & Maybery, 2015).

A classic paradigm for studying the continued influence effect involves presenting participants with fictitious scenarios involving the retraction of an event cause. One common example is a narrative where negligent storage of gas cylinders is initially held responsible for starting a warehouse fire, yet their presence is retracted shortly thereafter (H. Johnson & Seifert, 1994; Wilkes & Leatherbarrow, 1988). If participants are explicitly queried about the gas cylinders, they typically acknowledge the gap in their understanding (i.e., a gap in their mental event model) created by the earlier retraction, and correctly state that there were none. However, when answering inferential reasoning questions regarding the event—such as "what was the cause of the explosions?"—participants often still rely upon the outdated information. This indicates that people prefer to have an inaccurate over an incomplete event model, which can lead to reliance upon discredited information even after an explicit correction (Ecker, Lewandowsky, & Apai, 2011b).

Recommendation 1: Providing Factual Alternatives

One of the most effective methods of correcting misinformation is to provide an alternative factual cause or explanation to facilitate "switching out" the inaccurate information in an individual's initial situation model. For example, if people are told that it was not gas cylinders that caused the warehouse fire, but that there was evidence of arson, people are dramatically less likely to rely upon the original inaccurate information (H. Johnson & Seifert, 1994; Ecker, Lewandowsky, & Tang, 2010). The alternative explanation effectively plugs the model gap left by the retraction. The alternative should ideally have the same explanatory relevance as the misinformation it replaces, and it is important that it is plausible—in fact, if the

new information is *more* plausible and easy-to-understand than the original, updating is even more efficient (Baadte & Dutke, 2012).

In the real world, providing an alternative explanation to ameliorate reliance upon inaccurate information can be problematic, as often there is no available substitute—sometimes all that can be said about a piece of misinformation is that it is *not true*. For example, if a person is accused of a crime, they might simply turn out to be "not guilty" without an alternative suspect being readily available. The lack of adequate alternatives can have profound ramifications. For example, the ongoing rumors regarding missing Malaysian Airlines flight MH370, which disappeared over the Indian Ocean in 2014, have proven difficult to retract: In the absence of unequivocal evidence regarding what happened to the plane, traditional and social media was rife with speculations that the plane was hijacked by terrorists or a suicidal pilot (e.g., Quest, 2016). Arguably, belief in the hijacking speculation has been difficult to shift because a convincing factual alternative has not been available.

Dual Process Theory: Strategic and Automatic Memory Processes

The notion that retractions create gaps in mental models is useful to understand the basic phenomenon that is the continued influence effect. Invalidated information is not simply deleted from memory—memory does not work like a whiteboard and retractions do not simply erase misinformation. To explain why corrected misinformation is used during reasoning, some theorists have focused on the memory processes governing information retrieval, where a common assumption is that there are two separates types of memory retrieval, strategic and automatic (Yonelinas, 2002).

Strategic memory processes are effortful and allow for the controlled recollection of the information's contextual details. Similar to the meta-data of a computer file, contextual details

include information about the information itself. This includes qualities such as the information's spatiotemporal context of encoding, source, and veracity (Frithsen & Miller, 2014). A person's ability to use strategic memory processes efficiently will depend upon factors such as effort, motivation, the period of time since encoding, and age (e.g., Herron & Rugg, 2003). In contrast, automatic processes are fast and relatively acontextual, and serve to quickly provide an indication of memory strength or familiarity with an item or notion (Zimmer & Ecker, 2010).

Automatic retrieval processes can contribute to misinformation effects in two ways. Firstly, the evaluation of a statement's veracity is influenced by its familiarity; this is problematic as information can be accepted as true just because it seems familiar. When increased familiarity gives the illusion that information is valid, this is known as the *illusory truth effect* (e.g., Begg, Anas, & Farinacci, 1992). Secondly, when questioned about an event or otherwise cued, retracted misinformation can be automatically retrieved from memory without any accompanying contextual details, and potentially without recalling that the information has been retracted (cf. Ayers & Reder, 1998; Ecker et al., 2010). To illustrate, it has been argued that once misinformation has been encoded and then retracted, a "negation tag" is linked to the original memory representation (e.g., "Flight MH370 was hijacked–*NOT TRUE"*; cf. Gilbert, Krull, & Malone, 1990). When queried about the topic, fast automatic memory processes might simply retrieve the familiar claim, while strategic memory processes are required to retrieve the negation tag and dismiss the familiar statement as untrue. If strategic memory processes are not engaged, familiar claims are thus likely to be judged as true even after plausible retractions (Dechene, Stahl, Hansen, & Wanke, 2010).

Recommendation 2: Boosting Retrieval of the Retraction, Not Familiarity of the Myth

The extent to which people engage their strategic memory processes can be actively encouraged, and this can reduce misinformation effects. Ecker et al. (2010) found that presenting participants with a pre-exposure warning detailing the continued influence effect greatly reduced reliance on misinformation, and was as effective as providing a factual alternative. The authors argued that warnings not only allowed individuals to more effectively tag misinformation as false when encoding its retraction, but also boosted later recall of the retraction (or the "negation tag"). The effect of warnings was investigated mainly for theoretical reasons, and providing a pre-exposure misinformation warning will not be a viable option in most real world settings. However, any incentive to engage in strategic memory processes should be useful, such as boosting source-monitoring (Lindsay & M. Johnson, 1989; Poole & Lindsay, 2002).

Enhancing recollection is one way of reducing reliance on misinformation, but circumventing the inflation of a misconception's familiarity is potentially another way. This involves minimizing unnecessary explicit repetition of misinformation. For example, an educational pamphlet using a "myth-busting" format that repeats the myth before indicating that it is false (e.g., "Flight MH370 was hijacked—*FALSE*") can boost the familiarity of the misconception, potentially increasing the risk that misconceptions are later mistakenly remembered as being true. This misremembering of myths as facts was demonstrated by Skurnik, Yoon, Park, and Schwarz (2005), as well as Peter and Koch (2016). In both these studies, participants misremembered the originally false statements as true more often than misremembering originally true statements as false. Additionally, Swire, Ecker, and Lewandowsky (2016) found that retracting myths and affirming facts led to comparable belief change initially (i.e., belief reduction for myths, belief increase for facts), but that belief change

was less sustained with myths over the course of a one-week period. In other words, misinformation began to be "re-believed" while fact belief remained stable. Thus, where possible, communicators should focus on the facts and explicit repetition of a myth should be minimized if the retraction does not provide adequate information to allow people to revise their understanding.

Co-activation of Misconception and Corrective Facts

Despite the theoretically motivated suggestion to avoid myth repetition, for practicality, corrections usually do require repetition of the myth—the question then becomes how best to execute this. As discussed previously, presentation of factual alternative information is conducive to successful mental-model revision. Beyond that, several theoretical accounts have proposed that the *co-activation* of inaccurate knowledge and newly encoded factual information facilitates knowledge revision. Co-activation is believed to increase the likelihood that the individual notices discrepancies between originally-held misconceptions and factual evidence, and that they update their knowledge accordingly (Kendeou & van den Broek, 2007).

After a correction, both the outdated and new information may co-exist in memory, and can both be activated by relevant cues (cf. Ayers & Reder, 1998). Thus, it is crucial for efficient updating and knowledge revision that a sufficient amount and quality of factual information is provided, and ideally, that the correction also explains the reasons as to why the misconception is wrong (Seifert, 2002). Adding adequate detail to the new accurate information can systematically strengthen the correction by slowly decreasing interference from the outdated information (Kendeou, Smith, & O'Brien, 2013). This illustrates how when ample factual information is available, misinformation can be used as an educational tool (Bedford, 2010).

Recommendation 3: Refutations of Misinformation as an Educational Tool

A *refutation* involves not only a statement that the misconception is false, but a comprehensive explanation as to why it is incorrect (Hynd, 2001). The efficacy of refutations has primarily been investigated in the field of education, and has often focused on the updating of scientific misconceptions held by students in a classroom. A meta-analysis of 70 studies by Guzzetti, Snyder, Glass, and Gamas (1993) indicated that corrections are most successful when they include sufficient explanation as to why a misconception is false (and why the facts are true). Other educational strategies aimed at reducing reliance on misinformation such as class discussions, demonstrations, and non-refutational texts (which simply present the correct information without a description of the misconception itself), are often successful in the short term, but not after a delay (Guzetti, 2000).

It has been argued that the relative success of the refutation at promoting belief change is that, by design, it increases the likelihood of the old and new information being co-activated in memory (Kowalski & Taylor, 2009). It follows that when debunking a myth, its repetition seems acceptable (despite the potential myth-familiarity boost) as long as (1) the repetition serves to highlight a discrepancy between a misconception and factual evidence, thus promoting co-activation, (2) the focus of the intervention can be shifted promptly from the myth to the factual evidence, and (3) the target audience has the necessary resources—in particular in regards to time and motivation—to engage with the provided materials and sees the information source as credible, as would hopefully be the case in a classroom setting.

Retraction Source Credibility

People often do not have the time or inclination to be an expert in all fields, so most knowledge, to a degree, is reliant upon accepting what someone else (or google) claims to be

true. Thus, people hold many opinions and beliefs about events and causal relationships without having relevant involvement or expertise. For example, trust in climate scientists is a predictor of whether or not an individual acknowledges that climate change is anthropogenic (Mase, Cho, Prokopy, 2015). In general, high-credibility sources are more persuasive than low-credibility sources (Eagly & Chaiken, 1993), and the lower one's prior knowledge regarding a topic, the more influential source credibility becomes (Jung, Walsh-Childers, & Kim, 2016). The two core factors of source credibility discussed in the literature are (1) expertise—the extent to which the source is capable of providing accurate information, and (2) trustworthiness—the perception that the source is willing to provide information that the source itself believes to be accurate (Pornpitakpan, 2004). A source can independently have varying degrees of these two qualities, for example, a doctor may have a high degree of (perceived) expertise, but if found to be paid by pharmaceutical companies may have relatively low (perceived) trustworthiness.

When it comes to retracting inaccurate information or belief change, intriguingly trustworthiness seems to play a much larger role than expertise (McGinnes & Ward, 1980). For example, Guillory and Geraci (2013) investigated the credibility of retraction source by presenting participants with a story about a politician who was witnessed taking a bribe. This was later retracted by people with varying degrees of trustworthiness and expertise. The authors found that although trustworthiness was integral to the success of the retraction, expertise was not. It should be noted that the way expertise was operationalized in this study was more akin to "involvement in an event" rather than expertise in its perhaps more common meaning (i.e., "possessing relevant knowledge"). However, Ecker and Antonio (2016) replicated Guillory and Geraci's main finding with a more traditional interpretation of expertise and also found an effect of trustworthiness but not expertise on the effectiveness of retractions.

Recommendation 4: Building Credibility

The ability to successfully correct misinformation appears to rely more upon the source's perceived honesty and integrity than its expertise. This means that Leonardo DiCaprio's 2016 Oscar speech correcting climate-change misconceptions (Goldenberg, 2016) could be more effective than an expert communication. Additionally, Paek, Hove, Jeong, and Kim's (2011) found that YouTube videos created by peers had more impact in terms of attitude change than videos created by a non-profit organization. This means that social media can be an effective vehicle for influencing others, and Facebook or Twitter posts may have more influence on friends' opinions than expert advice.

Ideally, and ethically, science communicators should aim to combine high trustworthiness with high expertise. The quality and accuracy of the presented information will influence how the source itself is perceived—this includes factors such as the information's presentation, plausibility, and whether or not it is supported by good examples (Jung et al. 2016; Metzger, 2007). In general, perception of a source seems to be an iterative process in that the more quality information is released, the greater the level of perceived credibility. In mass communications in particular, basing claims on evidence, adequately referencing the evidence, and presenting data in an easily accessible way to minimize misinterpretations—and doing this consistently—will build credibility and thus contribute to a greater efficacy of corrections (Gigerenzer, Gaissmaier, Kurz-Milcke, Schwartz, & Woloshin, 2007).

Worldview

If an individual holds a strong belief that is fundamental to their identity, even the most credible source may not be able to shift it. A person's ideology often influences how information is sought out and evaluated, and if the information runs counter to prior beliefs, it is likely to be

ignored or more critically appraised (Wells, Reedy, Gastil, & Lee, 2009). This is known as *motivated reasoning* (Kunda, 1990). Motivated reasoning can be compounded due to the formation of ideological "echo-chambers," where information is exchanged primarily amongst people with similar viewpoints, such that corrections are less likely to reach the "target" audience (Barbera, Jost, Nagler, Tucker, & Bonneau, 2015). This is fostered by social media, where misinformation tends to circulate quicker than associated corrections (Shin, Jian, Driscoll, & Bar, 2016).

Even if a correction reaches the misinformed target audience, simply providing the correct information is inefficient, as continued reliance on misinformation is likely when the misinformation conforms to a person's pre-existing belief system, yet the correction does not (Lewandowsky, Stritzke, Oberauer, & Morales, 2005s). Retracting misinformation that runs counter to a person's worldview can ironically even strengthen the to-be-corrected misinformation, a phenomenon known as the *worldview backfire effect*; this has been demonstrated when correcting misinformation surrounding contentious issues such as climate change (Hart & Nisbet, 2012), or vaccine safety (Nyhan & Reifler, 2015). Worldview biases are particularly difficult to overcome, as even neutral coverage of an issue can lead to polarization (Jerit & Barabas, 2012).

Recommendation 5: Provide worldview- or self-affirming corrections

If a correction is regarding a contentious topic or politically sensitive subject matter, it is beneficial to frame the correction in such a way that it is congruent with the person's values in order to reduce perceived threat (Kahan, 2010). For example, conservatives are more likely to accept anthropogenic climate science if it is presented as a business opportunity for the nuclear industry (Feygina, Jost, & Goldsmith, 2010). Additionally, in line with the above-mentioned

effects of source credibility, worldview congruence can potentially be conveyed through the appropriate choice of messenger. Callaghan and Schnell (2009) found that attitudes towards gun control were affected not only by the way the information was framed, but also the source of the message. Participants who were presented an argument regarding the impacts of crime and violence were 19% more likely to support gun control measures if the message came from a *New York Times* journalist than if it was presented without a source. People also seem less defensive regarding counter-attitudinal information when their self-worth is strengthened. For example, Cohen, Aronson, and Steele (2000) demonstrated this effect of *self-affirmation*: participants who had been instructed to write about a personal quality that made them feel good about themselves were subsequently more likely to respond positively to evidence that challenged their beliefs regarding the death penalty.

Skepticism

Rather than evidence-denial driven by motivated reasoning, skepticism is the awareness of potential hidden agendas and a desire to accurately understand the evidence at hand (Mayo, 2015). Skepticism can reduce misinformation effects, as it leads to more cognitive resources being allocated to the task of weighing up the veracity of both the misinformation and the correction. For example, people rely less upon misinformation when given the task of fact checking, looking for inconsistencies and correcting inaccuracies as they read a text (Rapp, Hinze, Kohlhepp, & Ryskin, 2014). The increased deliberation over the accuracy of information is often instigated when the information counters an individual's worldview (Taber & Lodge, 2006). To illustrate, Lewandowsky et al. (2005) found that a greater degree of skepticism led to better discounting of retracted real-world news reports, and DiFonzo, Beckstead, Stupak, & Walders (2016) found that individuals with greater dispositional skepticism tended to believe

inaccurate rumors to a lesser extent. The ability to maintain doubt, question evidence and scrutinize the original data—even when it aligns with one's worldview—is conducive to avoiding reliance on misinformation, but it is a difficult task. Thus, honing the skill of knowing when to trust evidence, and when not to, can potentially have great benefits.

Recommendation 6: Fostering Skepticism

Skepticism is a quality that can be encouraged and even temporarily induced—for example, negative mood increases skepticism and improves accuracy in detecting deceitful communications (Forgas & East, 2008). There is also a growing movement suggesting that evidence-based evaluation and critical thinking should formally be taught in schools. Schmaltz and Lilienfeld (2014) suggested that activities such as asking students to identify pseudoscience on campus and in the media could highlight the plethora of falsifiable claims in the public sphere. Alternatively, the authors recommended activities where students create their own pseudoscience to demonstrate and experience the ease with which anecdotal evidence or "psychobabble" can be fabricated. Even examining real-world false advertising cases can be educational, for example, investigating the Federal Trade Commission's verdict to charge Lumosity $2 million for claiming its brain training could protect against cognitive impairment, or Dannon $21 million for claiming their yoghurt can prevent the flu (Lordan, 2010; Rusk, 2016). Lastly, the ability to question *causal illusions*—the perception that one event caused another, where in fact they are unrelated—can also be taught, and a better understanding about the probability of an outcome, the probability of a cause, and cause-outcome coincidences can help promote skepticism (Matute et al., 2015).

Conclusion

Assessing the accuracy of information can be a difficult task. In today's fast-paced society, mass communication and social media play a key role in the sharing and receiving of current events. In reality, the public do not have time to investigate each claim they encounter in depth; therefore, providing quality information is essential. In the aftermath of Brexit and the 2016 US election, where the political landscape was rife with misinformation and fake news (Barthel, Mitchell, & Holcomb, 2016; McCann & Morgan, 2016), the ability to correct inaccuracies has never seemed more pertinent. The six recommendations provided can serve as guidelines for mass communication as to how best to retract the plethora of misinformation in the public sphere. However, it is important to note that no corrective technique can reduce belief to base level, as if the misinformation was never previously mentioned. In addition, even if people do shift their opinion and acknowledge that information they previously believed to be true is incorrect, they are unlikely to change their voting preferences or feelings towards political candidates (Swire, Berinsky, Lewandowsky, & Ecker, 2016). Given what we know about misinformation and its correction, communicators thus hold a great deal of responsibility to ensure that the information initially released is as accurate as possible.

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