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The Psychology of Misinformation Across the Lifespan

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Abstract

Ubiquitous misinformation on social media threatens the health and well-being of young people. We review research on susceptibility to misinformation, why it spreads, and how these mechanisms might operate developmentally. Although we identify many research gaps, results suggest that cognitive ability, thinking styles, and metacognitive scrutiny of misinformation are protective, but early adverse experiences can bias information processing and sow seeds of mistrust. We find that content knowledge is not sufficient to protect against misinformation, but that it, along with life experiences, provides a foundation for gist plausibility (true in principle, rather than true at the level of verbatim details) that likely determines whether misinformation is accepted and shared. Thus, we present a theoretical framework based on fuzzy-trace theory that integrates the following: knowledge that distinguishes verbatim facts from gist (knowledge that is amplified by cognitive faculties and derived from trusted sources); personality as an information-processing filter colored by experiences; emotion as a product of interpreting the gist of information; and ideology that changes prior probabilities and gist interpretations of what is plausible. The young and the old may be at greatest risk because of their prioritization of social goals, a need that social media algorithms are designed to meet but at the cost of widespread exposure to misinformation.

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INTRODUCTION

Around the globe, millions of people can readily access information via technologies such as social media, with young people among the most frequent users (Pew Res. Cent. 2023, Roozenbeek et al. 2020). While much of that information is valuable and even lifesaving (e.g., information about evacuation routes or medication risks), the rising tide of information has carried with it increased exposure to factually false, inaccurate, or misleading information (Pennycook & Rand 2021, van der Linden et al. 2023). Collectively called misinformation, its prevalence is difficult to estimate, but studies of selected topics are troubling. For example, 29% of randomly selected videos on TikTok captioned with #coronavirus contained moderate or high levels of misinformation, with a median of 9.4 million views for the latter (Baghdadi et al. 2023). Moreover, there is evidence that this misinformation translates into health-compromising behaviors and behavioral intentions (Arechar et al. 2023, Loomba et al. 2021, Pierri et al. 2022, Romer & Jamieson 2020). Because young people turn to sources that expose them to large amounts of misinformation and because they are subject to vulnerabilities that increase the potential for harm, it is important to understand the mechanisms of misinformation and how they might apply to young people. Although there is little research on the effects of misinformation on children and young adolescents, we review mechanisms that can be expected to vary developmentally and describe an empirically grounded theoretical framework that can guide future research.

Specifically, we review research on what makes people susceptible to believing misinformation and why people tend to share misinformation with others. For both beliefs about misinformation (e.g., judgments about its truth or accuracy) and sharing on social media, we describe associations with individual differences—including numeracy, knowledge, cognitive ability, and cognitive style—as well as effects of motivation and trust in the credibility of sources, along with existing developmental findings. We then describe how fuzzy-trace theory provides an explanatory framework for future research on the development of misinformation, with implications for combatting misinformation acceptance and sharing.

DEFINITIONS AND BACKGROUND

In line with our definition above, misinformation ranges from subtly misleading to "utterly 'fake' or entirely fabricated" (van der Linden 2024, p. 3), with much misinformation in the real world not

a blatant contradiction of a clear fact (El Mikati et al. 2023, Langdon et al. 2024, Reyna et al. 2021a, van der Linden 2022). For example, a news headline reading "a 'healthy' doctor died two weeks after getting a COVID-19 vaccine" was not technically false: A doctor was previously healthy, received a COVID-19 vaccine, and did die two weeks later (van der Linden et al. 2023, p. 7; Wolfe 2021). But the headline falsely implies that the vaccine caused the death. As this example illustrates, although fact-checking can be a useful arbiter of truth (Pennycook & Rand 2019), "most misinformation is not fact-checked and [is] usually not completely false but rather [is] manipulative or misleading in some way" (van der Linden 2024, p. 3).

Disinformation refers to intentional manipulation, a deliberate attempt to mislead people (Pennycook & Rand 2021). Although distinguishing between intentional and unintentional misinformation is challenging (Pennycook & Rand 2021, van der Linden et al. 2023), it is important to do so (Broniatowski et al. 2018, Erlich et al. 2022). For example, perceiving the intent to persuade or mislead provides a metacognitive cue to examine information more closely and, as a result of such scrutiny, to reject misinformation. Research has consistently shown that children and adolescents are less capable of such metacognitive monitoring and thus would be expected to be more vulnerable to intentional manipulation than adults (Luna et al. 2015, Steinbeis 2023).

More generally, as we discuss below, defining misinformation implies theoretical commitments about its mental representation. Drawing on fuzzy-trace theory, it is crucial to distinguish two kinds of truth: verbatim truth at the level of precise details and gist truth at the level of underlying meaning (Reyna et al. 2021a). That is, people often believe misinformation and intentionally spread it because they believe its gist to be true, even when they realize that it is literally false (Langdon et al. 2024). Effects of gist on sharing go beyond whether a message conveys a narrative or story and whether it contains vivid imagery (Broniatowski et al. 2016). Thus, misinformation often insinuates itself into the mind of the recipient at the level of fuzzy gist for which truth is meaningful but not cut and dry (Reyna 2021). In this view, manipulating emotion ultimately derives from conveying a compelling gist—an interpretation of the facts that stirs the passions—in contrast to emotion manipulation being an intrinsic feature of misinformation (Reyna et al. 2021b).

ACCEPTING MISINFORMATION

Misinformation acceptance is typically measured by having participants rate how credible (how accurate or how true) they find stimuli (e.g., a statement, headline, social media post) to be. However, differentiating misinformation from true information—discernment—is often used as the outcome of interest because it incorporates both rejecting what is false and accepting what is true. Thus, that ability to differentiate should be distinguished from a loose or strict decision criterion with respect to incoming information, ranging from uncritical open-mindedness to indiscriminate skepticism (Hoes et al. 2024; see also Freiling et al. 2021) (see the section titled Thinking Style). Interventions that focus on one or the other of these without confronting the content of information can inadvertently encourage gullibility or undermine belief in the truth, respectively, which can then be exploited by purveyors of misinformation or disinformation. Differentiating true from false begins with knowledge, as we now discuss.

Individual Differences in Knowledge, Ability, Thinking Style, Metacognition, and Personality

In this section we address how individual differences in factual knowledge, numeracy, cognitive ability, thinking style, metacognition, and personality relate to misinformation acceptance. Developmental research and implications for each of these factors are discussed.

Factual knowledge. Knowledge is inherently a developmental construct because it accrues via life experience as well as formal and informal education. In particular, science education and numeracy (the ability to understand and use numbers; see the next section) are foundational types of knowledge that can provide some resistance to misinformation. For example, lower knowledge about health and basic science facts (e.g., "antibiotics kill viruses as well as bacteria") was associated with higher belief in misinformation and lower truth discernment regarding COVID-19 (Lee et al. 2020, Pennycook et al. 2020). Similarly, knowledge about cancer (cancer literacy) was associated with identifying cancer-related misinformation about chemotherapy (i.e., agreeing that the information was misleading), which negatively predicted subsequent belief in that misinformation (Wang & Jacobson 2022). Protective effects of knowledge have also been observed for political news headlines. Political knowledge (e.g., knowing election procedures and names of political figures) predicted finding fake antigovernment political news to be less plausible (Vegetti & Mancosu 2020). When people have expertise in a particular domain (e.g., history PhD students), they also tend to notice when questions contain an incorrect premise rather than simply answering the question as if the error were not present (Cantor & Marsh 2017).

Unsurprisingly, knowledge assessed with objective tests increases with educational attainment (Fazio & Sherry 2020). Thus, in addition to performance on objective tests of specific facts, educational attainment is generally associated with a lower likelihood of believing health-related misinformation, misinformation about nature facts, and other false claims such as that the earth is flat (Fazio & Sherry 2020, Martire et al. 2023, Scherer et al. 2021).

To illustrate, Fazio & Sherry (2020) studied 5-year-olds, 10-year-olds, and college students, who gave truth ratings for three groups of nature facts normed for each age group. For preschool- and kindergarten-level facts, all age groups rated true statements as more true than false statements after receiving a misinformation manipulation (rating how interesting misinformation items were), but the ability to discern true and false statements increased with educational level: 10-year-olds and adults were better at discerning compared with the youngest children (see **Figure 1**).

Fazio (2018) found similar effects—more knowledgeable older children were more accurate than younger ones—for comparable items that did not involve a misinformation manipulation. However, more knowledgeable older children were more susceptible to misinformation. Specifically, on a postmanipulation short-answer test, they were more likely to produce incorrect items that had been provided as multiple-choice alternatives on a prior test (see also Fazio & Marsh 2008). Note that mere memory testing—presenting a wrong answer as part of a multiple-choice test or asking whether an item was presented on a preliminary recognition test—and subsequently testing that item again produces increases in both judgments of truth and judgments of memory (see Reyna et al. 2016). As we discuss below, testing effects on truth judgments or on memory judgments hinges on whether tested items are consistent with gist as opposed to consistent with verbatim information.

At the other end of the developmental spectrum are older adults, who differ from young people in multiple ways but notably in knowledge and experience. Crystallized intelligence, which involves knowledge and experience, increases throughout childhood to early adulthood and remains relatively high (Li et al. 2004). With respect to specific knowledge, Vijaykumar et al. (2021) found that COVID-19 knowledge was higher among older adults (age 55 and older) compared with younger adults, and that older adults were better able to reject relevant misinformation.

Similarly, older adults (over the age of 65) do not show the repetition effect (that repetition increases truth ratings) for known as opposed to unknown statements (though knowledge does not moderate the repetition effect for younger adults; Brashier et al. 2017). Especially given the sometimes deleterious effects of knowledge (e.g., Fazio 2018), we are not claiming that knowledge

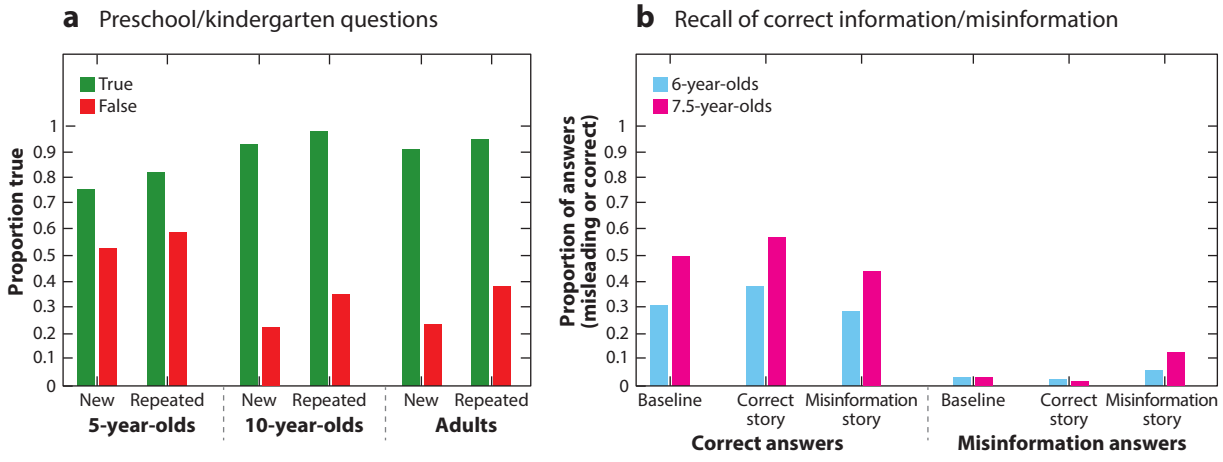

Figure 1

Developmental trends for misinformation acceptance and resistance. Panel *a* displays data from Fazio & Sherry (2020), illustrating how age and education are associated with discerning between true and false information when misinformation has been introduced through repetition. Panel *b* illustrates a similar effect of age with respect to providing accurate (correct) answers on a later cued recall test despite being exposed to misinformation in a story. The difference in correct answers after hearing misinformation in the story compared with baseline did not reach significance, and age did not interact with this effect. In addition, older children (7.5-year-olds) were more likely to provide the wrong answer (specifically, the misinformation provided in the story) compared with the younger age group. More misinformation answers were provided after hearing the misinformation story compared with baseline for the older children. Panel *b* adapted with permission from Fazio & Marsh (2008); copyright 2008 Elsevier.

and experience are sufficient to resist misinformation or that other correlates of aging do not matter.

Indeed, despite some protective effects of knowledge on misinformation acceptance, when people have relevant knowledge, they might still go along with misinformation for other reasons. This phenomenon is referred to as knowledge neglect (van der Linden et al. 2023). The classic Moses illusion illustrates this phenomenon: People often answer "two" to the question "How many animals of each kind did Moses take on the Ark?" despite knowing that it was Noah, not Moses, who went on the Ark (Erickson & Mattson 1981).

Other reasons why people may not rely on knowledge they already have include focusing on goals or motivations other than accuracy (Brashier & Schacter 2020, Reyna 2023b) or cognitive "laziness" (i.e., not engaging in analytical thinking) (Lin et al. 2023, Pennycook & Rand 2019), discussed further below. While failure to use the knowledge one has can be an important reason for not noticing misinformation or rating repeated misinformation as more true than nonrepeated misinformation, underlying knowledge of what is true or false is still often essential. The fact that 50% of Americans in a national survey incorrectly believe that antibiotics kill viruses (Besley & Hill 2020) is a lamentable lacuna in biological knowledge, but its importance goes beyond science education. This knowledge is directly relevant to accepting misinformation about treatments for sexually transmitted infections, understanding why antibiotics do not work to treat COVID-19, and making other health decisions (Reyna & Adam 2003, Reyna & Mills 2014). Thus, both factors—epistemic knowledge and the extent to which this knowledge is invoked in contexts involving misinformation—are important.

Numeracy. Numeracy is relevant to misinformation because being informed often involves the ability to interpret numerical information appropriately (Peters 2020, Reyna & Brainerd 2023). For example, the Vaccine Adverse Event Reporting System (VAERS) has been a large source

of misinformation about vaccination because people form misconceptions about what the data imply, in part due to an inability to understand what the numbers mean (Jamieson et al. 2024). For example, evidence that "of 2,605 infant deaths reported to VAERS from 1990 through 2019, 58% clustered within 3 days postvaccination and 78.3% occurred within 7 days postvaccination" should not be interpreted as clear evidence of a causal link between infant vaccination and sudden infant death syndrome (Miller 2021, p. 1324). Relatedly, numeracy facilitates appreciating that a number such as 2,605 must be interpreted relative to the total number of vaccinations. To guard against such misinterpretations of numbers, the Centers for Disease Control (2024a) warns that "the number of reports alone cannot be interpreted as evidence of a causal association between a vaccine and an adverse event."

Evidence indicates that those higher in numeracy tend to believe misinformation less (but see the section titled Motivation). For example, Roozenbeek et al. (2020) found that objective numeracy—performance on problems involving probability, percentages, and proportions—was associated with finding misinformation about COVID-19 to be unreliable. In a later study, Roozenbeek et al. (2022) again found that objective numeracy was associated with better veracity discernment, or the ability to distinguish between true and false news. According to the 2022 National Assessment of Educational Progress (known as the nation's report card), in mathematics, only 36% of fourth graders were at or above a proficient level (down from 41% in 2019) (Natl. Assess. Educ. Prog. 2022). This drops to only 26% of eighth graders (down from 34% in 2019). Thus, young people lack the proficiency to interpret the numbers in prevalent misinformation about vaccines, substances, infectious diseases, and diet (Wang & Togher 2024).

Although we have treated numeracy as part of a knowledge base (along with factual knowledge) that offers partial protection against misinformation, it is also classified as a cognitive ability. In the next section, we discuss how cognitive abilities—abilities to think analytically, logically, and efficiently that are tapped in intelligence tests—offer resistance to misinformation across the lifespan. These abilities are considered System 2 thinking, as distinguished from System 1's lazy intuition, in traditional dual-process theories. We then discuss additional System 2 faculties: thinking style (thinking preferences rather than abilities) and metacognition that monitors one's own and others' cognition for biases and errors. We end the section with evidence about developmental differences in System 2, with implications for susceptibility to misinformation. To preview, children are lower in cognitive ability, less willing to think analytically, and less likely to metacognitively monitor compared with adults, and, thus, they should be more vulnerable to misinformation, extrapolating from individual differences among adults. However, developmental research in each of these areas is sorely needed.

Cognitive ability. Traditional dual-process theories characterize two kinds of thinking that are thought to apply generally, but individuals can vary in the extent to which they rely on one system over the other. Briefly, System 1 is quick and intuitive in the traditional sense (relying on gut feelings), whereas System 2 is slow and reflective (Evans & Stanovich 2013, Kahneman 2011). System 2 is often further divided into analytical abilities (numeracy, logical reasoning) and metacognitive monitoring and censoring of the default biases and impulsive outputs of System 1 (see also Broniatowski & Reyna 2018, Reyna & Brainerd 2023). The cognitive ability to think analytically, cognitive style (preference for analytical thinking), and metacognition have each been found to be associated with lower susceptibility to misinformation, as we now discuss.

Cognitive ability, often measured using intelligence tests, has been found to be associated with the perceived accuracy of so-called fake news (Ahmed & Tan 2022). That is, higher scores on the Wordsum test of intelligence predicted lower accuracy ratings of fake political headlines, controlling for other factors. In addition, De keersmaecker & Roets (2017) examined the extent to which

cognitive ability was associated with attitudes toward a person after being misinformed about the person (told they were arrested for stealing drugs) and then informed that this misinformation was not true. Individuals with high cognitive ability (1 standard deviation above average) had more positive attitudes about the person after the misinformation was corrected compared with individuals with lower cognitive ability (1 standard deviation below average).

Although these findings are suggestive, correlations between cognitive ability and misinformation acceptance should be followed up with specific experiments that test underlying mechanisms, especially in developmental research. Experiments are needed because there are many potential explanations for these relationships: Higher cognitive ability generally produces higher educational attainment and a more extensive knowledge base, such as greater factual knowledge and numeracy, that can be used to directly refute misinformation. Higher cognitive ability also supports logical thinking, which can be used to spot inconsistencies in misinformation, for example, between the two claims that "global temperature cannot be measured accurately" and "temperature records show it has been cooling" (Ecker et al. 2022, p. 18). Being able to entertain and integrate contradictory information in working memory (including updating beliefs) is yet another feature of higher cognitive ability, consistent with the results of De keersmaecker & Roets (2017). In addition, although theoretically distinct from one another, cognitive ability tends to correlate with cognitive style (more ability with more willingness to use that ability) and with metacognition (more ability with greater monitoring of one's own reasoning and that of others), as discussed in the sections below.

Fuzzy-trace theory adds mechanisms beyond these traditional claims. Research on misinformation effects in memory has shown that individuals routinely entertain contradictory information in memory in the form of independent verbatim versus gist representations (Reyna et al. 2016); these effects are not related to cognitive ability in the sense of working memory capacity (Reyna & Brainerd 2023). Further, although cognitive ability is associated with better retrieval of verbatim information, which improves from childhood to adulthood, much misinformation does not directly refute a specific fact. For example, no specific fact contradicts the assertion that "Biden and Obama may have had Seal Team 6 killed!" (for the context of this quote, see Ahmed & Tan 2022, p. 3). A more likely possibility is that cognitive ability is associated with improved sensemaking, that is, the ability to evaluate whether misinformation makes sense according to gist—the plausibility of what could be true at a gist level rather than what is strictly true (Reyna 2012). Ironically, adults rely more on gist-based thinking than children do, making their judgments and decisions less objective, which would predict greater susceptibility to misinformation when that misinformation makes sense of objective reality, but developmental research is lacking on this specific question.

Longitudinal research that has tracked individuals from early childhood to middle age is broadly consistent with these potential mechanisms for the effects of cognitive ability, although the research did not measure susceptibility to misinformation directly (Moffitt et al. 2022). Intelligence in early childhood, reading ability in adolescence, and health knowledge at 45 years of age (in years prior to the pandemic) all distinguished COVID-19 vaccine-hesitant and vaccine-resistant groups from vaccine-willing groups as of 2021. These and other results from this study paint a vivid picture of long-term cognitive differences extending far back in development that could make individuals susceptible to misinformation, but those connections have yet to be verified empirically.

Thinking style. Beyond cognitive ability, individuals also differ in preferred thinking style. As suggested earlier and as related to trust (see the section titled Source Credibility and Trust), open-mindedness and skepticism are at two opposite poles with respect to general thinking style, and

both have been touted as important in resisting misinformation (with analytical thinking assumed to support skepticism, e.g., toward news on social media; Ahmed & Tan 2022). Actively open-minded thinking (AOT), or the willingness to consider alternative explanations or reasons for a position and the use of evidence to revise beliefs, is an important measure of cognitive style that has been studied with respect to misinformation (Stanovich & Toplak 2023). As expected, scoring higher on AOT has been associated with both better discernment of real versus fake news (Bronstein et al. 2021, Roozenbeek et al. 2022) and lower belief in fake news (Mirhoseini et al. 2023).

The Cognitive Reflection Test (CRT) (Frederick 2005) is often treated as a measure of thinking style in the literature, for example, when being defined by Pennycook & Rand (2019, p. 40) as "the willingness or propensity to think analytically" (for a review of CRT and similar measures, see Reyna & Brainerd 2023). However, the test carries substantial variance due to cognitive ability and to numeracy (Stanovich & Toplak 2023). The original version is composed of three math problems such as the bat-and-ball problem (a bat and ball together cost $1.10, and the bat costs $1.00 more than the ball; how much does the ball cost?) that have an appealing intuitive answer (10 cents) that must be resisted to arrive at the correct answer (5 cents). Other versions of the CRT include verbal problems that have also been used in misinformation research (Pennycook & Rand 2019, 2021).

Numerous studies have found that stronger performance on the CRT is associated with better discernment of true and false news (Arechar et al. 2023, Bronstein et al. 2021, Pennycook & Rand 2021). Arechar et al. (2023) also found that self-reported preference for analytical thinking (in addition to the CRT) was associated with better truth discernment (see also Martire et al. 2023). The standard interpretation of these results is that "people believe misinformation when they fail to engage in analytic thinking and instead rely on their intuitions" (Arechar et al. 2023, p. 1504).

As our discussion in the relevant sections above suggests, those who score high on the CRT could be less susceptible to misinformation through multiple mechanisms that we describe above, spanning cognitive ability (including analytic thinking), numeracy, and thinking style (willingness to think analytically). In addition, the original conceptualization of the CRT (Frederick 2005) emphasized not only the willingness to think analytically but also censoring or overriding intuitive responses as a result of deliberation (also called reflection), the slow part of "thinking fast and slow" (Kahneman 2011), to which we now turn.

Metacognition: censoring responses. Censoring of careless or inconsistent responses is an important metacognitive process according to traditional dual-process theory and fuzzy-trace theory. It is metacognitive because it involves critically assessing one's own thinking, which is more likely for adults than for children and for individuals with an active, rather than passive, thinking style. In traditional dual-process theory, extended deliberation beyond default intuitive responses facilitates the correction of reasoning biases or hasty errors, presumably making people less likely to fall prey to weakly supported or poorly reasoned misinformation.

Bago et al. (2020) tested this traditional account by experimentally manipulating "the extent of deliberation" first by having participants rate the accuracy of political news headlines under a cognitive load task ("memorizing a pattern of five dots in a 4 × 4 matrix") and requiring a quick response, and second by allowing participants to give a self-paced response about accuracy without a load. Participants in a control condition gave self-paced accuracy ratings a single time for the same headlines without a load task. They found that false headlines were rated as more accurate under the timed/load condition compared with when participants gave the second self-paced rating without load and compared with the single self-paced rating without load, which was interpreted as evidence that "deliberation corrected intuitive mistakes" (p. 1608).

However, accuracy is not always enhanced by deliberation (Epstein et al. 2023, Reyna & Brainerd 2023). For instance, Lin et al.'s (2023) results contradict a traditional dual-process interpretation because accuracy prompts increased attention to accuracy (sharing more true than false social media messages) but without increasing deliberation time. Moreover, Meyer & Frederick (2023) showed that System 1 intuitive responses can persist even when System 2 deliberation is induced, for example, by performing the arithmetic that should censor the default response for the bat-and-ball problem. Meyer & Frederick (2023) concluded that "many choose to uphold their intuition, even when confronted with simple arithmetic that contradicts it—especially if the intuition is *approximately* correct" (p. 1). Consistent with a parallel processing account of fuzzy-trace theory, gist-based approximate intuitive responses and analytical responses can coexist in a reasoner's mind from the outset of processing without necessarily influencing one another. This suggests that metacognitive interventions that reduce uncritical acceptance of misinformation must be accompanied by efforts to educate intuition by bringing concepts and context (provided by knowledge of history, science, math, etc.) to bear in resisting misinformation, not just instilling a domain-general critical attitude.

Regarding development, metacognitive ability follows a curvilinear pattern across the lifespan, increasing during adolescence and decreasing in older adulthood (Palmer et al. 2014, Weil et al. 2013). Children tend to be lower in such abilities compared with adolescents and adults, and older adults are lower on such abilities compared with younger adults. A few studies have examined the relationship between such System 2 processes and susceptibility to misinformation among developmental samples.

Given issues with administering the standard CRT to children, a developmental version (CRT-D) has been developed that includes nine verbal questions (Young & Shtulman 2020). Xu et al. (2022) found that higher scores on the CRT-D and the original CRT predict stronger ability to accurately judge false news (lower truth ratings) in adults, confirming prior results. Similarly, in adolescence, the original CRT correlated with better differentiation of true and false news articles (Greškovičová et al. 2022). However, Xu et al. (2022) found no significant relationship between CRT-D scores and the ability to judge false news for school-aged children. Although research indicates that the CRT-D is a valid and reliable measure, high-scoring children in Xu et al.'s study were not able to translate those cognitive faculties into better discrimination between fake and real news. Consistent with our conclusion above, we agree with the authors that children "may need additional content knowledge or source knowledge to succeed at this epistemologically challenging task" (Xu et al. 2022, p. 2992) (for more information on source knowledge, see the section titled Source Credibility and Trust). Shtulman et al. (2023) found that children scoring higher on CRT-D were better at differentiating impossible from improbable events, providing evidence that cognitive reflection helps children discern what could be true as opposed to simply what is true. This result obtained when controlling for executive function, which again underscores the importance of content knowledge (not just information processing) and is broadly consistent with our hypothesis that gist-based plausibility mediates susceptibility to misinformation (see also Langdon et al. 2024). Thus, cognitive ability, thinking style, and metacognitive censoring—all domain-general faculties that vary developmentally as well as across individuals—are not sufficient for discerning true from false information without development of knowledge about what is possible or plausible.

Personality. While cognition has moderate-to-high rank-order stability across development, personality changes considerably (Breit et al. 2024, Shiner et al. 2017). Hallmarks of personality maturation include increased agreeableness and conscientiousness and decreased neuroticism (Van den Akker et al. 2021). However, there is some evidence of a dip in personality maturation

during early adolescence, at which conscientiousness and agreeableness decrease and then increase again starting at around age 14 for girls and slightly later for boys (Van den Akker et al. 2021). This developmental dip may be relevant to misinformation susceptibility because agreeableness and conscientiousness are both associated with improved true–false news discernment, decreased belief in false news, and decreased sharing of false news in adults; agreeableness is also associated with decreased conspiratorial ideation (Bowes et al. 2023, Calvillo et al. 2021, 2024). Adding to this picture of vulnerability for adolescents, neuroticism peaks during adolescence (especially for girls) and then declines (Shiner 2019) and is associated with negative outcomes in adults (higher belief in and more sharing of misinformation) (Calvillo et al. 2024).

As the results of Moffitt et al. (2022) illustrate, personality does not develop in a vacuum. For example, adverse childhood events, such as abuse and neglect, were reflected in vaccine resistance decades later, accompanied by lower levels of agreeableness and higher levels of alienation (the tendency to feel mistreated and to expect the worst from others) as well as mistrust of institutions, family, and friends. It would not be surprising, as these authors argue, that such individuals would be susceptible to misinformation that "reinforces themes of suspicion, mistrust, fear, anger, alienation, and conspiracy" (Moffitt et al. 2022, p. 9).

More generally, personality acts as a filter in information processing that is colored by early life experiences, changing prior probabilities and gist interpretations of what is plausible (e.g., that the government would exploit people), which are not easily remedied through simply informing the uninformed using plain language (Moffitt et al. 2022; Reyna 2012, 2021). Recent research shows how gist understanding propagates through social media and ultimately influences behavior and health outcomes (Ding et al. 2024). To a greater extent than ever, social media are the social life of young people. Higher social vitality (e.g., enthusiasm and sociability, aspects of extraversion) and higher levels of reward sensitivity (sensation-seeking) compared with adults may further contribute to young people's desire for social connectedness and, thus, vulnerability to misinformation and conspiracy theories as they begin to explore social media (Smillie et al. 2019, Steinberg et al. 2018, van Prooijen 2022).

Emotion

Developmentally, adolescents tend to experience more emotions than adults, in terms of both frequency and intensity, and are more emotionally responsive to events (Guyer et al. 2016, Weinstein & Mermelstein 2007). Such heightened emotion during adolescence may place this group at heightened risk of susceptibility to misinformation, assuming that emotion reduces truth discernment by stirring up emotions and driving down analytical thinking (Steinberg et al. 2018, van der Linden et al. 2023). Although there is no research directly addressing this developmental question with misinformation (a gap that should be addressed in future research), research with adults supports the hypothesized effect of emotion.

For example, in an initial study, Martel et al. (2020) simply correlated emotionality [how emotional people felt across a range of emotions on the Positive and Negative Affect Schedule (PANAS) before viewing headlines] with ratings of the accuracy of true and false political headlines. They found that the intensity of almost every emotion (positive and negative) on the PANAS measured before viewing the headlines was associated with worse truth discernment, specifically with rating false headlines (but not true headlines) as more accurate. In a second study, Martel et al. (2020) experimentally induced emotional versus analytical thinking through instructions to "assess the news headlines by relying on emotion, rather than reason" or vice versa ("assess the news headlines by relying on reason, rather than emotion") (p. 9). A control group received no instructions about emotion versus reason. The group that relied on emotion had worse truth

discernment; they rated fake news as more accurate (with ratings of true headlines again being unaffected) relative to both the group relying on reason and the control group.

It makes sense that rating headlines based on criteria other than accuracy would lower the emphasis on accuracy, but often the concern with misinformation is that the content itself is inflammatory and emotionally manipulative (van der Linden et al. 2023). In this connection, Bago et al. (2022) examined emotional reactions to political headlines themselves. They found that heightened emotional reactions were associated with rating both real and fake news headlines as more accurate compared with headlines that were less emotionally evocative. This increase was larger for fake news and, therefore, emotion was related to lower truth discernment. Bago et al. (2022) also experimentally manipulated emotional responses by instructing participants to suppress their emotions about headlines, but this did not improve discernment.

Taken together, these studies support a traditional dual-process dichotomy between emotional gut feelings and reason/analytical thinking, in which the former promote acceptance of misinformation and the latter promotes its rejection (e.g., Martel et al. 2020). However, real headlines that evoked emotion were more accurately perceived as true compared with headlines that did not evoke emotion, which is consistent with the idea that emotions can "fall naturally out of getting the gist" of information (Reyna et al. 2021a, p. 499). Although misinformation on social media tends to be more emotional than real or true news (Carrasco-Farré 2022), much of social media is awash in emotion, and emotion per se does not indicate inaccuracy. Fuzzy-trace theory distinguishes emotional gut feelings from gist-based intuition, and each of these from analytical thinking, with different developmental implications (e.g., gist-based intuition and analytical ability increase from childhood to adulthood whereas uninhibited emotion declines). Moreover, emotion is not necessarily bad, and the pursuit of accuracy does not depend on suppressing emotion; emotion, when supported by the facts, can signal insight into the truth (Edelson et al. 2024).

Motivation

Political ideology generally emerges roughly in early adolescence (Alwin & Krosnick 1991). Many studies examine how political ideology, a system of beliefs and values that represents one's worldview, makes people susceptible to misinformation (Pennycook & Rand 2021). People tend to believe statements that are congruent with their political views as opposed to incongruent with these views, regardless of truth (e.g., Enders et al. 2023, Pereira et al. 2023). One explanation for this bias is that partisan identity results in motivated cognition, where "social goals. . .for holding certain beliefs. . .interfere with accuracy goals" in evaluating information (Rathje et al. 2023, p. 892).

However, differences in "pre-existing knowledge, or different prior beliefs, as a result of exposure to different partisan news outlets and social media feeds" could also explain this finding (Rathje et al. 2023, p. 892). To tease these two potential explanations apart (motivated cognition versus differences in knowledge and information exposure), Rathje et al. manipulated participants' motivations, encouraging a focus on accuracy in evaluating political news headlines (paying for correct identification of accurate headlines) or social goals (paying for correct identification of articles members of their own political party would like). Under the accuracy manipulation, partisan bias in evaluating news (number of politically congruent headlines rated as true minus number of politically incongruent headlines rated as true) was smaller (about 30% reduction) compared with the control condition. These effects were primarily driven by finding true politically incongruent news to be more accurate when accuracy was incentivized. No significant effect of the social-goals manipulation was observed in terms of partisan bias in evaluating news, although it led participants to share more politically congruent news regardless of truth.

Overall, these results suggest that partisan bias in discerning true and false news is a default motivation—little is gained by incentivizing it—but accuracy can be improved by incentivizing attention to already acquired knowledge (Pennycook & Rand 2021, Reyna 2023b); such effects might be expected to be magnified in adolescents for whom social goals are even more salient than accuracy goals compared with adults (Reyna & Brainerd 2023).

Knowledge and prior beliefs have also been demonstrated to be related to partisan asymmetry in the discernment of misinformation related to COVID-19, as well as perceived vulnerability to the pandemic. In particular, Calvillo et al. (2020) found that conservatives showed lower truth discernment of misinformation related to COVID-19, which was significantly related to knowledge about COVID-19 and approval of the US President (who played a large role in handling the pandemic) (see also Pereira et al. 2023). Although some studies report differences in judgments of accuracy or truth discernment between Republicans or conservatives and Democrats or liberals, once other explanatory variables are taken into account, these differences tend to decrease (Bago et al. 2020, Ecker et al. 2021, Ryan & Aziz 2021; see also Ditto et al. 2018, Baron & Jost 2019).

The influence of strong political motivations on susceptibility to misinformation can be conceived as a Bayesian inference problem, in which strong prior beliefs heavily influence perceived accuracy (Rigoli 2021, Zmigrod et al. 2023). Under this model, a politically polarized person is not irrational for being biased by their strong priors in the face of evidence that goes against their prior. A large amount of evidence would be required to shift the prior, and the effectiveness of increasing evidence would vary based on how diagnostic each piece of evidence was (Rigoli 2021). Consistent with this analysis, Pennycook & Rand (2021) reported that people were better at true–false discernment when they evaluated politically congruent news, for which they presumably had a deeper well of knowledge to draw from, compared with incongruent news. These results contradict a dual-process approach in which System 1's motivational biases decrease accuracy. Although a Bayesian approach explains how politically biased responses to misinformation could sometimes be grounded in prior knowledge and, hence, be rational, it clearly does not explain all examples of political bias in response to misinformation.

Beyond political ideology, social norms may also motivate responses to misinformation. For example, van der Linden et al. (2018) found that although conservatives and liberals differed in their judgment of the scientific norm related to climate change, being exposed to a descriptive norm ("97% of climate scientists have concluded that human-caused global warming is happening") significantly reduced this polarization. Similarly, Luo and colleagues (2020) examined how social consensus (number of likes associated with a political news headline) influenced judgments about whether the headline was fake or real. Although participants generally perceived news headlines as fake, the more messages were liked, the more participants thought the headlines were real—for both real and fake news (Luo et al. 2020).

Young children also tend to believe information and misinformation that have received consensus. Fusaro & Harris (2008) presented 3- and 4-year-olds with two adults who differed in their opinion about what the name of a novel object was. Then, two bystanders smiled and nodded their heads in response to one adult's claim and frowned and shook their heads in response to the others. The children mostly believed the name provided by the adult who received social assent. This finding was replicated in another study by Corriveau et al. (2009) involving verbal techniques to communicate consensus. Social consensus would be expected to have an outsized impact during adolescence because of the strong motivation for social approval from peers (Blakemore 2018). Longitudinal research is needed to understand how political ideology and misinformation codevelop, especially the degree to which developmental influences flow from misinformation (and disinformation) to shape political ideologies beginning in early adolescence.

Interactions Between Cognitive and Motivational Factors

Combining the cognitive and motivational factors that we discuss above, Kahan et al. (2012, 2017) introduced the motivated System 2 reasoning (MS2R) hypothesis to explain findings that people use numeracy and other cognitive skills to justify their ideological beliefs "via polarized risk perceptions, interpretations of probabilistic information, and identification of key probabilistic information" (Peters & Shoots-Reinhard 2023, p. 32). Some studies support this hypothesis, finding that those with strong analytical and numeracy abilities (System 2) marshal those abilities to support their desired conclusions on the basis of motivations such as political ideology or party affiliation and thus respond more favorably to ideologically congruent compared with incongruent information (Kahan & Peters 2017, Kahan et al. 2017).

Specifically, to test the MS2R hypothesis, Kahan and colleagues (2017) presented participants with 2 × 2 tables summarizing identical data either favorably or unfavorably on both politically charged ("gun-control ban") and neutral ("a new skin rash treatment") issues and asked participants questions about what the tables said. For example, the data for the gun-control ban example indicated that crime either increased (congruent for conservative Republicans) or decreased (congruent for liberal Democrats). As numeracy increased, participants from both ideological groups interpreted the data correctly for the neutral issue. However, for the politically charged issue, as numeracy increased, the correct interpretation of the data decreased for those with ideologically incongruent positions.

Recent efforts to replicate some of these initial findings in support of MS2R have failed (Persson et al. 2021, Stagnaro et al. 2023). In addition, using CRT instead of numeracy as a measure of System 2 thinking, Pennycook & Rand (2019) did not find evidence that those higher on CRT were worse at judging the accuracy of politically concordant fake news, as MS2R would predict. Instead, they found that those higher on CRT were better at discerning real and fake news regardless of political party orientation. Bago et al. (2020) found similar results when they manipulated the extent to which participants deliberated about headline veracity: Deliberation did not interfere with the ability of participants to judge the truth of fake news that aligns with their political orientation. Rather, deliberation improved the accuracy of judging news headlines regardless of the subjects' ideological alignment (but see Martel et al. 2024).

More research examining the underlying mechanisms of these effects in the context of misinformation is needed to determine the conditions under which logic, numeracy, and reflection promote or protect against political bias in receptivity to misinformation. A crucial factor that is missing from the System 1 and 2 framework—meaning-making as described in fuzzy-trace theory—provides a potential bridge between these disparate findings (Reyna 2012, 2023a; Reyna et al. 2021b). That is, reflecting or deliberating more, processing numbers more precisely, or being accurate at the level of minutiae can be important, but they are not the same thing as getting the gist of information or misinformation. Misinformation acceptance likely turns on whether messages do or do not make sense with respect to their gist, not their details (Jamieson 2021, Langdon et al. 2024, Wolfe 2021). Thus, when meaning-making (gist extraction) combines prior beliefs (ideological and otherwise) with the abilities of System 2 to make sense of information or misinformation, politically biased assimilation of evidence can result. Conversely, combatting misinformation requires more than logic, numeracy, or the kind of deliberation that reflects open-mindedness or critical reasoning (though, again, those are important); it requires a foundation of knowledge, the ability to extract the gist of messages, and gist-based insight into what is plausible, as discussed below.

Development from childhood to old age can be viewed from this perspective as an evolving quest for essential meaning, which is satisfied when misinformation explains observation (Gelman

2005). That is, essentialism is the emphasis on underlying meaning—the essence underlying reality—rather than on what can be observed superficially, which Gelman (2005) has studied developmentally and linked to evolving conceptual development. Consonant with fuzzy-trace theory's emphasis on gist (underlying meaning) rather than superficial literal details, misinformation would be expected to be most persuasive when it explains reality in terms of its underlying meaning (essence or gist) rather than its literal truth.

Source Credibility and Trust

Knowledge and information are obtained not only through direct observation but also through sources such as official government summaries and trusted others. Adults and children generally tend to trust others, even strangers, by default (Dunning et al. 2019, Jaswal et al. 2010). Using longitudinal data on US citizens, Poulin & Haase (2015) found that people's agreement with statements such as "most people can be trusted" increases steadily between ages 18 and 87. However, there are developmental differences in trust: Although there is some evidence that children and adolescents are capable of assessing source credibility, evidence shows that they tend to do this less than adults, increasing their susceptibility to misinformation. For example, a study of sixth graders' online search strategies revealed that, on average, students evaluate the trustworthiness of sources for only 39% of the websites they read (Barzilai & Zohar 2012), and less than 20% of high schoolers questioned the credibility of spurious claims on social media (Breakstone et al. 2021).

Trust and credibility of information sources support misinformation acceptance directly and indirectly. Trust in sources also propagates misinformation via what is called organic reach: Interacting with information (e.g., commenting or liking), dwell time while reading, or sharing with wider networks greatly increases the number of people that misinformation reaches (Buchanan & Benson 2019).

Social cues for trust. As might be expected, political party affiliation and ideology influence the perceived credibility of a source. For example, when asked the first thing that comes to mind when hearing the term fake news, people associated the term with nonconcordant media sources (e.g., with Fox News by liberals and with CNN by conservatives; van der Linden et al. 2020). Young children also use social cues to evaluate the trustworthiness of sources. For example, early studies on suggestibility found that children as young as 4 years old are more trusting of adults than same-age peers, which meant that they were more suggestible to postevent misinformation from adults than from their same-age peers (Ceci et al. 1987).

Trust in science and official sources. Trust in scientists and scientific sources is of special concern with respect to belief in misinformation. A recent study found that younger adults (age 18–54) and older adults (age 55+) both found corrective information from the World Health Organization to be more credible than misinformation, but this effect was smaller for younger compared with older adults (Vijaykumar et al. 2021). Additionally, Roozenbeek et al. (2020) found that self-reported trust in scientists predicted a decrease in susceptibility to misinformation about COVID-19. Despite the generally salutary effects of trust in science, blind trust in misinformation that appears to be scientific could have opposite consequences. Misleading forms of misinformation may include seemingly scientific references and statistics that nevertheless communicate the wrong meaning. Using pseudoscientific reports about COVID-19 and genetically modified organisms, O'Brien et al. (2021) found in four studies that participants with high trust in science were more likely to believe and spread false claims that included scientific references.

Knowledge and trust attributions. Although appeals to authority, such as to scientists or government officials, can increase misinformation acceptance, trust in sources can be undermined

when they seem to lack knowledge. For example, when 6-to-7-year-olds had concrete knowledge that a toy can do several things, and they witnessed a teacher giving incomplete instructions about the toy, they mistrusted this teacher (Gweon & Asaba 2018). In addition, 6-to-7-year-olds distrusted a person who did not explain obvious information about a toy when giving instructions, and thus explored a new toy provided by this person more broadly on their own (Gweon et al. 2014). Ironically, this implies a positive effect of an unreliable communicator because that unreliability provoked questioning of an authority figure (an adult) appropriately (based on reliability) and shows that children do not passively accept all adult sources as credible. This result also highlights the importance of prior knowledge about how things work, especially among young people; violation of such knowledge is a critical cue that promotes further investigation and potential resistance to misinformation.

Trust is not the same thing as deference, which also differs developmentally. For example, after seeing three lines that differed in length and being asked to point to the "big line," 3- and 4-year-olds copied three adults who pointed to one of the two smaller lines about 20% of the time (Corriveau & Harris 2010). In a second study, 3- and 4-year-olds pointed to the line the adults selected about 29% and 23% of the time, respectively. Importantly, however, most children later indicated that the informants were not very good at choosing the largest line. This finding suggests that young children may defer to the judgment of adults, even when they do not trust their credibility. Trust and deference to authority are also characteristic of many adults, and they predict susceptibility to misinformation (Osborne et al. 2023).

Message characteristics and trust. Characteristics of a message itself can make it less or more trustworthy. Breaking news about neutral content was judged to be less trustworthy and credible than objective news, suggesting that people tend to be wary of seemingly sensational information (Pelau et al. 2023). In contrast, numbers enhance source credibility. That is, people rate news articles as being higher in quality when numbers are present, unless they perceive there to be mistakes or miscalculations (Appelman 2023). This finding held regardless of whether this perception was objectively accurate or not. Other evidence indicates that people also prefer news reports that provide meaningful interpretive labels for numbers (Peters 2020, Reyna & Brainerd 2023). In addition, news reports that included both numbers and visual representations of numbers were perceived as more credible than those that included numbers alone (Du et al. 2019), again suggesting that interpretability augments credibility.

Repetition

None of the factors we discuss above have to do with the simple manipulation of repeating a message, but the effect of repetition is one of the most important and longstanding topics in misinformation research. Repetition increases belief in misinformation, even when a person has relevant knowledge to the contrary (Fazio et al. 2015). The repetition effect (also known as the illusory truth effect) refers to rating repeated (mis)information as more true than nonrepeated (mis)information (Dechêne et al. 2010, Udry & Barber 2024). That is, repeated statements, both true and false, are believed more than new statements. Repetition studies typically involve an initial exposure to the (mis)information, where participants rate how interesting statements are, followed by a truth phase where participants rate statements (for example, using a scale from "definitely false" to "definitely true") (Fazio et al. 2015). In the truth phase, typically half of the statements are repeated from the exposure phase, while the other half are new. The repetition effect has been observed for general knowledge items (e.g., Brashier et al. 2020, Fazio & Sherry 2020), news headlines (e.g., Pennycook et al. 2018, Pillai & Fazio 2024), and COVID-19 health information (e.g., Unkelbach & Speckmann 2021). The repetition effect has also been observed

in naturalistic settings and for repeated statements in the media (Fazio et al. 2022, Pillai et al. 2023).

Ease of processing, or processing fluency, is one of the main explanations offered for the repetition effect (for a recent review, see Udry & Barber 2024). Repetition is thought to increase how easy it is for people to process information, and thus it acts as a cue that the repeated information is true (Pillai & Fazio 2024). Processing fluency can be perceptual (the ease of reading because of color contrast) or conceptual (the ease with which the meaning of a statement is processed). Recent evidence failing to detect a difference in the size of the repetition effect for verbatim repetitions of news headlines compared with paraphrased repetitions of news headlines is consistent with the conceptual, but not perceptual, fluency account of the repetition effect (Pillai & Fazio 2024; but see Unkelbach 2007). Consistent with the conceptual fluency account, two additional studies observe the repetition effect with nonverbatim repetitions (Béna et al. 2023b, Gratton et al. 2024; for a meta-analysis, see also Dechêne et al. 2010). Thus, the repetition of the gist of a message, not reactivation of its verbatim representation, makes false information seem more true, reminiscent of findings in the false-memory literature in which repeating the theme of a list of words (but not the verbatim words) makes new information seem old (Reyna et al. 2016).

Importantly, the repetition effect is not observed when metacognitive vigilance is likely to be high, as when accuracy ratings, as opposed to ratings about how interesting the statement is, are used during the exposure phase (Brashier et al. 2020). Along similar lines, the repetition effect is eliminated when headlines are posed as questions instead of statements in the exposure phase (Calvillo & Harris 2023). Further, when opinions are presented and participants are instructed to separate opinions from facts in the exposure phase, the repetition effect is not observed for opinions (Riesthuis & Woods 2024). In addition, the size of the repetition effect has been found to decrease when sources are viewed as unreliable (Begg et al. 1992), for conspiracy statements as opposed to trivia statements (Béna et al. 2023a), and for clickbait as opposed to regular news articles (Béna et al. 2023b).

Notably, substantial heterogeneity has been observed across individuals and items, even when the repetition effect is observed on average (Lacassagne et al. 2022). Individual difference factors such as analytical thinking (CRT) that play an important role in accuracy ratings and truth discernment do not predict the repetition effect (De keersmaecker et al. 2020). If anything, contrary to dual-process explanations, a higher need for cognition and verbal measures of CRT predicted a stronger repetition effect (Brashier & Rand 2021, Newman et al. 2020).

With respect to the heterogeneity of items, Lacassagne et al. (2022) provided the mean truthfulness ratings for each statement, but did not appear to observe the repetition effect for some statements that were completely implausible (e.g., "Elephants weigh less than ants"), although statistical significance for individual statements was not presented (see also Pennycook et al. 2018). However, for false statements that could be true on some level (e.g., "A monsoon is caused by an earthquake," if one were to confuse "tsunami" with "monsoon"—both extreme events involving lots of water), the repetition effect is observed. Therefore, implausibility in the sense of what could be true at a gist level (broadly true but false at the level of details) may provide an important boundary condition for the repetition effect. Although Fazio et al. (2019) conclude the opposite, their operationalization of plausibility—the percentage of people who judge a statement to be accurate—does not capture whether a statement could be construed as true on a gist level (Langdon et al. 2024). Instead, it captures how many people evaluated it as true. Therefore, these conclusions are not necessarily at odds; the term plausibility is simply being used in two different ways (Reyna 2012).

Developmentally, the repetition effect has been demonstrated in children as young as 5 years old, and the size of the repetition effect did not differ by age group (Fazio & Sherry 2020). This

may seem surprising, although the authors note that the study was underpowered to detect developmental differences. However, there are two features of this experiment beyond power that may contribute to this result. The first is that when participants are asked to evaluate how interesting a statement is in the exposure phase of the experiment, this is a levels-of-processing manipulation that encourages semantic, gist-based thinking (Reyna et al. 2016, Thapar & McDermott 2001; in children, see also Kheirzadeh & Pakzadian 2015). Therefore, while developmental differences in the relative emphasis on verbatim versus gist ways of thinking are typically observed between adults and children, since this experiment manipulated the level of processing such that both adults and children were encouraged to use gist, it is not entirely surprising that a developmental difference was not observed (similar effects occur in false memory; Holliday et al. 2011, Reyna et al. 2016). This interpretation is bolstered by the fact that the materials used in the study were child-friendly (e.g., "A calf is a baby cow"), and thus meaningful for each of the age groups included in the study (Fazio & Sherry 2020).

In contrast to children and younger adults who show the repetition effect, older adults (over age 65) do not show the effect for statements they know are false (Brashier et al. 2017). However, for statements they do not know are true or false, they show a similar repetition effect as younger adults. This finding has been interpreted to mean that older adults "stick with what they know; they reject claims that contradict their knowledge, even when these falsehoods feel fluent" (Brashier & Schacter 2020, p. 317). Alternatively, older adults compared with younger adults might have a firmer grasp of what is plausible for known facts and thus be less susceptible to repetition-induced plausibility.

SHARING MISINFORMATION

Many factors that promote misinformation acceptance also promote sharing of misinformation on social media, which is a major vector for spreading misinformation. Like acceptance, factors such as repetition, extraversion, source credibility, partisan bias, trust, and gist increase sharing of misinformation (Broniatowski et al. 2024, Calvillo et al. 2024, Garrett & Bond 2021, Osmundsen et al. 2021, Vellani et al. 2023). For example, consistent with fuzzy-trace theory, the presence of gist in a message was found to be the strongest predictor of retweets per follower in an analysis of 10,000 tweets about vaccination (Broniatowski & Reyna 2020).

However, there are important differences between misinformation acceptance and sharing (Pennycook & Rand 2021): People are more willing to share false information than they are to accept that false information is true (Arechar et al. 2023), and when focusing on sharing rather than accuracy, truth discernment declines (Epstein et al. 2023). Prompting people to focus on accuracy or explain why a headline is true or false reduces sharing of fake news on social media, supporting a latent ability to discriminate their truth and falsity (Arechar et al. 2023, Pennycook & Rand 2022, Reyna 2023b; but see Roozenbeek et al. 2021). In general, the effects are similar for CRT on both sharing and misinformation acceptance (e.g., Pennycook et al. 2020). CRT and accuracy prompts have been found to interact such that those higher on CRT were less likely to share misinformation when prompted to think about accuracy compared with those lower on CRT (Pennycook & Rand 2022).

Thus, mechanisms such as inattention to accuracy—a lax System 2—have been offered to explain sharing, but it may also be driven by attention to other goals such as social engagement and endorsement (Reyna 2023b). Consistent with this interpretation, misinformation was shared more often when liked by others and when incentivized to identify articles that would be liked by members of their political party (Rathje et al. 2023; but see Ceylan et al. 2023). Adolescents may be particularly influenced by social motivations to share, with attendant risks of habitual social media use (Maza et al. 2023, Sherman et al. 2018).

Older adults (age 65 and older) share almost twice as much misinformation online compared with their younger peers (age 45 to 65) and almost seven times more than younger adults (age 18 to 29) (Brashier & Schacter 2020, Guess et al. 2019; for similar results, see also Grinberg et al. 2019). Among the explanations offered for these age differences are lower levels of digital literacy, lack of knowledge, and reduced cognitive reflection (e.g., lower CRT performance) in older adults (Brashier & Schacter 2020; but see Osmundsen et al. 2021). One might think that sharing misinformation is less of a concern for young children because platforms do not technically allow children under age 13 to use their services (e.g., TikTok 2024). Nevertheless, 11% of parents with children ages 5–8 report that their child uses TikTok, and this increases to 30% of parents of children ages 9–11 (Auxier et al. 2020). However, little research has been done concerning whether children and adolescents are more likely to share misinformation than other age groups.

SUMMARY AND THEORETICAL FRAMEWORK

The World Economic Forum surveyed 1,490 experts across academia, business, government, the international community, and civil society who identified misinformation and disinformation as "the most severe global risk" in the next two years (World Econ. Forum 2024). Artificial intelligence can now generate vast amounts of believable misinformation that is less recognizable as false than misinformation generated by humans (Goldstein et al. 2024, Spitale et al. 2023). Social media, amplified by algorithms and bots, transmits this misinformation to individuals across the lifespan, but the young and the old may be especially vulnerable to its ill effects.

As discussed above, children have lower knowledge, numeracy, analytical ability, formal education, and metacognitive sophistication (including source-credibility judgment) than young adults, whereas older adults are more trusting and focused on social goals over accuracy. Adolescents may be the most vulnerable because of their high social media use and desire for social connectedness. However, little research has been conducted on developmental differences in exposure to, belief in, and willingness to share misinformation—and none on emerging issues such as trust in generative artificial intelligence. Furthermore, although a dual-process perspective has guided some research, theory remains relatively underdeveloped in this area, leaving major gaps in understanding.

We outline an alternative to traditional dual-process theory that builds on its insights but deviates from it in crucial ways that are required to understand misinformation acceptance and sharing (**Figure 2**). This alternative—fuzzy-trace theory—is grounded in evidence concerning individual and developmental differences (Reyna 2012, 2021). Foremost, fuzzy-trace theory provides an empirically motivated distinction between verbatim and gist representations of information and predicts that adults prefer to rely on the latter in most cognitive tasks. Thus, what is true according to the gist of a proposition, that is, broadly true in principle regardless of the verbatim details, should mainly drive misinformation acceptance and sharing, consistent with the findings we review. **Table 1** provides examples of these distinctions.

The inverse—true verbatim but false at the level of gist—is not just murky (as opposed to blatant), but is viewed as morally offensive because it violates the default that gist supersedes verbatim in ordinary communication (Langdon et al. 2024, Reyna et al. 2016). If ordinary communication emphasizes underlying meaning over surface detail (i.e., essence) as predicted, manipulations that encourage message recipients to consider why a false fact might be true or could become true should increase the perception that its gist is true, as is observed (Helgason & Effron 2022). Repetition might invite this consideration of gist plausibility, which is not just fluency or familiarity. **Table 2** illustrates how joining gists might mediate effects of misinformation, including repetition.

Background knowledge, science education, and experience, which vary across development and individuals, help people recognize what is plausible (Reyna 2020). Thus, combatting

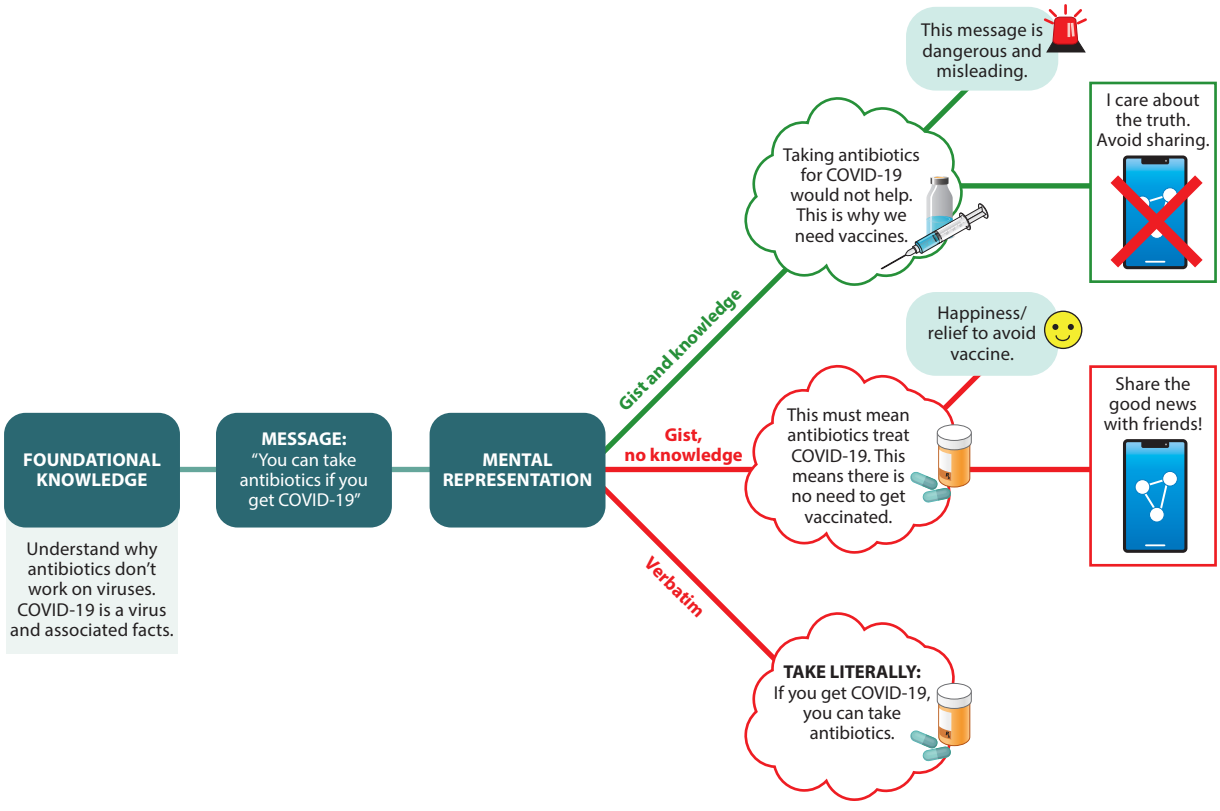

Figure 2

Key concepts from the fuzzy-trace theory misinformation framework. This figure illustrates a literally verbatim true but false gist example of misinformation. Gist representations then cue relevant values and emotions that relate to this understanding of the information. Importantly, truth is a value that many people hold dear, and thinking about what is true helps people notice when a message is false. According to fuzzy-trace theory, all of these factors—mental representation, values, and emotions—contribute to whether one believes and shares misinformation on social media.

Table 1 Examples of gist and verbatim representations and misrepresentations of the fact that "from January 1 to December 31, 2019, 1,274 individual cases of measles were confirmed in 31 states"

	True gist	False gist
True verbatim	Verbatim: "from January 1 to December 31, 2019, **1,274** individual cases of measles were confirmed in **31** states."	Verbatim: "from January 1 to December 31, 2019, **1,274** individual cases of measles were confirmed in **31** states."
	Gist: "there was a huge increase in this serious and highly contagious disease across the country."	Gist: "there was a negligible increase in this mild, hard to transmit disease in a few states."
False verbatim	Verbatim: "from January 1 to December 31, 2019, **1,001** individual cases of measles were confirmed in **29** states."	Verbatim: "from January 1 to December 31, 2019, **1,001** individual cases of measles were confirmed in **29** states."
	Gist: "there was a huge increase in this serious and highly contagious disease across the country."	Gist: "there was a negligible increase in this mild, hard to transmit disease in a few states."

This fact is from the Centers for Disease Control (2024b). This table illustrates how gist and verbatim (mis)information operate together. Even true verbatim information can lead to being misinformed in a gist sense if one takes away the wrong meaning from that information. Conversely, if someone takes away the right meaning from verbatim misinformation, they are not misinformed in a meaningful gist sense (although they have been subject to verbatim misinformation).

Table 2 Examples of stimuli from misinformation studies

Misinformation manipulation	False	True	Joining gists	Source
Stories/ narratives	Autumn is another word for spring.	Autumn is another word for fall.	Autumn is a season. Spring and fall are seasons.	Fazio & Marsh (2008)
Repetition	A calf is a baby horse.	A calf is a baby cow.	A calf is a baby farm animal. Baby horses and baby cows are baby farm animals.	Fazio & Sherry (2020)
	Amphibians are animals that begin life on land and then move to the water.	Amphibians are animals that begin life in the water and then move to land.	Amphibians live on land and in water. Beginning life on land and moving to the water or beginning life in the water and then moving to land both involve living in land and water.	Fazio & Sherry (2020)
	Cirrus clouds often bring thunderstorms.	Cumulonimbus clouds often bring thunderstorms.	Certain kinds of clouds bring thunderstorms. Cirrus and cumulonimbus are kinds of clouds.	Fazio & Sherry (2020)
	Pufferfish contain a toxin called botulinum, which is up to 1,200 times more lethal to humans than cyanide.	Pufferfish contain a toxin called tetrodo[to]xin, which is up to 1,200 times more lethal to humans than cyanide.	Pufferfish contain a lethal toxin. Botulinum and tetrodotoxin are lethal toxins.	Fazio & Sherry (2020)
	A date is a dried plum.	A prune is a dried plum.	A date is a dried fruit. Dates and prunes are dried fruits.	Fazio et al. (2015)
	The Atlantic Ocean is the largest ocean on Earth.	The Pacific Ocean is the largest ocean on Earth.	The Atlantic Ocean is a large ocean. The Atlantic Ocean and Pacific Ocean are large oceans.	Fazio et al. (2015)
	The Minotaur is the legendary one-eyed giant in Greek mythology.	The Cyclops is the legendary one-eyed giant in Greek mythology.	A legendary character from Greek mythology is a one-eyed giant. The Minotaur and Cyclops are characters from Greek mythology.	Fazio et al. (2015)
	Deer meat is called veal.	Deer meat is called venison.	Deer meat is a kind of meat. Veal and venison are kinds of meat.	Brashier et al. (2017)
Prior testing	"What country did the Pilgrims come from: England, Germany, Ireland, or Spain?" (In this example, false information is introduced as answer choices, along with the correct answer).	England	Pilgrims are people who came to America in history. In history, people came to America from England, Germany, Ireland, and Spain.	Marsh et al. (2012)

The examples in the table are stimuli used from various studies where misinformation (typically false verbatim facts) could be conceived of as examples of a true gist of the misinformation, assuming average knowledge and background information.

misinformation through prebunking does not involve a choice only between narrow-spectrum interventions that teach specific facts or broad-spectrum interventions that teach digital literacy and reasoning skills that apply across facts (Lewandowsky & van der Linden 2021). There is another broad-spectrum approach that involves teaching what makes sense at the level of gists that apply broadly, such as why antibiotics are not effective against viruses. In contrast, teaching broad-spectrum open-mindedness or skepticism of emotional messages can backfire because they do not relate to the content of messages. Getting the gist of true information often implies feeling appropriate emotions; neutrality is not truth (Carrasco-Farré 2022, Reyna 2021).

Ironically, research on misinformation reveals that people value truth since they are more likely to share true than false information even when their goals are social. Values in fuzzy-trace theory are represented in long-term memory like other information, namely, at varying levels of precision from verbatim (situation-specific) to gist principles (core values that apply broadly) (Reyna & Mills 2014). In this view, values activated in context can become goals that direct behaviors, such as sharing. This theoretical assumption accounts for the frequent finding in the misinformation literature (and other literatures) that people can strongly hold values that are not retrieved and implemented in context without prompts (aka retrieval cues). Also consistent with fuzzy-trace theory and the principle of encoding specificity (like retrieves like), providing a more gisty cue to retrieve the core value of truth was more effective than providing a more precise cue in encouraging people to accurately judge statements about COVID-19 as true or false (Hwang & Jeong 2023).

More generally, misinformation takes root in ignorance, uncertainty, and attendant anxiety because these factors make it hard to make sense of the world. Misinformation often fills that explanatory void. Making sense of the world privileges gist-based plausibility over adherence to verbatim details. Even when details are learned, verbatim memories quickly become inaccessible while gist memories endure and transfer to a broader array of contexts. Inadequate knowledge of science, mathematics, history, and other domains does not pose a threat because people fail to retrieve specific facts that negate misinformation but because they cannot understand the why behind the facts.

Susceptibility to misinformation is exacerbated by mistrust and suspicion of those perceived as powerful elites (the government, the rich, and scientists working on inscrutable topics) and filtered through biases in worldview that reflect adverse early experiences, information exposure, social norms, and moral values. Therefore, misinformation is effective when it makes sense of the world and troubling events in it, that is, when it offers a qualitative meaning that connects the dots of reality and explains the big picture in terms of core values (Reyna 2020). This meaning might be misguided, but it is likely to become entrenched as algorithms continue to provide users more and more of what they already believe. The developmental origins of these beliefs and how they can be changed remain a frontier for future research.

DISCLOSURE STATEMENT

V.F.R. advises the World Health Organization (which is working with Meta) on health communications. The authors are not aware of any other affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

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