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The Importance of Science Education, Scientific Knowledge, and Evaluation Strategies for the Successful Detection of COVID-19 Misinformation

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ABSTRACT

An important goal of science education is to equip students with the scientific knowledge and evaluation skills necessary to identify misinformation. However, the specific role of science education and knowledge and the evaluation strategies most commonly relied on in this process remain unclear. The two studies presented here leverage educational diversity to explore these issues: Study I focused on a representative sample of the general population ($n = 500$), where science education is compulsory up to 10th grade. Study II focused on a representative sample from an ultra-Orthodox community ($n = 800$), where science education in school is not compulsory. Respondents in both studies were asked to share misinformation they heard during the COVID-19 pandemic and explain why they did not believe it. Using content analysis of participants' open-ended answers, we found that about half of the general population and only a third of the ultra-Orthodox sample were able to identify misinformation when confronted with such. Science knowledge was correlated with accurately identifying misinformation in both studies, but science education was correlated with performance only among the general public who widely receives mandatory science education. Participants from the general public who justified their suspicion using content evaluation were more likely to identify misinformation correctly. At the same time, ultra-Orthodox were more likely to perform well when they justified their suspicion based on the evaluation of the source. These findings highlight the difficulty of recognizing misinformation in real life. Having scientific knowledge and awareness of sources doesn't guarantee protection from being misled—but it helps.

1 | Introduction

Education in general and science education, in particular, aim to equip students and, hence, future generations with the skills to recognize misinformation and enhance their preparedness to assess information (Barzilai and Chinn 2020; van Prooijen 2017) to become critical consumers of science information (National Research Council 2012). Recently, researchers have argued that having the ability to differentiate between accurate and false information is essential for scientifically educated people (Allchin 2022; Osborne et al. 2022; Osborne 2023). However, there is a gap between this ideal and current teaching practices—specifically, between the emphasis on information evaluation strategies and the limited application of such practices in classrooms. This raises questions about whether current methods allow learners to distinguish truth from falsehood within a scientific context (Osborne 2023). This study aims to investigate the roles of science education, scientific knowledge, and evaluation strategies in adults' ability to make this distinction.

While it is obviously impossible to predict decades ahead the specific scientific knowledge that will provide individuals with the greatest utility when trying to identify misinformation in everyday life, studies have shown that scientific knowledge may be useful beyond the confines of formal education (Shauli and Baram-Tsabari 2019; Sadler and Zeidler 2005). Other studies, however, suggest that it has little impact (Covitt et al. 2009; Jho et al. 2014; Dalyot et al. 2021). It remains unclear to what extent scientific knowledge has a role in adult life challenges such as decision-making, reasoning in everyday situations and specifically identifying misinformation. Additionally, since years of science education do not always equate to a corresponding level of scientific knowledge, the role of science education in this context is also unclear. To empirically contribute to the conflicting literature, the first research question guiding this study is: (1) How well can people with different levels of science education and scientific knowledge identify misinformation in their daily lives in the context of the COVID-19 pandemic?

People may be well-educated, but no one can be an expert on all science-related issues. The science encountered in everyday life usually extends far beyond the limited knowledge learned in formal education (Baram-Tsabari and Osborne (2015)). Science education should equip students with the tools needed to evaluate the reliability of science-related information, even when the subject matter is beyond their own understanding (Osborne and Pimentel 2022; 2023). The literature identifies various ways in which people assess information, including evaluating surface credibility cues, professional design, and popularity, which demand little effort from users (Machackova and Smahel 2018). The literature also highlights two key critical evaluation strategies that involve deeper cognitive engagement: first-hand evaluation of the claims' correctness (content evaluation), and second-hand evaluation of the source (source evaluation) (Sperber et al. 2010; Bromme and Goldman 2014).

Recent studies highlight source evaluation as the key approach for assessing complex scientific information, acknowledging the epistemic dependence of non-experts and their limited ability to directly assess the accuracy of scientific claims (Osborne and Allchin 2024). The public, however, often faces contentious issues, which spotlight contradictory claims from experts on topics still under investigation or debate (Barzilai et al. 2020). What evaluation strategies would be most useful for assessing information quality and identifying misinformation in such situations? To address this issue, our second research question asks: (2) What evaluation strategies are most commonly relied on when individuals correctly identify misinformation?

The idea that science education should empower its students with the ability to discern science-related misinformation is part of a bigger vision of the importance of scientific knowledge (e.g., terms and principles) and its practices (e.g., procedural and epistemic) to adult life. The ability of adults to identify science-related misinformation in everyday life is likely to vary depending on the nature and extent of the science instruction they receive. Consequently, we sought answers to our research questions using two distinct samples. In Study I we surveyed a representative sample of individuals for whom science education was compulsory up to 10th grade as part of the national curriculum. Study II surveyed a representative sample of the ultra-Orthodox sector in Israel for whom science education was not compulsory and also less valued by the community's leaders.

Issues surrounding the COVID-19 pandemic presented an ideal opportunity to investigate these questions across very different groups, given the widespread impact of the pandemic on those interested and knowledgeable about life sciences, as well as on those who are not. The global spread of the virus was accompanied by widespread misinformation, as the Director General of the World Health Organization (WHO) noted: "We are concerned about the levels of rumors and misinformation. We're not just fighting an epidemic; we're fighting an infodemic. Fake news spreads faster and more easily than this virus and is just as dangerous" (WHO 2020). For these reasons, the COVID-19 pandemic is a suitable context for studying the roles of science education, scientific knowledge, and evaluation strategies in addressing the challenges posed by misinformation for groups with and without mandatory science education.

2 | Literature Review

2.1 | Misinformation and Its Implications

In the 21st century, information is easily created, stored, and distributed without traditional gatekeepers, thus making the information landscape in what has been called "the post-truth era" ever more complex (Molina et al. 2021). The "post-truth era," is a term that refers to the diminishing or even complete negation of the role of facts in public life (Osborne et al. 2022). Scholars differentiate between misinformation, which is often shared without the intent to deceive, and disinformation, which is created and spread with the deliberate aim of deception (Wardle and Derakhshan 2017). In the current study, misinformation is used as an umbrella term for post-truth phenomena such as fake news, rumors, and conspiracy theories covering any information that turns out to be false regardless of the disseminators' intentions (Ecker et al. 2022).

Misinformation challenges the general public since it undermines knowledge of crucial scientific topics such as vaccines, climate change, and the COVID-19 pandemic (Osborne 2023). The coronavirus outbreak underscored the detrimental impact of misinformation: the dissemination of inaccurate information regarding the use of methanol and ethanol as COVID-19 remedies resulted in the tragic deaths of over 100 individuals in Iran (Lima et al. 2022); the spread of misinformation about the effectiveness of chloroquine against COVID-19 led to numerous overdose cases in Nigeria (Tasnim et al. 2020), and misinformation influenced individuals' inclination to wear masks and willingness to vaccinate (Douglas 2021).

Misinformation can also discredit established social institutions and knowledge validation by suggesting that policy recommendations are the work of political, media, and medical elites with nefarious motives (Valaskivi 2022). Misinformation, thus, can erode public trust in official institutions and experts. Ognyanova et al. (2020) found that exposure to fake news was linked to decreased trust in the media. This erosion of epistemic trust may prompt individuals to overlook expert guidance, with the potential for severe consequences (Swire-Thompson and Lazer 2020; Wu et al. 2022), such as lesser willingness to vaccinate (Tanzer et al. 2021). Individuals who believe in conspiracy theories are less likely to perceive epistemically authoritative sources as credible and more inclined to trust nonexpert sources (Imhoff et al. 2018). This might result from exposure to misinformation or even contribute to it—those who lack trust in experts may initially seek out contradictory information (Altay et al. 2023).

Healthy skepticism may help individuals effectively identify misinformation (Roozenbeek and van der Linden 2022). However, relying only on individual critical approaches may also promote hyper-skepticism, rejecting genuine information and expert advice (Allchin 2023). Therefore, science education has a role in preparing its graduates to navigate misinformation, helping them recognize when to trust their own knowledge and when to foster intellectual humility by acknowledging the limits of their understanding, especially when assessing claims outside their area of expertise (Pimentel and Osborne 2025).

2.2 | The Role of Science Education and Scientific Knowledge in Misinformation Detection

The Organization for Economic Co-operation and Development's (OECD) Programme for International Student Assessment (PISA) 2025 science framework (2023) states that: "A scientifically educated person can engage in reasoned discourse about science, sustainability, and technology to inform action. This requires the competencies to…Research, evaluate, and use scientific information for decision making and action" (p. 9). This competency specifically addresses the problem of misinformation: "When it comes to scientific information, both valid and misinformed, all citizens need the competency to judge the credibility and value of the information that commonly surrounds any science-related issue" (p. 23). This working definition relates closely to the emphasis in numerous countries on pursuing science literacy as a primary objective of science education (Osborne 2023).

Science literacy refers to the ability to read scientific information, evaluate its content critically, and use the information for various purposes, such as making decisions in everyday life (National Academies of Sciences Engineering and Medicine 2016). This definition aligns with Roberts (2007) Vision II of science literacy which emphasizes the essential skills and knowledge people need to navigate the realm of science in their day-to-day experiences (Roberts and Bybee 2014). Given its focus on real-world contexts involving science, this perspective of science literacy necessitates the ability to grapple with the challenges presented by misinformation.

In their analysis of different conceptualizations of science literacy, Sharon and Baram-Tsabari (2020) use the Grasp of Evidence framework (Duncan et al. 2018) to explore how common components of science literacy may contribute to non-experts' (vs. experts') ability to identify misinformation. They argued that four of these components are most likely to help individuals identify misinformation in everyday life: (a) Understanding scientific practices, (b) identifying and judging appropriate scientific expertise, (c) epistemic knowledge, and (d) dispositions and habits of mind (i.e., awareness of one's biases). Aside from scientific practices that are taught as part of procedural knowledge, however, the other components still receive scant attention in science education (Sharon and Baram-Tsabari (2020)).

A notable omission from this list is scientific knowledge. According to Sharon and Baram-Tsabari (2020), the interplay between scientific knowledge and everyday reasoning tasks is complex. On the one hand, scientific content knowledge facilitates problem-solving through the application of established scientific principles, thus enhancing people's capacity for effective reasoning in various contexts. Scientific experts, for example, owe some of their proficiency in tackling novel problems to a well-organized reservoir of knowledge centered on domain-specific 'big ideas' (National Research Council 2002). Nevertheless, much of the evidence supporting successful knowledge transfer originates from studies involving simplified tasks that may not accurately mirror real-world complexities. The utility of scientific content knowledge in everyday situations hinges on factors such as task complexity and requisite depth of knowledge. This complexity makes it challenging to determine in what ways and for which specific issues content knowledge is most advantageous for identifying misinformation in daily life (Sharon and Baram-Tsabari (2020)). This is exemplified by OECD's PISA 2025, stating that detecting misinformation "requires students to possess both procedural and epistemic knowledge but may also draw, to varying degrees, on their content knowledge of science" (OECD 2023, p. 23).

Although it is clearly impossible to forecast which specific scientific knowledge will be most useful for identifying misinformation in everyday life decades from now, research has shown that scientific knowledge can be valuable beyond formal education. One study found that parents of hearing-impaired children sometimes applied their science content knowledge as a basis for understanding the contextual scientific terms of audiology, and those who lacked such general science knowledge were disadvantaged (Author, 2019). For example, parents could build on their understanding of concepts like decibels, frequency, and reading graphs to interpret the audiogram they are handed when their kids are being diagnosed.

Additional research has indicated the significance of scientific knowledge within specific contexts when making decisions in daily life. In their study, Sadler and Zeidler (2005) explored how knowledge of genetics relates to reasoning about scientific issues such as cloning and gene therapies. They found that students with more knowledge about genetics presented more coherent arguments and concluded that content knowledge enhanced the quality of these students' discussions on such socio-scientific issues (SSI) (Sadler and Zeidler 2005). Within the context of the COVID-19 pandemic, Rozenblum et al. (2025) found that people with more science education tended to rely less on misinformation when justifying their decisions to adhere to social distancing guidelines.

Other studies, however, have failed to find a significant association between scientific knowledge and its practical application in daily decision-making. Covitt et al. (2009) interviewed 22 middle and high school students, asking them about SSI, and then evaluated the students' decisions and how they justified them. Yet, scientific knowledge derived from formal education had less of an impact on the students' reasoning than personal experiences. The researchers suggested that conventional science education plays a minimal role in shaping students' decision-making on SSI. Similarly, Jho et al. (2014) explored how students' scientific knowledge and attitudes influenced decisions regarding the continued operation of a nuclear power plant in Korea. Contrary to expectations, the researchers found no correlation between scientific knowledge and the decisions made by the participants, suggesting that scientific understanding played a minor role in decision-making. Also, Dalyot et al. (2021) found that individuals placed limited emphasis on scientific knowledge when making decisions about SSI, such as Wi-Fi radiation.

Thus, the extent to which scientific knowledge has a role in adult life challenges, such as decision-making and reasoning in everyday situations, especially when confronting misinformation, remains uncertain. Moreover, as years of science education do not always translate to a comparable level of scientific knowledge, the role of science education in this context is also ambiguous.

2.3 | The Role of Evaluation Strategies in Misinformation Detection

Evaluating the quality and source of scientific information is viewed as a central skill and an expected outcome of science literacy (e.g., Allchin 2022; Duncan et al. 2018; Osborne and Pimentel 2022; 2023; Sharon and Baram-Tsabari (2020)). One influential conceptualization of science literacy defined the goal of science education for all learners as becoming 'competent outsiders'. Competent outsiders are not necessarily expected to understand the science but should be able "to interact with sources of scientific expertise in ways that help them achieve their own goals" (Feinstein 2011: 180), including identifying misinformation.

In practice, however, many people seem ready to adopt beliefs claiming to be scientific even when there is scant evidence supporting them and compelling evidence to the contrary (Allchin 2022). While people generally prefer information and knowledge that is accurate and generated through trustworthy means, Barzilai and Chinn (2020) point to four challenges in acquiring such information or verifying it as such: (1) people sometimes lack the ability to evaluate information; (2) cognitive biases may cause people to believe information that supports their positions even if it is wrong; (3) people do not believe in their ability to find reliable information in an environment flooded with misinformation, or they do not care, and (4) people do not consider that scientific research methods are the most appropriate way to study the natural world. Most of the literature on evaluation strategies has addressed the first issue.

Epistemic vigilance is defined as the awareness of both the content and the source's reliability (Sperber et al. 2010). Content awareness is expressed as a direct assessment of its accuracy (first-hand evaluation). This approach involves directly gauging the validity of information and essentially making epistemic judgments about which claims are true. The accuracy of a knowledge assertion can be ascertained through a direct comparison with other forms of knowledge, including personal experiences and general knowledge about the subject, or by engaging in a critical analysis of its logical consistency (Bromme and Goldman 2014). This procedure requires individuals to pause, engage in thought, and reflect on the content.

When individuals pause and engage in thoughtful consideration, their knowledge base is likely to play a more significant role. Consequently, Pennycook and Rand (2021) argue that some difficulties in discerning truth from falsehood arise from a lack of adequate reflection on one's pre-existing knowledge, and not only from having insufficient or inaccurate prior knowledge.

In many cases, however, individuals lack the requisite prior knowledge to evaluate information directly. The second dimension of epistemic vigilance, awareness of the reliability of the source (second-hand evaluation; Bromme and Goldman 2014) involves utilizing strategies that do not necessitate a deep understanding of the scientific topic but rather ask: Can I trust this source? It entails assessing the reliability of information via a thorough examination of the source itself or by evaluating the source's expertise (Tseng et al. 2021). Source evaluation, particularly in online environments, enables individuals to distinguish between reliable and unreliable information, supporting both their formal and informal learning and informing personal decision-making (Scharrer et al. 2025). This approach emphasizes our epistemic dependence on the expertise of others, defined as our dependence on the intellectual efforts of fellow knowers and the information they provide through their testimonies (Hardwig 1985; Norris 1997). It's important, however, to note that this method is only effective if the individual can accurately identify experts and credible sources. The public frequently encounters controversial issues that highlight conflicting expert opinions on topics still under investigation or debate (Barzilai et al. 2020). According to Caulfield and Wineburg (2023), in situations like this, the key challenge is to assess the range of expert opinions to distinguish among competing theories, majority and minority views, areas of consensus, legitimate uncertainty, and fringe perspectives. According to this view, when genuine uncertainty exists within the expert community, the most appropriate response is often to "wait and see." However, in such cases, the most effective strategies for evaluating information quality and detecting misinformation remain unclear (Barzilai et al. 2020).

2.4 | The Present Study

The literature review suggests a gap in understanding the specific role of science education, the influence of scientific knowledge, and the evaluation strategies most commonly used in the process of identifying misinformation. Thus, within the context of the COVID-19 pandemic, we seek to address the following questions:

1. How well can people with different levels of science education and scientific knowledge identify misinformation in their daily lives in the context of the COVID-19 pandemic?

2. What evaluation strategies are most commonly relied on when individuals correctly identify misinformation?

To address these inquiries, we leveraged data from two surveys conducted during the second wave of COVID-19 in Israel (November to December 2020), targeting two distinct groups: a representative sample of the general population in which science education is compulsory up to 10th grade (Study I) and a representative sample of individuals from the ultra-Orthodox sector for whom science education is not compulsory (Study II). The questionnaires covered items related to scientific knowledge and self-reported strategies for evaluating information. It also asked respondents to provide actual examples of misinformation about COVID-19 they encountered in daily life. Our study encompasses a diverse sample because if science education aims to equip all learners for active civic participation, it is imperative to investigate the responses to these questions in the context of a representative cross-section of the population (Tabak and Dubovi 2023).

As the COVID-19 pandemic has heightened public and research attention vis-à-vis misinformation, its proliferation on the internet, and its ramifications, it provides a unique setting for our research objectives. The high likelihood that the topic was pertinent to all participants provided a methodological advantage for this study (Tabak and Dubovi 2023). The relevance of the subject matter can influence the depth of cognitive engagement and the utilization of different evaluation strategies.

3 | Materials and Methods

This study was based on a secondary analysis of two surveys that were distributed to two representative samples of adults during the second wave of the COVID-19 pandemic in Israel (November to December 2020). Study I involved a sample of general population adults in which science education is compulsory until 10th grade ($n = 500$), whereas Study II involved a sample of ultra-Orthodox adults in which science education is not compulsory ($n = 800$).

3.1 | Participants

Study I: A random sample of 500 adults was obtained through the Panel4all online survey company. Stratified sampling was followed by random sampling within each stratum. Information on sampling and recruitment can be found in (Rozenblum et al. 2025). The resulting sample was representative in terms of gender, age, and level of religiosity (Appendix 1); however, respondents with higher education were overrepresented (53% of the sample participants had or were pursuing a college degree vs. 40% in the general population).

Study II: A random sample was drawn from the database of the Eskaria market research firm. The database contains content information about over 400,000 adult members of the Jewish ultra-Orthodox community. For ideological reasons, many ultra-Orthodox people do not use the internet (Malach & Cahaner 2021), so Eskaria collected their information via a telephone survey. The sample closely mirrored the general population distribution of religious affiliations within the ultra-Orthodox community (Lithuanian, Hasidim, Sephardim). The vast majority of respondents were married (87%) and young (82% aged 21–49), reflecting the high marriage rates in this population and the relatively youthful demographic profile of this sector today in Israel, as well as the challenge of recruiting older respondents. The sample was somewhat more masculine than the general population (59% men), and respondents with higher education were slightly overrepresented (26.8% had or were pursuing a college degree vs. 19% in the general ultra-Orthodox population). Complete details are given in Appendix 2. Procedures for sampling, recruitment, and representativeness can be found in (Taragin-Zeller et al. 2023).

The focus on the ultra-Orthodox community for this study stems from its distinctive position on science education. Since the establishment of the State of Israel, the ultra-Orthodox community has run its own educational framework consisting of K–12 gender-segregated schools. The educational system prepares youngsters for gender-specific roles, with males primed to become religious scholars and females prepared to support them as primary breadwinners and homemakers. Therefore, male education revolves predominantly around religious subjects (such as Torah studies), while female education incorporates limited exposure to nonreligious subjects (Perry-Hazan 2013). Ultra-Orthodox women who will probably enter the labor force and thus navigate the secular world to some extent usually study some science until the age of 15. Boys' religious studies require minimal exposure to science or mathematics, so they generally receive no formal science education after 5th grade (around the age of 11–12) (Manny-Ikan and Rosen 2013; Taragin-Zeller et al. 2024).

Most ultra-Orthodox education occurs within private institutions that receive 55% of their funding from the State and are theoretically obligated to teach 55% of the national core curriculum. While the licensing and public funding of these private schools are contingent on adherence to the core curriculum (Ministry of Education 2003), compliance with these regulations remains uncertain due to the reluctance of many ultra-Orthodox schools to participate in standard external evaluations, compounded by inadequate supervision of educational content, materials, and faculty by the Ministry of Education (State Comptroller 2020). Consequently, enforcement of these core requirements remains spotty (Perry-Hazan et al. 2024). Furthermore, members of this community are likely to have little informal exposure to scientific knowledge beyond the confines of their educational institutions, as indicated by a study documenting the deliberate omission of potentially contentious scientific information by ultra-Orthodox newspapers (Taragin-Zeller et al. 2024).

Ethics. Study I received ethical institutional review board (IRB) approval (2020-091). The data for Study II were collected by the Haredi Institute for Public Affairs. The secondary analysis of the data was waived by the IRB committee of the [Institute]. Verbal consent was acquired by the "Eskaria" survey company.

3.2 | Measures

The questionnaires used here were developed by five science communication and science education researchers to explore public interactions with science during the pandemic. The questionnaires were based on a previous research tool exploring parents' knowledge and engagement with science vis-à-vis everyday health issues (Shauli and Baram-Tsabari 2019). The questionnaires comprised culturally adapted everyday life dilemmas related to the pandemic that allowed us to examine public engagement practices, and requests to share instances of misinformation the respondents had encountered and the evaluation strategies they used. In addition, there were questions about the respondents' level of education and knowledge, and demographic variables. Here, we only describe the measures and items used in the current analysis.

3.2.1 | Detecting Misinformation

Open-ended responses to the prompt "There are many rumors about COVID-19. Tell us about one you did not believe" were used to evaluate respondents' capacity to detect misinformation when confronted with such (Table 1). A codebook was developed based on the identification of characteristics from participants' responses, followed by a quantitative analysis based on this identification (Krippendorff 2018). The responses were scored in terms of whether the respondents (1) identified misinformation correctly, (2) mistakenly identified correct information as misinformation, or (3) did not offer any information. To classify misinformation, we relied on the scientific agreement and guidelines that existed during the second wave of the pandemic, at the time of data collection. When it was unclear whether the information was true or false, we turned to official popular science websites such as the Ministry of Health, the health NGO 'Midaat', and the local fact-checker website "Irrelevant".

Our understanding of science in the context of the pandemic has evolved since the data were collected. To mitigate the risk of anachronisms during coding, any uncertainties related to the truth value of specific claims were considered relative to the time they were initially raised. These cases were rare, but to address them, we examined information from official scientific websites and well-known media and communication websites for the time frame of the survey period. The first author and a research assistant independently coded 10% of the responses. The results of an inter-rater reliability test of this random selection of responses were significant, with a Cohen's kappa = 0.918 (CI^{95} = [0.85–0.97], $p < 0.001$) (McHugh 2012), which is considered a high level of agreement (Cohen 1968). Following this reliability test, the first author coded the rest of the data.

3.2.2 | Identifying Evaluation Strategies

Responses to the prompt "How did you decide whether to believe it [the statement the respondent provided] or not?" helped identify the strategies respondents used when evaluating scientific (mis) information (Table 2). In Study I, this was assessed using a close-ended question that asked participants to indicate all the strategies that they used to evaluate the information they had heard. The list included content evaluation (first-hand evaluation strategy), source evaluation (second-hand evaluation strategy) – addressed as critical evaluation strategies, as well as alternative strategies, such as the expression of general skepticism and skepticism toward social media. In Study II, to reflect the cultural particularities of the ultra-Orthodox community, we used an open-ended question asking participants to explain why they doubted the information they

TABLE 1 | Codebook guiding the identification of misinformation in response to the question: "There are many rumors about COVID-19. Tell us about one you did not believe".

Criterion	Explanation	Examples
Identified misinformation correctly	The response described misinformation about COVID-19	I did not believe that: • Bleach heals • A patient doesn't get infected twice • Children don't get infected • That the coronavirus doesn't exist • 5 G caused Covid-19
Identified correct information as misinformation	The response described correct information about COVID-19 that was erroneously misclassified as wrong	I did not believe that: • People die from COVID • The virus causes memory loss • That coronavirus came from bats • That there is a vaccine
The response did not identify any information	The respondent did not identify any information	• I don't know • I didn't hear

* When it was unclear whether the information was true or false at the time of data collection, we examined official or popular science websites such as the websites by the Ministry of Health, health NGO, and local fact-checker.

TABLE 2 | Codebook of evaluation strategies in response to the question: "There are many rumors about COVID-19. Tell us about one you did not believe. How did you decide whether to believe it or not?".

	The strategy	Explanation	Criterion	Operationalization in Study II	Examples from Study II	Close-ended answer in Study I
Critical evaluation best practices	First-hand evaluation (Content: Is it true?)	"What to believe?": Assesses claims based on consistency or coherence with prior knowledge or by engaging in a critical analysis of its logical consistency (Bromme and Goldman (2014))	The plausibility of the information	An evaluation based on the reasonableness, reliability, and logic of the information (without explicit reliance on prior knowledge)	"Because it does not make sense that there is COVID during the day and there is no COVID at night" (F, BA)	The information does not make sense
			Personal knowledge and experience	An evaluation based on personal knowledge and experience	"I didn't believe that children don't get infected with COVID, because I got infected from my baby girl" (F, TC)	
			Scientific related knowledge	The explanation is justified and based on science	"I don't believe in the vaccines because they invented the vaccine in a short time" (F, TC)	
			Justification is based on objective reality	The explanation is justified and based on what is happening in the world	"Because you see that the entire economic situation in the world is in crisis and they wouldn't have done it" (F, MA)	
	Second-hand evaluation (Source: Should I believe this source?)	"Whom to trust?": Utilizing strategies that do not necessitate a deep understanding of the scientific topic such as appraising the credibility of the source (Bromme and Goldman (2014))	Consultation with experts: The respondent asks experts about the information	Reaching out to people with pertinent expertise (directly to doctors, epidemiologists, virologists, etc.)	"I ask a doctor" (M, Y)	I consulted with someone with relevant training (such as a doctor)
			Source evaluation: The respondent examines the sources, authors, venues, or channels that report, publish, or share the information, including mentions of the source's	Referring to a specific source (such as the Ministry of Health, CDC, WHO, etc.)	"Because I saw the data from the Ministry of Health" (M, BA)	I checked with official sources, such as the Ministry of Health
				Reliance on official sources – general reference	"Because I have confidence in the professionals who are not such liars" (M, BA)	The media said this was not true

(Continues)

TABLE 2 | (Continued)

	The strategy	Explanation	Criterion	Operationalization in Study II	Examples from Study II	Close-ended answer in Study I
			identity and trustworthiness.			
Alternative strategies	Expressions of skepticism	Skepticism as an explanation for the assessment	General skepticism	General skepticism without details	"I don't believe anything' (M, Y)	
			General skepticism due to the "infodemic"	Skepticism due to awareness of post-truth phenomena	"I don't believe in conspiracies" (M, BA)	I didn't believe this information because there is a lot of fake news
			Skepticism toward social media			The news was published on a social network, and I don't trust social networks
	Mistrust of official institutions	An expression of mistrust of official institutions as an explanation for the assessment	Mistrust of politics	Lack of trust in the political system and politicians	"I think it's political and not health risks" (M, Y)	
			Mistrust of the media	Mistrust of the media and the press	"Because I don't believe what is written in the press" (M, TC)	
			Mistrust of the health system	Mistrust of doctors and the health system	"Only doctors kill patients" (M, Y)	
	Additional sources of authority	Consulting with people of unknown expertise in the field	Religious authority	Consultation with religious authority	"Because my rabbi said that you should be vaccinated, and he knows what he's talking about" (M, HSY)	I consulted with a religious authority
			Family and friends			One of my friends or a family member told me this is not true
	Writing style	The assessment of writing style refers to evaluating linguistic	Assesses the source by examining the writing style	An evaluation based on the style of writing (spelling errors, emojis)	"Usually it is written in simpler words with spelling errors and full	An evaluation based on the style

(Continues)

TABLE 2 | (Continued)

The strategy	Explanation	Criterion	Operationalization in Study II	Examples from Study II	Close-ended answer in Study I
	complexity, language correctness, spelling, or punctuation			of exclamation points" (M, O)	of writing (spelling errors, emojis)
No strategies were used	No evaluation skills were reported		There is no indication of any evaluation skill or criteria being used	"There is none" (M, Y)	Nothing I heard sounded untrue to me

* M = male; F = Female; Y = Yeshiva; HSY = High School Yeshiva; TC = Technical certificate; BA = Bachelor's degree; MA = Master's degree; O = Other

provided. A codebook was developed to identify content evaluation and source evaluation strategies (critical evaluation strategies) as well as alternative strategies distilled from the responses by initial content analysis, followed by a quantitative analysis based on this identification (Krippendorff 2018). The first author and a research assistant independently coded 10% of the responses. The results of an inter-rater reliability test of this random selection of responses were significant, with a Cohen's kappa = 0.941 (CI^{95} = [0.88–0.99], $p < 0.001$) (McHugh 2012), indicating a high level of agreement (Cohen 1968). Following this reliability test, the first author coded the rest of the data.

3.2.3 | Science Education Level, Content and Procedural Science Knowledge and Contextual Scientific Knowledge

Demographics. Participants' self-reported level of science education was determined using a close-ended question (Table 3, first line). The other demographic variables were self-reports of gender, age group, and highest level of formal education.

Scientific content knowledge. Scientific content knowledge was assessed using questions from a well-established scale for measuring adult knowledge of science (National Science Board 2016). The scale was developed collaboratively by Miller (1998) in the US and Durant et al. (1989) in the UK, and has been used for decades by the US National Science Foundation (NSF) to measure civic science literacy. The goal when designing these questions was to assess whether an individual likely possessed the knowledge that might be needed to understand a quality newspaper's science section. In this study we used two factual textbook questions related to the life sciences translated by Shauli and Baram-Tsabari (2019) (Table 3). Respondents were scored 1 point for each correct answer, and a normalized score ranging from 0 to 1 was computed (Study I: M 0.63, SD 0.3).

Scientific procedural knowledge. Scientific procedural knowledge was assessed using two reasoning textbook questions from the same well-established scale. We used items related to drug development and testing, given their relevance to COVID-19-related decision-making (Table 3). Respondents were scored 1 point for each correct answer, and a normalized score ranging from 0 to 1 was computed (Study I: M 0.7, SD 0.4).

In Study II, we refrained from asking the content and procedural questions to avoid inducing a test-like environment for individuals who do not receive a science education and to ensure the inclusivity of cultural differences.

Scientific knowledge in the context of COVID-19. Much scientific knowledge is acquired outside formal education (Irwin and Wynne 1996), often to address specific contexts and emerging needs (Ranney and Clark 2016; Zummo et al. 2021). To address this issue, both Studies I and II explicitly tested for scientific knowledge in the context of COVID-19. Just like science knowledge, which is highly shaped by one's education and cultural capital, knowledge about COVID-19 is also not an independent variable. Since knowledge of COVID-19 essentially did not exist before the pandemic, all of it was acquired recently, primarily from scientific information disseminated

TABLE 3 | Items examining aspects of scientific knowledge.

Independent variables	Questions	Analysis	Study I	Study II
Science education level	What is your level of education in science? None (0); Elementary education + high school without matriculation (1); high school with STEM elective courses (2); nonacademic professional course (3); nonscientific college degree (4); scientific college degree (5)	Distribution	**V**	**V**
General scientific content knowledge[1]	1. Antibiotics kill viruses as well as bacteria (T/F)	Normalized score range 0–1	**V**	
	2. A doctor tells a couple that their genetic makeup means that they have one in four chances of having a child with an inherited illness. Does this mean that if their first child has the illness, the next three will not? (T/F)		**V**	
General scientific procedural knowledge[1]	Two scientists want to know if a certain drug is effective against high blood pressure. The first scientist wants to give the drug to 1,000 people with high blood pressure and see how many of them experience lower blood pressure. The second scientist wants to give the drug to 500 people with high blood pressure and not give the drug to another 500 people with high blood pressure, and see how many in both groups report lower blood pressure. 1. Which is the better way to test this drug? A. The first scientist's method: Give the drug to 1,000 people B. The second scientist's method: Give the drug to 500 people and not give it to another 500 people 2. Why is it better to test the drug this way? (open-ended response)	Normalized score range 0–1	**V**	
Scientific knowledge in the context of COVID-19[2]	Anyone who encounters a person who tested positive for COVID-19 must self-quarantine for 14 days following the encounter, even if the person exposed has been going about their regular activity for several days. 1. Would self-quarantining help at this point? 2. Why? (open-ended response)	Normalized score range 0–1	**V**	**V**
	People taking immunosuppressive drugs are at risk of developing COVID-related complications because: (1) Their bodies struggle to carry oxygen (anemia); (2) They suffer from high blood pressure; (3) They have a deficiency of functioning white blood cells; (4) They have hypercoagulability; (5) It is unclear		**V**	
	Johnson & Johnson is developing an active vaccine against COVID. What are the components of this vaccine? (1) Inactivated or weakened virus (or parts of it); (2) Antibodies to the virus from a person or animal that has recovered from the virus; (3) Phagocytes (engulfing cells); (4) Substances that harm the virus but do not harm humans		**V**	

[1]National Science Board 2016; translated by Shauli and Baram-Tsabari (2019)
[2]Rozenblum et al. (2025)

through the media rather than from schools. Thus, this knowledge is closely tied to the sources of information individuals consume, their epistemic networks, and their trust in different institutions.

To measure scientific knowledge in the context of COVID-19, participants were asked to respond to one open-ended item: “Anyone who encounters an individual who has tested positive for COVID-19 must self-quarantine for 14 days immediately after the encounter, even if the person exposed has been going about their regular activities for several days. Would self-quarantine help at this point? Why?”. The responses were categorized according to their (1) correctness, (2) explanation, and (3) utilization of scientific language, as follows:

1. The response was scored as either incorrect if it indicated isolation would not help (0 points) or correct if it indicated it could help (1 point). Intercoder reliability exceeded $\kappa = 0.8$ for both studies.
2. The explanations were classified into three groups: Incorrect explanation, e.g., “Because isolation is not the solution” (0 points); partial explanation focusing on one element, e.g., “Because it will prevent further infections” (1 point); and full explanation (considered a correct answer), addressing two elements or more, e.g., “The person may still be carrying the virus, and can infect others by exposing them to it” (2 points). These scores were then normalized. The intercoder reliability exceeded $\kappa = 0.8$ for both studies.
3. Respondents’ use of scientific concepts was assessed, scoring them based on quantity and complexity. Reading and understanding a scientific text depends on the reader's prior knowledge and involves grasping key concepts that encompass facts, phenomena, processes, principles, and central ideas originating outside the text (Norris and Phillips 2003). To address this aspect, scientific concept identification and classification were based on their first appearance in the national science curricula for elementary, junior, and high school, which all share the primary goal of promoting scientific literacy (Laslo and Baram-Tsabari 2019; Taragin-Zeller et al. 2020). Points were awarded for accurate usage of scientific concepts. The following were considered correct use of terms, e.g., “You can be contagious even if you do not have symptoms,” was scored one point for the use of the term ‘contagious,’ —elementary school level, and two more points for the use of the term ‘symptoms’—middle school level. “Incubation takes time, and even if he is infected, he will be isolated, so others won't be exposed” was scored three points for using the term ‘incubation,’ which is considered a high school-level term. These scores were then normalized.

In Study I, two additional close-ended questions were asked (Table 3). These addressed the structure and function of the immune system and were adapted from elective high school biology exams. Respondents were scored 1 point for each correct answer, and a normalized score, ranging from 0 to 1, was computed.

The mean for normalized COVID-19 knowledge in Study I was 0.59, (SD. 0.2), and for Study II, 0.41 (SD. 0.25).

3.3 | Statistical Analysis

To examine the distribution of misinformation detection across different levels of science education and different levels of scientific knowledge, a Kruskal-Wallis analysis and a one-way ANOVA were used, with the significance set to $p = 0.05$. To assess the role of different evaluation strategies and scientific knowledge levels in detecting misinformation, we tested for correlations in the two groups.

4 | Results

4.1 | Study I: Representative Sample That Received Compulsory Science Education

4.1.1 | Science Education, Scientific Knowledge, and the Identification of Misinformation

Over half of the sample (55%, $n = 277$) was able to remember and share misinformation they encountered about COVID-19 (e.g. “I didn't believe that children are less contagious”). Almost a quarter of the sample (24%, $n = 123$), however, identified a correct piece of information about COVID-19 as misinformation (e.g., “I didn't believe that it was caused by a virus”), and 21% ($n = 100$) did not remember seeing any misinformation (“I didn't hear a thing”).

A Kruskal-Wallis analysis indicated a significant difference among respondents, with respondents who completed the compulsory level of science education versus respondents who took elective science classes in high school ($X^2 = -42.418$, $p < 0.05$) and respondents who had a degree in the sciences ($X^2 = -45.133$, $p < 0.005$). Whereas less than half of the respondents with only compulsory science education could identify a piece of misinformation correctly (46.5%), those with elective science classes in high school or with degrees in science were better able to do so (63.3% and 66%, respectively; Figure 1).

Respondents with more scientific content knowledge, more scientific procedural knowledge, and more scientific knowledge of COVID-19 were better at identifying misinformation correctly than those with a lower level of scientific knowledge. A one-way ANOVA was conducted to investigate the effect of scientific content knowledge, scientific procedural knowledge and COVID-19-specific scientific knowledge of the ability to identify misinformation; the results were significant (scientific content knowledge: $F(2, 499) = 7.46$, $p < 0.001$; scientific procedural knowledge: $F(2, 498) = 8.148$, $p < 0.001$; scientific knowledge in the context of COVID-19: $F(2, 497) = 5.465$, $p < 0.005$). A post hoc analysis utilizing the Games-Howell Test revealed marked disparities in scientific content knowledge between participants who accurately identified misinformation and those who identified accurate information as misinformation ($p < 0.001$, 95% CI [0.054–0.246]). Similarly, we found disparities in scientific procedural knowledge between

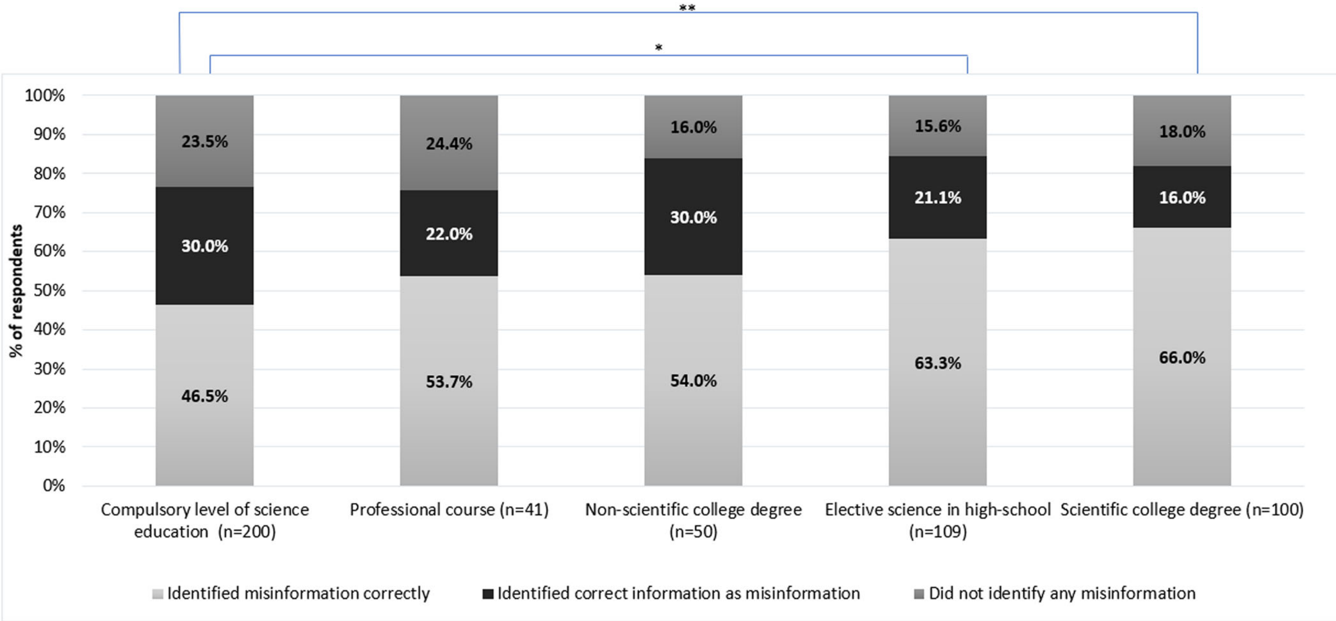

FIGURE 1 | Distribution of misinformation detection across different science education levels in a representative sample in which science education is compulsory. *marks significance at the 0.05 level. ** marks significance at the 0.005 level. Kruskal–Wallis analysis.

participants who accurately identified misinformation and those who identified accurate information as misinformation ($p < 0.005$, 95% CI [0.039–0.247]). Significant discrepancies in scientific knowledge in the context of COVID-19 were also observed between participants who correctly identified misinformation and those who erroneously classified accurate information as misinformation ($p < 0.05$, 95% CI [0.012–0.13]) (see Figure 2).

4.1.2 | Information Evaluation Strategies and the Identification of Misinformation

Participants were asked to elaborate on why they felt that the item they provided was misinformation. Using content analysis, we identified several strategies that helped respondents identify misinformation. On average, respondents used 1.5 strategies out of a list of nine items (Table 2, right column).

Of the 277 participants who correctly identified misinformation, 68% used content evaluation strategies; however, of the 123 who identified correct information as misinformation, a significant portion—42%—also employed these strategies. A similar percentage of participants employed source evaluation when identifying misinformation, regardless of whether they did so correctly (48%) or incorrectly (46%). Likewise, a comparable proportion expressed general skepticism and skepticism toward social media when identifying misinformation, whether accurately (50%) or inaccurately (58%) (Appendix 3).

4.1.3 | Parameters Correlating With Successfully Identifying Misinformation

Of the 500 participants who provided an example of misinformation, 400 participants either correctly identified it or erroneously classified correct information as misinformation. In the following section, we discuss the parameters that might have helped these 400 respondents identify misinformation correctly.

Scientific knowledge and science education were found to be somewhat helpful in identifying misinformation correctly. A weak positive correlation was observed between scientific content knowledge and the correct identification of misinformation ($r(400) = 0.188$, $p < 0.001$). Among participants who correctly identified misinformation ($n = 277$), 49% received the highest scores in scientific content knowledge. A large majority of those who mistakenly identified correct information as misinformation (33%, $n = 123$), however, also received the highest scores. Similarly, scientific procedural knowledge was weakly positively correlated with correctly identifying misinformation ($r(400) = 0.172$, $p < 0.001$). Of those who correctly identified misinformation, 65% achieved the highest scores in procedural knowledge. A large majority of those who mistakenly identified correct information as misinformation (55%, $n = 123$), however, also had the highest scores. For COVID-19-specific knowledge, a very weak positive correlation was found with correctly identifying misinformation ($r(400) = 0.139$, $p < 0.005$). Among those who correctly identified misinformation, 29% achieved the highest score in COVID-19 knowledge, with a comparable 25% of those who misidentified correct information also achieving high scores. Additionally, science education showed a weak positive correlation with the correct identification of misinformation ($r(400) = 0.141$, $p < 0.005$). Of those who correctly identified misinformation, 34% had taken elective science classes in high school or held degrees in science, whereas only 25% of participants who incorrectly identified accurate information as misinformation had such educational backgrounds.

Participants with more scientific knowledge tended to base their evaluations on their own reasoning, even when incorrect.

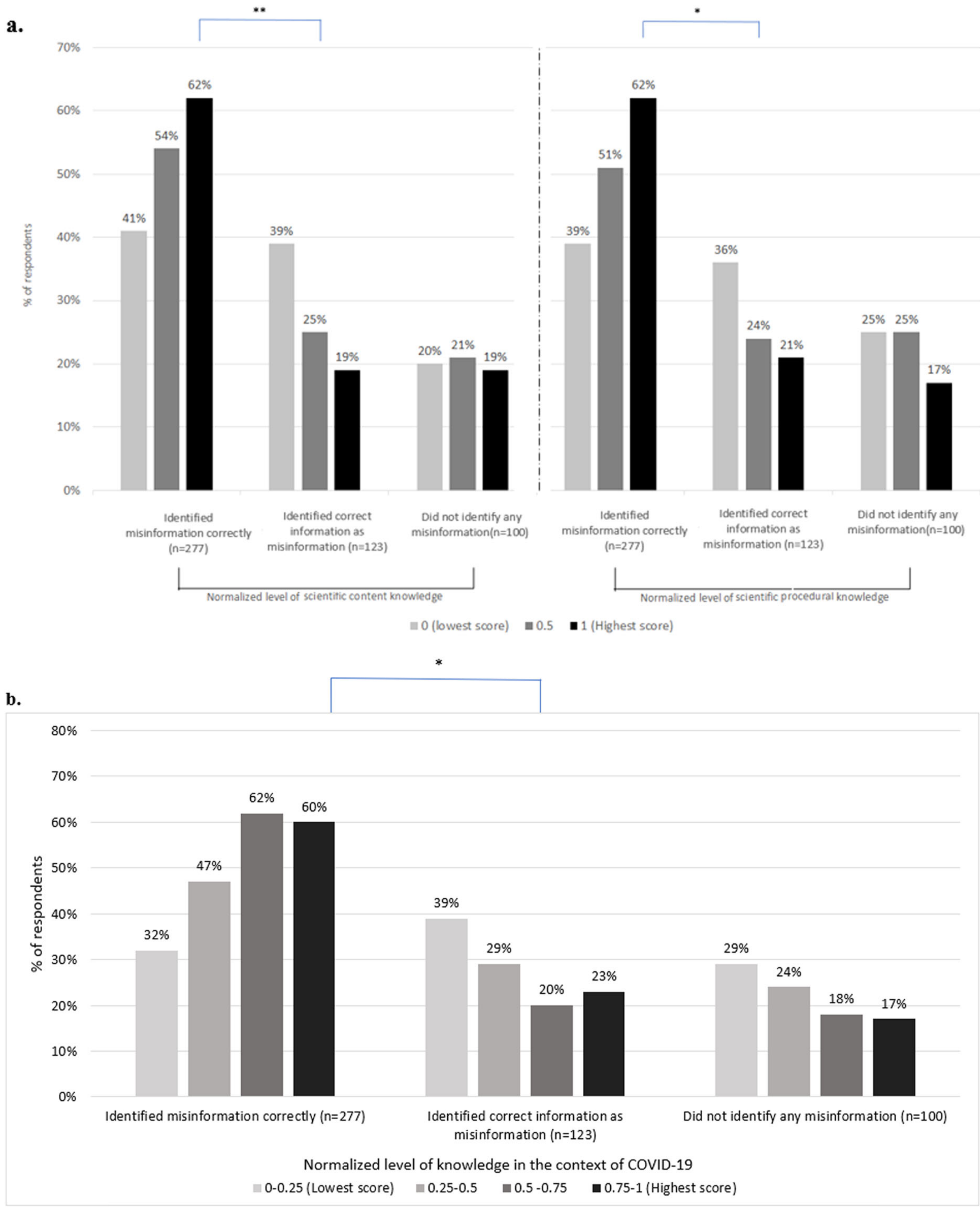

FIGURE 2 | Distribution of misinformation detection across different levels of scientific knowledge in a representative sample in which science education is compulsory. a. Scientific content and procedural knowledge. *marks significance at the 0.05 level. ** marks significance at the 0.001 level. One-way ANOVA with post hoc analysis utilizing the Games-Howell Test. b. Scientific knowledge in the context of COVID-19. *marks significance at the 0.05 level. One-way ANOVA with post hoc analysis utilizing the Games-Howell Test.

A weak positive correlation was observed between scientific content knowledge and the use of content evaluation strategies ($r(400) = 0.124$, $p < 0.05$). Among participants using content evaluation strategies ($n = 239$), 51% had the highest scores in scientific content knowledge; however, 16% of those using content evaluation strategies scored the lowest. Furthermore, there was a weak positive correlation with scientific procedural knowledge ($r(400) = 0.171$, $p < 0.001$), with 65% of participants using content evaluation strategies scoring highest in procedural knowledge, while 12% scored the lowest. No correlation was found between COVID-19-specific knowledge and the use of content evaluation strategies, nor was there any correlation between the use of source evaluation strategies and any of the scientific knowledge variables.

A weak positive correlation was found between using content evaluation strategies and the identification of misinformation correctly ($r(400) = 0.237$, $p < 0.001$). Of those correctly identifying misinformation ($n = 277$), 68% used content evaluation strategies. However, a large majority of those who mistakenly identified correct information as misinformation (42%, $n = 123$) also used content evaluation strategies. No correlation was found between all the other evaluation strategies - source evaluation strategies, writing style evaluation, expressions of skepticism, additional sources of authority - and the correct identification of misinformation.

4.2 | Study II: Representative Sample That Did Not Receive Compulsory Science Education

4.2.1 | Science Education, Scientific Knowledge In the Context of COVID-19, and the Identification of Misinformation

Almost a third of the sample (34%, $n = 273$) was able to remember and report a piece of misinformation they encountered about COVID-19 (e.g. "I didn't believe that bleach can be a cure"). A little more than a third of the sample (35%, $n = 292$), on the other hand, classified a correct piece of information about COVID-19 as misinformation (e.g. "I didn't believe that people died from COVID-19"), and one-third (31%, $n = 235$) did not remember encountering any misinformation ("I do not recall hearing misinformation").

In this sample of individuals who were educated in institutions where science education is not mandatory, 513 of the 800 adults surveyed did not have any science education at all (64%), 6% had science up to 10th grade, another 9% had elective science in high school, about 7% had some science in a professional course, and the rest had taken some science courses at the college level (14%). While diverse, there were no significant differences in successfully identifying misinformation regardless of the level of science education (Appendix 4). Ultra-Orthodox women generally receive more science education than men, in their capacity as breadwinners. Nevertheless, in our sample, 52% of the female respondents did not have any science education at all, compared to 73% of the men. No significant differences in the success of identifying misinformation vis-à-vis the level of science education were found for either men or women.

Individuals with more scientific knowledge of COVID-19, however, were better at identifying misinformation correctly than those with a lower level of COVID-19-related scientific knowledge. A one-way ANOVA, conducted to investigate the effect of scientific knowledge of COVID-19on the ability to identify misinformation, yielded significant results ($F(2797) = 4.142$, $p < 0.05$). A post hoc analysis utilizing the Games-Howell Test revealed significant disparities in scientific knowledge in the context of COVID-19 between participants who correctly identified misinformation and those who erroneously classified accurate information as misinformation ($p < 0.05$, 95% C.I. = [0.008–0.118]) (see Figure 3).

4.2.2 | Information Evaluation Strategies and the Identification of Misinformation

Participants were asked to elaborate on why they doubted the information they reported using an open-ended question. Using

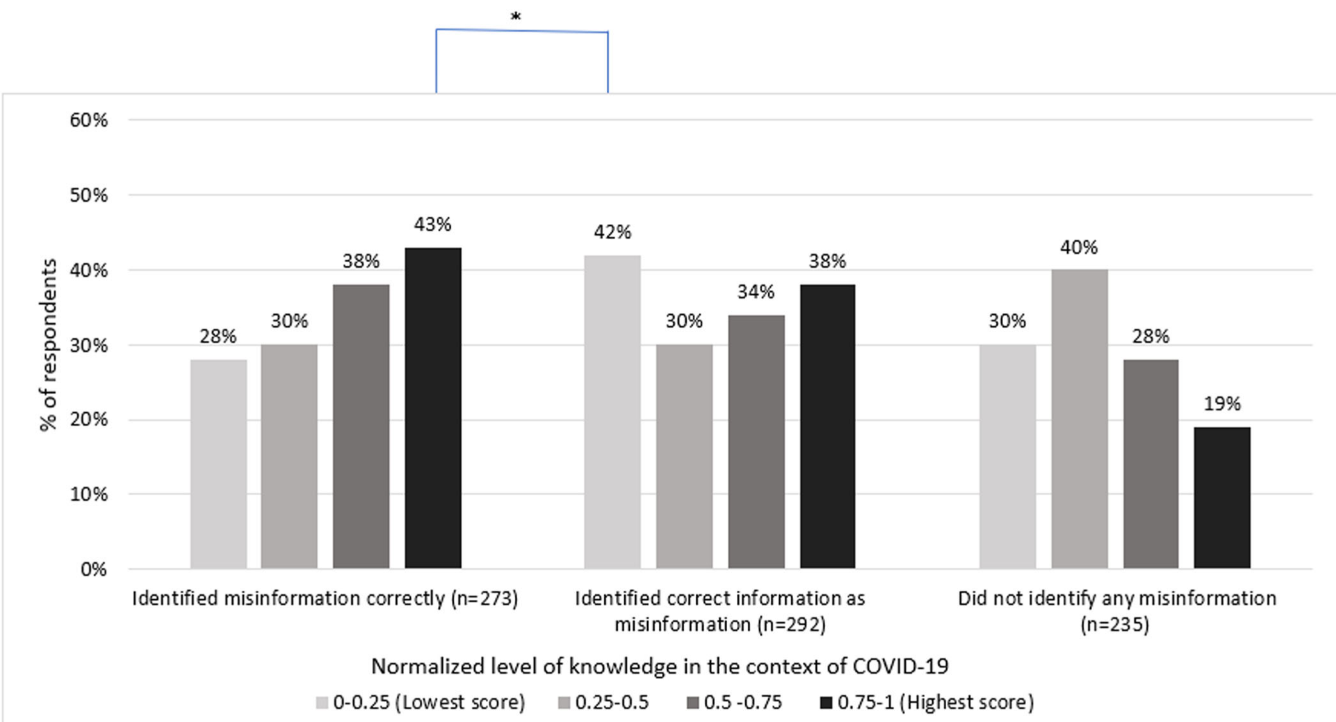

FIGURE 3 | Distribution of misinformation detection across different levels of scientific knowledge in the context of COVID-19 in a representative sample in which science education is not compulsory. *marks significance at the 0.05 level. One-way ANOVA with post hoc analysis utilizing the Games-Howell Test.

content analysis, we identified strategies that helped them classify misleading information. On average, the respondents used 1.4 strategies out of 14 possible strategies identified in the sample (Table 2).

Of the 273 participants who correctly identified misinformation, 63% used content evaluation strategies; however, of the 292 who misidentified correct information as misinformation, a large group of 52% also used it. Source evaluation was used by 12% of those who correctly identified misinformation, which is four times higher than the 3% of those who misidentified correct information as misinformation. Similarly, general skepticism was reported three times more frequently by participants who correctly identified misinformation (9%) compared to those who mistakenly identified correct information as misinformation (3%). On the other hand, 29% of participants who identified correct information as misinformation expressed mistrust of official institutions, in contrast to only 6% of those who correctly identified misinformation (Appendix 5).

4.2.3 | Parameters Correlating With Successfully Identifying Misinformation

Only 565 of the 800 participants provided an example of misinformation. In the following sections, we discuss the parameters that might have helped these respondents classify misinformation correctly.

In the representative sample that did not receive compulsory science education, no correlation was found between the level of science education and identifying misinformation. Having scientific knowledge in the context of COVID-19, however, was somewhat helpful in identifying misinformation correctly, with a very weak positive correlation ($r(565) = 0.112$, $p < 0.01$) (scientific content and procedural knowledge were not tested in this sample). Among those who correctly identified misinformation, 61% performed higher than the average in COVID-19 knowledge, with a comparable 50% of those who misidentified correct information also achieving above the average.

Respondents who knew more about COVID-19 tended to base their evaluation to a greater extent on source evaluation strategies (even those who misidentified the information): a very weak positive correlation was found between scientific knowledge in the context of COVID-19 and the use of a source evaluation strategies ($r\ (565) = 0.093$, $p < 0.05$). No correlation was found between scientific knowledge in the context of COVID-19 and the use of a content evaluation strategies.

A weak positive correlation was found between using source evaluation strategies and correctly identifying misinformation ($r\ (565) = 0.172$, $p < 0.001$): 12% employed source evaluation strategies when correctly identifying misinformation, compared to only 3% who did not. Furthermore, a weak positive correlation was observed between expressions of skepticism and the correct identification of misinformation ($r(565) = 0.137$, $p < 0.001$): 9% of those who identified misinformation correctly also expressed skepticism, compared to 3% of those who misidentified it.

Expressions of mistrust towards official institutions had a medium negative correlation with correctly identifying misinformation ($r(565) = -0.300$, $p < 0.001$). Almost 30% of the respondents who identified correct information as misinformation also expressed mistrust of official institutions tasked with providing credible information to the public as compared to only 6% of those who labeled misinformation correctly (Figure 4. No correlation was found between content evaluation strategies, writing style evaluation, and correctly identifying misinformation.

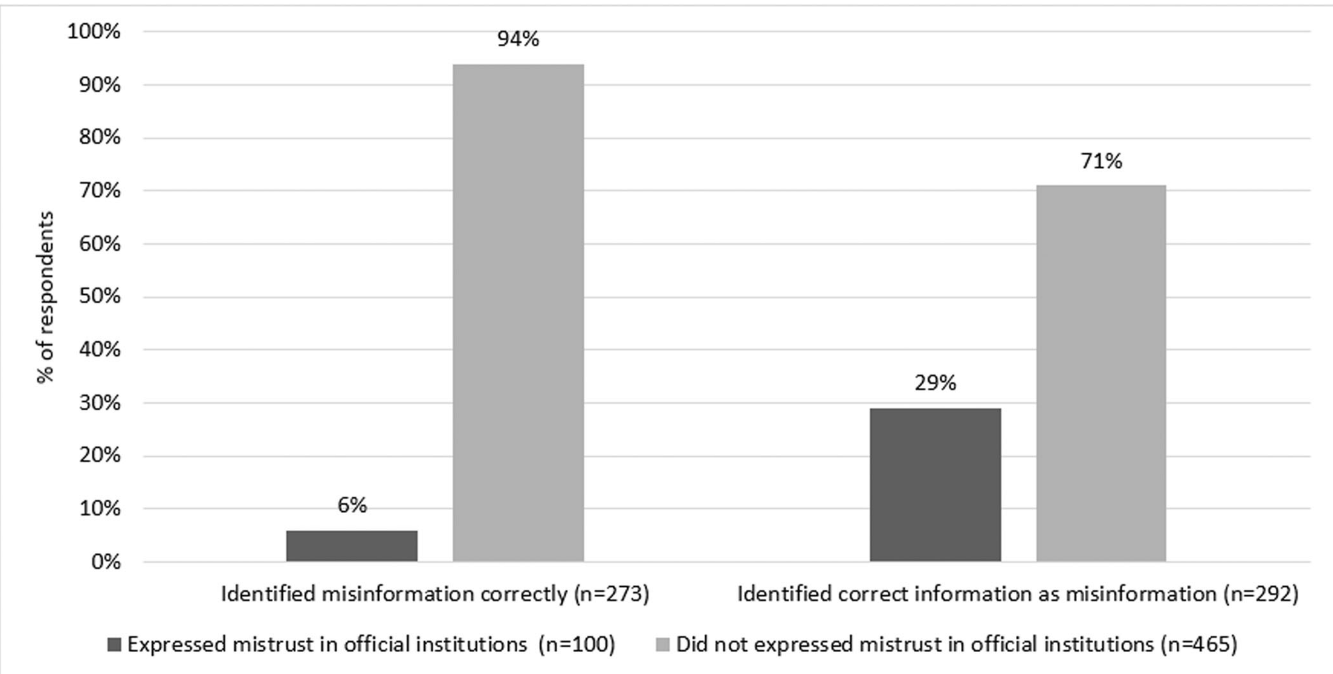

FIGURE 4 | Mistrust of official institutions and successfully identifying misinformation in a representative sample in which science education is not compulsory.

5 | Discussion

The literature is inconclusive as to the importance of science education and scientific knowledge in enhancing everyday reasoning and problem-solving (Shauli and Baram-Tsabari 2019; Covitt et al. 2009; Dalyot et al. 2021; Jho et al. 2014; Sadler and Zeidler 2005). Specifically, it is unclear whether and how science education and scientific knowledge contribute to countering misinformation (Rozenblum et al. 2025; Sharon and Baram-Tsabari (2020)) and which are the most commonly relied evaluation strategies for detecting it (Barzilai et al. 2020). This study capitalized on the COVID-19 pandemic to examine how well people with different levels of science education and scientific knowledge differed in their susceptibility to mistakenly identifying true claims as false. It also explored which evaluation strategies were associated with the ability to identify misinformation in the context of COVID-19. The findings suggest that while scientific knowledge contributes to correctly identifying misinformation, source evaluation may help people, regardless of their scientific background.

When considering the role of science education in the identification of misinformation, Study I, involving the general population in which science education is compulsory, indicated that respondents with more science education were somewhat better at correctly identifying misinformation than those with less science education. People who were in a science track in high school or had a degree in the sciences were somewhat better at correctly identifying misinformation than individuals with only a compulsory 10th-grade science education (Figure 1). In addition, when considering the role of scientific knowledge in the identification of misinformation, in this sample, respondents with more scientific content knowledge, more scientific procedural knowledge, and more scientific knowledge of COVID-19were also somewhat better at correctly identifying misinformation than respondents with a lower level of scientific knowledge (Figure 2). Finally, in this sample, assessing content using the evaluation strategy of plausibility (content evaluation, Table 2) proved to be the most frequent strategy in accurately identifying misinformation. However, the use of this strategy also resulted in a large number of cases where correct information was incorrectly identified as misinformation. Although the findings suggest that science education and scientific knowledge play a role, increasing content knowledge alone is not sufficient to improve the ability to identify misinformation.

Study II examined a sample from the ultra-Orthodox sector in Israel that attended schools where science education is not compulsory. Here, when considering the role of science education in the identification of misinformation, respondents with higher levels of science education were no better at correctly identifying misinformation, but when considering the role of scientific knowledge, scientific knowledge related in the content of COVID-19 significantly correlated with the correct identification of misinformation. In this sample, assessing content using source evaluation strategy proved to be correlated with the ability to accurately identify misinformation. Furthermore, in this sample those who mistrust official sources were more likely to misidentify the nature of the information.

5.1 | The Role of Science Education and Knowledge In Correctly Identifying Misinformation In the Context of Covid-19

The framework guiding PISA 2025 states that "A scientifically educated person can engage in reasoned discourse about science, sustainability, and technology to inform action. The degree to which 15-year-old students can undertake these tasks is a measure of the outcomes of their science education" (p. 8). One way in which science education can help foster these outcomes is by providing people with knowledge, since knowledge has been shown to support the evaluation of scientific information (Barzilai et al. 2020; Pennycook and Rand 2021). In the specific case of evaluation of scientific misinformation, however, the literature is scarce and inconclusive; for example, Ecker et al. (2022) claimed that a lack of knowledge and skills impairs the ability to detect misinformation, while Rozenblum et al. (2025) did not find an association between scientific content knowledge and the tendency to rely on misinformation.

Our findings support the notion that scientific knowledge contributes to the ability to correctly identify misinformation. Across both studies, scientific knowledge in the context of COVID-19 was correlated with the ability to correctly identify misinformation. These findings are consistent with Barzilai et al. (2020), who found that learners' prior knowledge of a topic can influence their judgment of claims. In Study I, content knowledge and scientific procedural knowledge (which was not included in Study II) were also correlated with the ability to identify misinformation correctly. This finding extends Barzilai et al. (2020) by suggesting that general scientific knowledge, not just specific topic knowledge, is relevant for evaluating information. However, as discussed later in section 5.2, greater content knowledge may increase the likelihood that individuals rely on logic and prior knowledge rather than evaluating sources, an approach that does not always yield positive results.

The case of the level of science education presented a more complicated picture. In Study I individuals with higher levels of science education were somewhat better at correctly identifying misinformation than those with less science education. This finding aligns with Rozenblum et al. (2025), who found that people with higher levels of science education relied less on misinformation. In Study II, in a sample where science education was not compulsory, the level of science education was not a significant factor in correctly identifying misinformation across all the statistical analyzes. This finding should be viewed in the context of the type of science education taught in ultra-Orthodox schools, which emphasize religious studies rather than scientific practices and habits of mind (Perry-Hazan 2013). Future studies on the role of science education in misinformation detection should examine not only the length and intensity of instruction but also the goals of science education on the continuum between the descriptive and inquisitive approaches.

5.2 | The Role of Evaluation Strategies In Correctly Identifying Misinformation In the Context of Covid-19

Critical evaluation strategies positively correlated with the ability to correctly identify misinformation in both studies, but they differed between the samples. In Study I, a content evaluation strategy that is based on assessing the plausibility of the content was the only critical evaluation strategy that was correlated with the ability to identify misinformation correctly. This is consistent with Pennycook and Rand (2021), who found that when individuals take the time to think and critically evaluate the plausibility of content they encounter, they are better at identifying misinformation. However, it is important to recognize that the plausibility assessment is made based on a prior acquisition of information from sources deemed reliable, subsequently adopting the scientific argument as one's own. Over time, people may believe they made the original assessment of the content themselves, regarding it as the primary reason for their belief.

In Study I, respondents with more scientific content knowledge and more scientific procedural knowledge tended to base their assessment to a greater extent on the evaluation of the content, even if they were wrong in their identification. This expands on Barzilai et al. (2020), who reported that learners with greater prior topic knowledge primarily used content evaluation strategies (we did not find a similar association with knowledge of COVID-19).

These findings suggest that scientific knowledge increases individuals' likelihood of basing their evaluations on their logic and prior knowledge. Nevertheless, this epistemically independent approach frequently results in error, since many (42%) of the respondents who used content evaluation strategies misidentified correct information as misinformation. Of these, 12% had taken elective science courses in high school or college. These participants may have clung to the myth of intellectual independence (Norris 1997), along with the sense of competency that comes with limited knowledge. Research indicates that moderate levels of scientific knowledge can lead to overconfidence in one's ability to assess scientific information (Fernbach et al. 2019; Lackner et al. 2023; Light et al. 2022). For example, a series of studies on resistance to genetically modified foods revealed that the strongest opponents had a limited understanding of science and genetics but rated their knowledge of the technology as the highest (Fernbach et al. 2019). Similar findings were reported by Light et al. (2022) who found that those who most strongly oppose the scientific consensus on topics such as climate change, genetically modified food, vaccines, nuclear power, homeopathy, evolution, the Big Bang theory, and COVID-19 tend to know less about the relevant subjects but believe they know more.

It can be argued that the emphasis on content in science education may foster epistemic hubris—the belief that one can easily become an expert without specialized training (Pongiglione 2024). This overconfidence negatively impacts epistemic conduct, hinders the development of knowledge and true beliefs, and can lead to significant consequences when individuals who mistakenly see themselves as experts begin spreading misinformation (Pongiglione 2024). Therefore, science education should not only teach on content but also cultivate intellectual humility, emphasizing the limits of one's knowledge, particularly when evaluating claims beyond one's expertise (Pimentel and Osborne 2025).

Furthermore, evidence is frequently presented to the public in a selective or biased manner. For example, the argument that masks are ineffective against COVID because the virus is three times smaller than the holes in the mask is a compelling and seemingly logical claim. However, it is deeply flawed due to missing or overlooked information (Litke 2020). Thus, as noted by Osborne and Allchin: "The nonexpert simply does not have the expertise to spot experimental flaws, to recognize cherry-picked data, to detect flawed statistical analyzes, to consider unstated alternative hypotheses and more. Evaluating complex scientific evidence and explanations can only be done competently by scientific experts and not the lay public" (p. 5, 2024). This strengthens the claim by Barzilai et al. (2020) that knowledge-based validation, when it is immediate, easy, and vivid, can be misused when the more demanding processes of assessment, such as source evaluation strategies, are neglected.

In Study II, where science education was not compulsory, the source evaluation strategy was the one that correlated with the ability to correctly identify misinformation. This aligns with Barzilai et al. (2020), who found that learners with low or no prior topic knowledge rely heavily on source evaluation strategies. These findings underscore the need for all students to become "competent outsiders," capable of engaging with sources of scientific expertise even if they do not understand the underlying science (Feinstein 2011).

Both the level of knowledge and familiarity with evaluation strategies are important, thus, individuals must adjust their approach to misinformation according to their own knowledge. Science education can be useful if it develops meta-epistemic awareness (Barzilai et al. 2020), as it helps individuals recognize when to rely on content evaluation versus source evaluations, depending on their current knowledge and capabilities.

5.3 | Between Mistrust and Healthy Skepticism

General skepticism arising from awareness of prevalent misinformation sometimes contributes to the ability to identify misinformation correctly. The findings from both studies underscore the importance of adopting healthy skepticism when assessing misinformation. In Study I, general skepticism was expressed by 51% of respondents. Among these 256 users of this strategy, 55% correctly identified misinformation, while 28% mistakenly misidentified it (Appendix 3). While these are impressive percentages, general skepticism, however, did not correlate with the ability to identify misinformation correctly among all participants. In Study II, general skepticism emerged as a valuable strategy for accurately identifying misinformation. While only 5.6% of respondents demonstrated skepticism, 56% of these 45 participants correctly identified misinformation, compared to just 18% who misidentified it (Appendix 5). Furthermore, in Study II, general skepticism correlated with the ability to identify misinformation correctly. The considerable difference in percentage probably stems from the use of open-ended versus close-ended measures. This suggests that educating individuals in healthy skepticism could be beneficial in everyday situations.

Nevertheless, one should also be aware of naive believers, who may accept information and disinformation equally, and hyper-skeptics, who reject misinformation and genuine information alike. For instance, flat-earthers use plausibility arguments and emphasize direct empirical observations—both sound epistemic strategies—but apply them inappropriately, relying on cherry-picked data and confirmation bias, leading to false conclusions (Gomes 2020). Additionally, this strategy can be exploited by purveyors of disinformation. For instance, "they echo the theme of 'Do Your Own Research' (D.Y.O.R.) while feeding the reader cherry-picked evidence and incomplete, one-sided arguments. They promote blanket skepticism, rather than measured analysis, with the result that 'an ounce of skepticism is worth a pound of doubt'" (Allchin 2023 p.264).

Unlike general skepticism, which was found in our study generally useful, mistrust of official institutions poses a challenge in evaluating misinformation. Study II revealed that respondents expressing this form of mistrust were prone to perceiving true information as false: 13% of participants used this alternative evaluation and provided justifications such as mistrust of politics "Because everything is manipulated, they have political interests in inflating the number of patients" (female, technical certificate), mistrust in the health system and medical community: "I have a general distrust of the WHO and its reports on diseases" (male, yeshiva), or mistrust of the media "Because the media are only a source of stress, and the situation is not that bad" (male, yeshiva). Among users of this strategy, almost five times more people misidentified correct information as misinformation than correctly identifying it (Figure 4). This aligns with literature suggesting a link between mistrust of official institutions and belief in misinformation (Imhoff et al. 2018; Ognyanova et al. 2020). While lack of science education might be one cause of such mistrust, the ultra-Orthodox society is also characterized by complex relations with surrounding society and its epistemic institutions (Taragin-Zeller et al. 2022). Thus, it appears beneficial to implement measures that enhance people's understanding of the nature of scientific knowledge and its connection to policy decisions (Post et al. 2021). Furthermore, there is a need to teach students about science as a set of social practices and the institutions that represent them (Zucker and Miller 2024). These educational implications might not be relevant to the unique case of the ultra-Orthodox but could support informed epistemic trust among the general population who experience education that includes science.

5.4 | Limitations

Several limitations should be considered when evaluating the results. Our measure of evaluation strategies in Study I was close-ended answers, which limited potential responses and structured them. In Study II we used open-ended responses to remedy this problem, at the price of potential interpretation biases. In addition, this study relies on a post-hoc self-report questionnaire, meaning that the assessment was not conducted in real time. It is possible, for example, that the rumors shared by participants were more memorable and sensational than the general rumors they encountered. However, the primary focus of this study is on understanding participants' thought processes. From the strategies reported by respondents, one can infer what they perceive as correct, relevant, and optimal actions when addressing misinformation.

Furthermore, data collection was performed in 2020. Since then, we have witnessed rapid polarization in public trust in science and significant shifts in the digital media landscape. Yet, we think that while caution is being called for in generalizing the findings, they remain highly relevant and useful today. The study examined how scientific knowledge and science education contribute to identifying misinformation. In this context, the COVID-19 pandemic served as a unique case study of scientific information that was highly relevant to all participants, thus providing a methodological advantage. Members of the ultra-Orthodox community are not necessarily exposed to mainstream science misinformation, or such topics may not be a primary concern for them. However, the pandemic affected all segments of the population, creating a common point of reference across both samples. Additionally, the study examined the evaluation strategies that helped participants assess the information. Although public trust in science and the digital media landscape have changed significantly since the data were collected, the critical evaluation strategies examined in this study are being discussed today as a way to prepare future adults to manage misinformation.

Finally, the characteristics of the ultra-Orthodox community are educationally unique. While our findings may contribute to understanding other religious or enclave communities, their generalizability might be limited for other groups with limited science education. This study also did not explore how other attributes within this community and the general population influence the ability to discern misinformation, such as beliefs or social backgrounds.

6 | Conclusion and Implications for Practice

Do these findings inform actionable implications for formal science education? And can the insights gained in the context of COVID-19 be generalized to other science education domains? We believe they can.

Identifying misinformation in real-life situations is challenging. Despite the usefulness of science education, scientific knowledge, and the implementation of different strategies, only half of the participants in Study I and a third in Study II correctly identified misinformation. The relevant lesson is that identifying misinformation in real-life situations is a complex and demanding task. Thus, it cannot be assumed that either students or their educators are immune to the appeal of misinformation simply because of their prior scientific knowledge, experience with reliable sources, or even skeptical mindset.

Using critical evaluation strategies can lead to misidentification: no strategy guarantees successful results. In study I, a large proportion of those incorrectly identifying correct information as misinformation were using validated and recommended strategies according to their self-report. 123 participants incorrectly identified correct information as misinformation, of them 57 participants—46% - used source evaluation (Appendix 3). In contrast, using "general skepticism" which is not a recommended strategy was many times correlated with a favorable outcome. Of the 256 participants who reported it as one of their strategies, 55% were indeed reporting misinformation (section 4.3). We cannot make any claim, however, regarding the appropriateness of applying those strategies and how and why participants were using them to reach their conclusions. The respondent's use of any such strategy cannot be deemed to reflect ideal behavior while using these strategies cannot guarantee successful results. A holistic educational approach combining all these factors may be the most effective way to identify misinformation.

The importance of intellectual humility. Science education should also foster intellectual humility by highlighting the limits of one's knowledge and teaching people to recognize when to rely on their own scientific understanding and when to trust experts in navigating novel science-related situations.

Author Contributions

Shakked Dabran-Zivan: conceptualization, investigation, writing – original draft, methodology, validation, visualization, writing – review and editing, project administration, formal analysis. **Ayelet Baram-Tsabari:** conceptualization, investigation, funding acquisition, writing – original draft, methodology, validation, writing – review and editing, project administration, supervision, resource.

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Appendices

See Table A1.
See Table A2.

TABLE A1 | Sample characteristics for Study I compared to benchmark data for the general population.

Variables		The sample (N = 500)	Data generated by the Central Bureau of Statistics (2022)
Gender	Female	52.5%	51.3%
	Male	44.6%	48.7%
	Missing	2.9%	
Age	18–22	9%	11%*
	23–29	16%	10%**
	30–39	23%	19%
	40-–49	15%	19%
	50–59	19%	15%
	60+	15%	26%
	Missing	3%	—
Religi-osity	Secular	44%	44%
	Traditional	29%	32%
	Religious	16.5%	11.5%
	Ultra-Orthodox	6.8%	12%
	Missing	3.3%	—
Edu-cation	None	0%	6%
	Elementary and high school without matriculation	8.4%	24%
	High school with matriculation	16.1%	22%
	Tertiary education without a degree	20%	13.2%
	Bachelor's degree	35.8%	20.2%
	Master's/PhD	17%	14.4%
	Missing	2.7%	—

*20–24;
**25–29.

TABLE A2 | Sample characteristics of Study II compared to benchmark data for the general population.

Variables		The sample (N = 800)	Data generated from the Central Bureau of Statistics (2022)
Gender	Female	40.8%	45%
	Male	58.7%	55%
	Missing	0.5%	—
Age	18–29	30.6%	33%*
	30–39	35.8%	28%
	40–49	15.3%	17%
	50–59	10%	11%
	60+	7.7%	11%
	Missing	0.5%	
Edu-cation	Yeshiva/seminar	46.8%	35%
	High school yeshiva	3.9%	11%
	Technical certificate	17.9%	27%
	Bachelor's degree	20.4%	19%**
	Master's/PhD	6.4%	
	Other	4.2%	8%
	Missing	0.5%	--

*20–29;
**The Central Bureau of Statistics report does not differentiate between BA/BSc and MA/MSc or PhD.

See Table A3.

TABLE A3 | Strategies used to evaluate COVID-19 misinformation in a representative sample in which science education is compulsory.

	The strategy	Criterion	Close-ended statements	% who reported using the strategy ($n = 500$)	% of strategy users who correctly identified misinformation ($n = 277$)	% of strategy users who identified correct information as misinformation ($n = 123$)
Critical evaluation best practices*	First-hand evaluation – Content: Is it true?	The plausibility of the information	The information does not make sense	53% ($n = 268$)		
		Personal knowledge and experience				
		Scientific related knowledge			68% ($n = 189$)	42% ($n = 51$)
		Justification based on objective reality				
	Second-hand evaluation – Source: Should I believe this source?	Source evaluation	I checked with official sources, such as the Ministry of Health	17.6% ($n = 90$)	20% ($n = 57$)	19% ($n = 23$)
			The media said this was not true	16% ($n = 80$)	17% ($n = 47$)	19.5% ($n = 24$)
		Consultation with experts	I consulted with someone with relevant training (such as a doctor)	8.8% ($n = 44$)	10% ($n = 29$)	8% ($n = 10$)
		Total second-hand evaluation		42.8% ($n = 214$)	48% ($n = 133$)	46% ($n = 57$)
Alternative strategies	Expressions of skepticism	General skepticism due to the "infodemic"	I didn't believe in this information, because there is a lot of fake news	29.6% ($n = 148$)	27% ($n = 75$)	38% (n = 47)
		Skepticism toward social media	The news was published on a social network and I don't trust social networks	21.6% (n = 108)	23% ($n = 65$)	19.5% ($n = 24$)
		Total general skepticism		51% ($n = 256$)	50% ($n = 140$)	58% ($n = 71$)
	Additional sources of authority	Family and friends	One of my friends or a family member told me this is not true	3.8% ($n = 19$)	3% ($n = 10$)	5% ($n = 6$)
		Religious authority	I consulted with a religious authority	0.4% ($n = 2$)	0.3% ($n = 1$)	0.8% ($n = 1$)
		Total additional sources of authority		4% ($n = 21$)	3.3% ($n = 11$)	6% ($n = 7$)

(Continues)

TABLE A3 | (Continued)

The strategy	Criterion	Close-ended statements	% who reported using the strategy ($n = 500$)	% of strategy users who correctly identified misinformation ($n = 277$)	% of strategy users who identified correct information as misinformation ($n = 123$)
Writing style	Assesses the source by examining the writing style	The style of writing (spelling errors, emojis) raised my suspicions	4.4% ($n = 22$)	5% ($n = 13$)	3% ($n = 4$)
No strategies were used	Nothing I heard sounded untrue to me		11.4% ($n = 57$)	0%	2% ($n = 3$)

Note: More than one type of strategy could have been used by the same person. Not all participants who reported using a strategy also provided an example of misinformation—either correctly or incorrectly identified.
*Based on Barzilai et al. 2020; Bromme and Goldman 2014; Tseng et al. 2021.

See Figure A1.

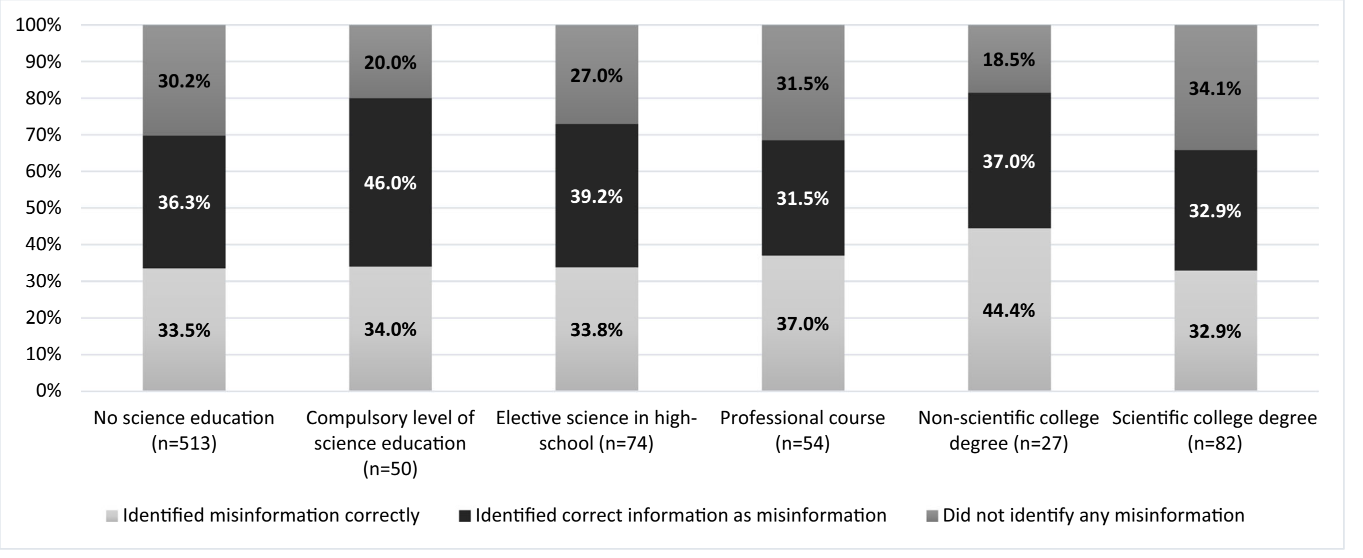

FIGURE A1 | Success in misinformation detection across different science education levels in Study II.

See Table A4.

TABLE A4 | Strategies used to evaluate COVID-19 misinformation in a representative sample in which science education is not compulsory.

	The strategy	Criteria	The parameters	% who reported using the strategy ($n = 800$)	% of strategy users who correctly identified misinformation ($n = 273$)	% of strategy users who identified correct information as misinformation ($n = 292$)
Critical evaluation best practice*	First-hand evaluation – Content: Is it true?	The plausibility of the information	An evaluation based on the reasonableness, reliability, and logic of the information (without explicit reliance on prior knowledge)	34% ($n = 275$)	51% ($n = 139$)	43% ($n = 127$)
		Personal knowledge and experience	An evaluation based on personal knowledge and experience	3.75% ($n = 30$)	3.6% ($n = 10$)	6.5% ($n = 19$)
		Scientific related knowledge	The explanation is justified and based on science	3% ($n = 24$)	4% ($n = 10$)	5% ($n = 14$)
		Justification is based on objective reality	The explanation is justified and based on what is happening in the world	1.75% ($n = 14$)	4% ($n = 12$)	0.7% ($n = 2$)
		Total first-hand evaluation		43% ($n = 344$)	63% ($n = 171$)	52% ($n = 151$)
	Second-hand evaluation – Source: Should I believe this source?	Consultation with experts	Reaching out to people with pertinent expertise (directly to doctors, epidemiologists, virologists, etc.)	0.25% ($n = 2$)	0.4% ($n = 1$)	0%
		Source evaluation	Reliance on official sources - general reference	5.3% ($n = 43$)	10.6% ($n = 29$)	2% ($n = 6$)
			Referring to a specific source (such as the Ministry of Health, CDC, WHO, etc.)	0.63% ($n = 5$)	1% ($n = 3$)	0.7% ($n = 2$)
		Total second-hand evaluation		6% ($n = 50$)	12% ($n = 33$)	3% ($n = 8$)
Alternative strategies	Expressions of skepticism	General skepticism due to the infodemic	Mistrust due to awareness of post-truth phenomena	2.88% ($n = 23$)	7% ($n = 18$)	1.2% ($n = 4$)
		General skepticism	General mistrust without details	2.75% ($n = 22$)	2% ($n = 7$)	1.2% ($n = 4$)
		Total general skepticism		5.6% ($n = 45$)	9.2% ($n = 25$)	3% ($n = 8$)
	Mistrust in officials' institutions	Mistrust of politics	Lack of trust in the political system and politicians	10% ($n = 79$)	5% ($n = 13$)	23% ($n = 67$)
		Mistrust of the health system	Mistrust of doctors and the health system	2.4% ($n = 19$)	0.7% ($n = 2$)	6% ($n = 17$)
		Mistrust of the media	Mistrust of the media and the press	0.25% ($n = 2$)	0.3% ($n = 1$)	0.3% ($n = 1$)
		Total mistrust of official institutions		13% (n = 100)	6% (n = 16)	29% (n = 85)

(Continues)

TABLE A4 | (Continued)

The strategy	Criteria	The parameters	% who reported using the strategy ($n = 800$)	% of strategy users who correctly identified misinformation ($n = 273$)	% of strategy users who identified correct information as misinformation ($n = 292$)
Additional sources of authority	Religious authority	I consulted with a religious authority	3.13% ($n = 25$)	5% ($n = 14$)	3% ($n = 8$)
Writing style	Assesses the content by examining the writing style	An evaluation based on the style of writing (spelling errors, emojis) raised my suspicion.	0.13% ($n = 1$)	0.4% ($n = 1$)	0%
No strategies were used	No indication of any evaluation skill or criteria being used		29.13% ($n = 233$)	0%	7% ($n = 21$)

Note: More than one type of strategy could have been used by the same person. Not all participants who reported using a strategy also provided an example of misinformation – either correctly or incorrectly identified.
*Based on Barzilai et al. 2020; Bromme and Goldman 2014; Tseng et al. 2021